Wireless Radiation and EMF Studies
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Setting Guidelines for Electromagnetic Exposures and Research Needs

Barnes F, Greenebaum B. Setting Guidelines for Electromagnetic Exposures and Research Needs. Bioelectromagnetics. 2020 Apr 20. DOI: 10.1002/bem.22267

Abstract

Current limits for exposures to nonionizing electromagnetic fields (EMF) are set, based on relatively short-term exposures. Long-term exposures to weak EMF are not addressed in the current guidelines. Nevertheless, a large and growing amount of evidence indicates that long-term exposure to weak fields can affect biological systems and might have effects on human health. If they do, the public health issues could be important because of the very large fraction of the population worldwide that is exposed. We also discuss research that needs to be done to clarify questions about the effects of weak fields. In addition to the current short-term exposure guidelines, we propose an approach to how weak field exposure guidelines for long-term exposures might be set, in which the responsibility for limiting exposure is divided between the manufacturer, system operator, and individual being exposed.

https://pubmed.ncbi.nlm.nih.gov/32311139/

Excerpts

"Both IEEE and ICNIRP base their analyses on rigorous reviews of the scientific literature and on established firm evidence of health effects in humans. The present guidelines are based on acute exposures; to date both IEEE and ICNIRP have not found sufficient evidence to include health effects of long-terrm exposures at lower levels. However, over the last 20 years the evidence has become extremely strong that weaker EMF over the whole range for frequencies from static through millimeter waves can modify biological processes. There is now solid experimental evidence and supporting theory showing that weak fields, especially but not exclusively at low frequencies, can modify reactive free radical concentrations and that changes in radical concentration and that of other signaling molecules, such as hydrogen peroxide and calcium, can modify biological processes …"

"The evidence that weak radiofrequency (RF) and low-frequency fields can modify human health is still less strong, but the experiments supporting both conclusions are too numerous to be uniformly written off as a group due to poor technique, poor dosimetry, or lack of blinding in some cases, or other good laboratory

practices. Based on recent studies by the National Toxicology Program (NTP) [Smith-Roe et al., 2020] and the Ramazini Foundation [Falcioni et al., 2018] as well as laboratory data, the International Agency for Research on Cancer (IARC) has declared RF fields as possible human carcinogens [IARC, 2013]. A recent paper extends the NTP studies by evaluating genotoxicity in animals exposed to fields at or over the guideline limits and found DNA damage in Comet assays [Smith-Roe et al., 2020]. Many other papers indicate similar results, but many negative results are also in the literature."

"PROPOSED APPROACH TO SETTING EXPOSURE LIMITS

From these and other lines of solid research, the guidelines for exposure could be revised. Increased emphasis on long-term exposures may require refining the concept of dose to more flexibly combine exposure time and field intensity or energy absorbed. Eventual guidelines might suggest limiting cell phone calls to X hours per day with exposure levels above Y W/m2, and for Z days per week exposure should be less than Y W/m2 to allow the body to reset its baseline."

"What is missing in the current guidelines or regulations are guidelines for long-term exposure to weak EMF…."

"Guidelines should be set at three levels: the individual user, local company, and national or international level…. External guidance, in terms of informed recommendations or at least analysis of various intensities and styles of usage from some agency such as the Federal Communications Commission (FCC) or NIH, would be useful.

Limits on the time for operations of base stations and exposures in adjacent living spaces are not controlled by the user and must be set by competent authorities, based on scientific evidence. It is likely to be difficult to specify times when exposures to RF signals are zero or below some limit. What will be needed is being able to say with some certainty that exposure below a given level has not been shown to cause changes in body chemistry above some level. A starting point might be current levels from TV and radio stations that are large enough to give signal-to-noise ratios around 20 dB (100-fold) with typical receiving systems. Currently, mean values for the population's exposure to these systems are estimated to be around 0.1 V/m and peak exposures range up to 2 V/m, which exceed current exposure limits for a small fraction of the population. Therefore, one starting point for exposure limits might be an average of 0.1 V/m, not based on research but on practicality, until further research results dictate either a lower or higher limit."

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Regarding ICNIRP'S Evaluation of the National Toxicology Program's Carcinogenicity Studies on Radiofrequency Electromagnetic Fields

Melnick R. Regarding ICNIRP'S Evaluation of the National Toxicology Program's Carcinogenicity Studies on Radiofrequency Electromagnetic Fields. Health Physics. June 2020; 118(6): 678-682. doi: 10.1097/HP.0000000000001268

No abstract

Conclusion

ICNIRP's misrepresentation of the methodology and interpretation of the NTP studies on cell phone RF radiation does not support their conclusion that "limitations preclude drawing conclusions about carcinogenicity in relation to RF EMFs." In contrast to the ICNIRP evaluation, a 3-d independent peer-review of the NTP studies concluded that there was clear evidence of carcinogenic activity in male rats exposed to RF radiation (NTP 2018c). In addition, the dosimetry issue raised in the ICNIRP note falsely portrays the relevance and utility of the NTP cancer data for assessing human cancer risks. After all, it was the US Food and Drug Administration that requested the NTP studies of cell phone radiation in experimental animals to provide the basis to assess the risk to human health. The NTP studies show that the assumption that RF radiation is incapable of causing cancer or other adverse health effects other than by tissue heating is wrong. If ICNIRP's goal is truly aimed at protecting the public from potential harm, then it would be appropriate for this group to quantify the health risks associated with exposure to RF-EMFs and then develop health-protective guidelines for chronic exposures, especially for children, who are likely to be more susceptible than adults to adverse effects of RF radiation. At the very least, ICNIRP should promote precautionary advice for the general public rather than trying to justify their decision to dismiss findings of adverse health effects caused by RF-EMFs and thereby retain their 20+ y-old exposure guidelines that are based on protection against thermal effects from acute exposures.

https://journals.lww.com/health-physics/Citation/2020/06000/Regarding_ICNIRP_S_Evaluation_of_the_National.11.aspx

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Electromagnetic hypersensitivity (EHS, microwave syndrome) – Review of mechanisms

Stein Y, Udassin IG. Electromagnetic hypersensitivity (EHS, microwave syndrome) – Review of mechanisms. Environmental Research. vol. 186. Available online 30 March 2020, 109445.
https://doi.org/10.1016/j.envres.2020.109445

Abstract

Electromagnetic hypersensitivity (EHS), known in the past as "Microwave syndrome", is a clinical syndrome characterized by the presence of a wide spectrum of non-specific multiple organ symptoms, typically including central nervous system symptoms, that occur following the patient's acute or chronic exposure to electromagnetic fields in the environment or in occupational settings. Numerous studies have shown biological effects at the cellular level of electromagnetic fields (EMF) at magnetic (ELF) and radio-frequency (RF) frequencies in extremely low intensities. Many of the mechanisms described for Multiple Chemical Sensitivity (MCS) apply with modification to EHS. Repeated exposures result in sensitization and consequent enhancement of response. Many hypersensitive patients appear to have impaired detoxification systems that become overloaded by excessive oxidative stress. EMF can induce changes in calcium signaling cascades, significant activation of free radical processes and overproduction of reactive oxygen species (ROS) in living cells as well as altered neurological and cognitive functions and disruption of the blood-brain barrier. Magnetite crystals absorbed from combustion air pollution could have an important role in brain effects of EMF. Autonomic nervous system effects of EMF could also be expressed as symptoms in the cardiovascular system. Other common effects of EMF include effects on skin, microvasculature, immune and hematologic systems. It is concluded that the mechanisms underlying the symptoms of EHS are biologically plausible and that many organic physiologic responses occur following EMF exposure. Patients can have neurologic, neuro-hormonal and neuro-psychiatric symptoms following exposure to EMF as a consequence of neural damage and over-sensitized neural responses. More relevant diagnostic tests for EHS should be developed. Exposure limits should be lowered to safeguard against biologic effects of EMF. Spread of local and global wireless

networks should be decreased, and safer wired networks should be used instead of wireless, to protect susceptible members of the public. Public places should be made accessible for electrohypersensitive individuals.

Many of the mechanisms described for Multiple Chemical Sensitivity (MCS) apply with modification to EHS. Repeated exposures result in sensitization and consequent enhancement of response (Overstreet, 2001; Latremoliere and Woolf, 2009; Molot, 2013; Sage, 2015). Many hypersensitive patients appear to have impaired detoxification systems that become overloaded by excessive oxidative stress (Korkina, 2009; De Luca et al., 2014). Patients can have neurologic, neuro-hormonal and neuro-psychiatric symptoms following exposure to EMF as a consequence of neural damage and over-sensitized neural responses (Dwyer and Leeper, 1978; Pall, 2016). EMF can induce changes in calcium signaling cascades (Liboff, 1984; Blackman et al., 1985; Smith et al., 1987; Pall, 2013, 2015), significant activation of free radical processes and overproduction of reactive oxygen species (ROS) in living cells (Irmak et al., 2002; Zmyslony et al., 2004; Friedman et al., 2007; Blank and Goodman, 2009; De Iuliis et al., 2009; Georgiou, 2010; Avci et al., 2012; Jing et al., 2012; Bilgici et al., 2013; Burlaka et al., 2013) as well as altered neurological and cognitive functions (Frey, 1961; Thomas et al., 1986; Carrubba et al., 2007; Nittby et al., 2009; Xu et al., 2010; Molot, 2013; Yakymenko et al., 2016; Pall, 2016; Kim et al., 2017) and disruption of the blood-brain barrier (Salford et al., 2008; Nittby et al., 2009). Magnetite crystals absorbed from combustion air pollution could have an important role in brain effects of EMF (Maher et al., 2016).

Conclusions

In the modern world, exposure to electromagnetic radiation has become inescapable. There are many people who develop adverse health effects as a result of exposure to EMF. This review of the literature included numerous self-reported neurologic and neuropsychiatric symptoms which have a temporal relationship to EMF exposures. Further studies suggest that EMF exposure may be associated with changes in cerebral blood flow which correspond to abnormalities on PET scan of the brain. Some of the researchers have even localized the brain abnormalities to the temporal lobe, thought to be the closest site of exposure to cell phones. Because of the widespread use of EMF technology, it is difficult to avoid exposure.

https://www.sciencedirect.com/science/article/abs/pii/S0013935120303388?via%3Dihub

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Risks for health associated with use modes and radiation level of cell phones in modern younger schoolchildren

Vyatleva OA, Kurgansky AM. [Article in Russian]. Risks for health associated with use modes and radiation level of cell phones in modern younger schoolchildren. Gigiena i sanitariia 98(11):1267-1271. Nov 2019. DOI: 10.18821/0016-9900-2019-98-11-1267-1271.

Abstract

Introduction. The wide coverage of modern schoolchildren with cell phones (CP), the increased vulnerability of children to radiofrequency radiation, the lack of age standards for safe CP use determined the aim of the study: to identify CP radiation levels and use modes, associated with the health risks in modern schoolchildren.

Material and methods. In a cross-sectional study of 80 modern schoolchildren (8.57 ± 0.75 y.o; 2017-2018

education years) without neurological complications in history by measuring CP power flux density (PFD), questioning and risks calculating, there were determined the radiation levels and daily modes of CT use (calls number - CN, duration of call - CD, and calls total duration - CTD), which are associated with the risks of clinically significant health deviations (dizziness, 4 or more colds per year, and frequent (several times a week) headaches, sleep disturbances, fatigue, anxiety, low mood, poor attention, and memory).

Results. The risk of dizziness increases when children use CP with a maximal PFD ≥100 μW/cm² (OR = 4.44; 95% CI: 1.15-9.27), or if CTD increases from 6.25 to ≥12 minutes (OR= 8.55; 95% CI 1.74-7.11). Increasing CN from 1-2 to 3-5 causes the risk of frequent anxiety (OR 7.86; 95% CI 1.26-31.8). Using the «push-button» CPs in comparison with smartphones is associated with the frequent low mood (OR= 5.42; 95% CI: 1.47-6.10).

Conclusion. The use of «push-button» CP, CP with PFD ≥ 100 μW/cm², CTD ≥ 6.25 minutes, CN > 1-2 cause risks for children's health.

https://www.medlit.ru/journalsview/gigsan/view/journal/en/2019/issue-11/3994-risks-for-health-associated-with-use-modes-and-radiation-level-of-cell-phones-in-modern-younger-schoolchildren/

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Association Between Maternal Exposure to Magnetic Field Nonionizing Radiation During Pregnancy and Risk of Attention-Deficit/Hyperactivity Disorder in Offspring in a Longitudinal Birth Cohort

Li DK, Chen H, Ferber JR, Hirst AK, Odouli R. Association Between Maternal Exposure to Magnetic Field Nonionizing Radiation During Pregnancy and Risk of Attention-Deficit/Hyperactivity Disorder in Offspring in a Longitudinal Birth Cohort. JAMA Netw Open. 2020 Mar 2;3(3):e201417. doi: 10.1001/jamanetworkopen.2020.1417.

Abstract

Importance: An association between maternal exposure to magnetic field (MF) nonionizing radiation during pregnancy and the risk of attention-deficit/hyperactivity disorder (ADHD) has been reported in both animal and human studies.

Objectives: To determine whether maternal exposure to high levels of MF nonionizing radiation is associated with an increased risk of ADHD in offspring by using more accurate measurements of MF nonionizing radiation levels and physician-diagnosed ADHD, rather than self-reports, and to determine whether the association differs for the subtypes of ADHD with or without immune-related comorbidities.

Design, Setting, and Participants: A longitudinal birth cohort study was conducted at Kaiser Permanente Northern California among 1482 mother-child pairs whose mothers were participants of an existing birth cohort and whose level of exposure to MF nonionizing radiation was captured during pregnancy in 2 studies conducted from October 1, 1996, to October 31, 1998, and from May 1, 2006, to February 29, 2012. The offspring were followed up from May 1, 1997, to December 31, 2017.

Exposure: All participating women wore a monitoring meter for 24 hours during pregnancy to capture the level of exposure to MF nonionizing radiation from any sources.

Main Outcomes and Measures: Physician-diagnosed ADHD and immune-related comorbidities of asthma or

atopic dermatitis up to 20 years of age in offspring captured in the Kaiser Permanente Northern California electronic medical record from May 1, 1997, to December 31, 2017. Confounders were ascertained during in-person interviews during pregnancy.

Results: Among the 1454 mother-child pairs (548 white [37.7%], 110 African American [7.6%], 325 Hispanic [22.4%], 376 Asian or Pacific Islander [25.9%], and 95 other or unknown [6.5%]; mean [SD] maternal age, 31.4 [5.4] years]), 61 children (4.2%) had physician-diagnosed ADHD. Using Cox proportional hazards regression to account for follow-up time and confounders, compared with children whose mothers had a low level of exposure to MF nonionizing radiation during pregnancy, children whose mothers were exposed to higher levels of MF nonionizing radiation had more than twice the risk of ADHD (adjusted hazard ratio [aHR], 2.01; 95% CI, 1.06-3.81). The association was stronger for ADHD that persisted into adolescence (≥12 years of age), with an aHR of 3.38 (95% CI, 1.43-8.02). When the subtypes of ADHD were examined, the association existed primarily for ADHD with immune-related comorbidities (asthma or atopic dermatitis), with an aHR of 4.57 (95% CI, 1.61-12.99) for all ADHD cases and an aHR of 8.27 (95% CI, 1.96-34.79) for persistent cases of ADHD.

Conclusions and Relevance: Consistent with the emerging literature, this study suggests that in utero exposure to high levels of MF nonionizing radiation was associated with an increased risk of ADHD, especially ADHD with immune-related comorbidity. The findings should spur more research to examine the biological association of in utero MF exposure with risk of ADHD in offspring, given that almost everyone is exposed to it.

Excerpts

Approximately 11% of all children aged 4 to 17 years (>6.4 million children) in the United States receive a diagnosis of, or treatment for, attention-deficit/hyperactivity disorder (ADHD). Attention-deficit/hyperactivity disorder has been associated with poor school performance during childhood and with lifelong disabilities....

One nonchemical factor that has not been examined is the ever-present nonionizing radiation, also known as magnetic fields (MFs), emitted from electric appliances, power lines, and wireless devices and networks including cell phone towers....

Once a pregnant woman had given consent to participate in the study, she was asked to wear an EMDEX meter (Enertech Inc) to capture the level of MF nonionizing radiation exposure. During the 24-hour monitoring period, which occurred during the first or second trimester, the meters (EMDEX II and EMDEX Lite) captured levels of 40 to 800 Hz of MF nonionizing radiation encountered by the participating woman throughout her daily life. The MF nonionizing radiation level was measured in milligauss....

To examine the association of high levels of MF nonionizing radiation with risk of ADHD, we used the 90th percentile of the 24-hour measurements as the MF index, which reflects the MF nonionizing radiation level at or above which a participant was exposed to for 10% of the time during the day. Given that everyone is exposed to MF nonionizing radiation at some levels, to classify participating women into low or high MF nonionizing radiation exposure groups, based on the experience of previous studies,9,10,19 we used a cutoff based on the 25th percentile of the MF index's distribution, which corresponded to 1.3 mG. The participants whose MF nonionizing radiation level was lower than 1.3 mG were classified as having a low level of MF nonionizing radiation exposure during pregnancy, while the participants whose MF nonionizing radiation level was 1.3 mG or higher were classified as having a relatively higher daily level of MF nonionizing radiation exposure.

Conclusions Using a longitudinal birth cohort study design, we examined the association between maternal exposure to MF nonionizing radiation during pregnancy and risk of ADHD in offspring throughout childhood up to age 20 years. The study improved over previous studies by enhancing the accuracy of measuring MF nonionizing radiation exposure and of ADHD diagnosis. The findings provide new evidence that in utero exposure to a high level of MF nonionizing radiation is associated with an increased risk of ADHD in offspring. The association is primarily between MF nonionizing radiation exposure and ADHD with immune-related comorbidities and persistent cases of ADHD. The findings reveal a possible new risk factor that is ubiquitous in our modern day lives and should spur more research to examine this potential association.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7093768/

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Long-term effect of mobile phone use on sleep quality: Results from the cohort study of mobile phone use and health (COSMOS)

Tettamanti G, Auvinen A, Åkerstedt T, Kojo K, Ahlbom A, Heinävaara S, Elliott P, Schüz J, Deltour I, Kromhout H, Toledano MB, Poulsen AH, Johansen C, Vermeulen R, Feychting M, Hillert H, COSMOS Study Group. Long-term effect of mobile phone use on sleep quality: Results from the cohort study of mobile phone use and health (COSMOS). Environment International. https://doi.org/10.1016/j.envint.2020.105687.

Highlights

• Above median mobile phone call-time was associated with less sleep disturbance.
• Above 90th percentile mobile phone call time was associated with insomnia.
• Adjustment for network suggests association with insomnia was not due to RF-EMF

• Other potential explanations may be related to behavior and psychological factors.

Abstract

Background Effects of radiofrequency electromagnetic field exposure (RF-EMF) from mobile phone use on sleep quality has mainly been investigated in cross-sectional studies. The few previous prospective cohort studies found no or inconsistent associations, but had limited statistical power and short follow-up. In this large prospective cohort study, our aim was to estimate the effect of RF-EMF from mobile phone use on different sleep outcomes.

Materials and methods The study included Swedish (n = 21,049) and Finnish (n = 3120) participants enrolled in the Cohort Study of Mobile Phone Use and Health (COSMOS) with information about operator-recorded mobile phone use at baseline and sleep outcomes both at baseline and at the 4-year follow-up. Sleep disturbance, sleep adequacy, daytime somnolence, sleep latency, and insomnia were assessed using the Medical Outcome Study (MOS) sleep questionnaire.

Results Operator-recorded mobile phone use at baseline was not associated with most of the sleep outcomes. For insomnia, an odds ratio (OR) of 1.24, 95% CI 1.03–1.51 was observed in the highest decile of mobile phone call-time (>258 min/week). With weights assigned to call-time to account for the lower RF-EMF exposure from Universal Mobile Telecommunications Service (UMTS, 3G) than from Global System for Mobile Communications (GSM, 2G) the OR was 1.09 (95% CI 0.89–1.33) in the highest call-time decile.

Conclusion Insomnia was slightly more common among mobile phone users in the highest call-time category, but adjustment for the considerably lower RF-EMF exposure from the UMTS than the GSM network suggests that this association is likely due to other factors associated with mobile phone use than RF-EMF. No association was observed for other sleep outcomes. In conclusion, findings from this study do not support the hypothesis that RF-EMF from mobile phone use has long-term effects on sleep quality.

Open access paper: https://www.sciencedirect.com/science/article/pii/S0160412019339194

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Exposure to cell phones reduces heart rate variability in both normal-weight and obese normotensive medical students

Alassiri M, Alanazi A, Aldera H, Alqahtani SA, Alraddadi AS, Alberreet MS, Alhussaini AI, Alotaibi Y, Alkhateeb MA, Shatoor AS. Exposure to cell phones reduces heart rate variability in both normal-weight and obese normotensive medical students. Explore (NY). 2020 Mar 2. pii: S1550-8307(20)30087-2. doi: 10.1016/j.explore.2020.02.006.

Abstract

BACKGROUND: We investigated and compared the effect of the radiofrequency electromagnetic field (RF-EM) emitted by a cell phone on the electrocardiogram and heart rate variability (HRV) of normotensive normal-weight and obese medical students.

METHOD: Twenty medical student volunteers, normal weight (age = 23 ± 2, BMI = 23.05 ± 1.72) or obese (age = 24 ± 2, BMI = 32.39 ± 4.78), were exposed to a cell phone (1) close to the heart in silent mode, no ringing or vibrating; (2) close to the heart in ring and vibration mode; (3) next to the ear (brain) while listening; and (4) next to the ear while listening and speaking.

RESULTS: The average basal HR of obese students significantly increased, while the PR interval; time domains, including standard deviation (SD) of all normal R-R intervals (SDNN), mean of the SD of all normal R-R intervals (SDNNi), SD of the average of normal R-R intervals (SDANN), and percentage of R-R intervals at least 50 ms different from the previous interval (pNN50); and high-power frequency (HF) decreased. The LF/HF ratio also significantly increased. The SDNN, SDNNi, SDANN, pNN50, and HF levels significantly decreased and the LF/HF significantly increased in normal-weight and obese individuals only when the phone was near the apex of the heart in ring and vibration mode. All changes were more profound in obese students.

CONCLUSION: Keeping the phone in a chest pocket reduced the HRV of normal-weight and obese medical students and exaggerated the effect of obesity on sympathetic activation.

https://www.ncbi.nlm.nih.gov/pubmed/32249199

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The different sources of electromagnetic fields: Dangers are not limited to physical health

Deruelle F. The different sources of electromagnetic fields: Dangers are not limited to physical health. Electromagn Biol Med. 2020 Mar 10:1-10. doi: 10.1080/15368378.2020.1737811.

Abstract

The impact of electromagnetic waves on health has been clearly established by many studies in recent decades. No State, with the exception of Russia, takes any real precautions in terms of standards for the population. Conflicts of interest and political lies are used to hide the truth about the dangers of electromagnetic pollution.In addition, it would seem that other sources of radiation than the most well-known ones (mobile phones, digital enhanced cordless telecommunication (DECT) phones, bluetooth, base stations, Wi-Fi, 4G, 5G) come into play. A system such as HAARP (High-frequency Active Auroral Research Program), as well as directed wave beams (related to past and recent scandals) must be analyzed and considered in a comprehensive way to understand why the wave level is only increasing despite the considerable amount of scientific work demonstrating that the standards are not adequate to maintain public health.Thus, official documents show that the impact of electromagnetic waves is not only physical and biological. Indeed, the climate and the behavior of the population are also targeted.

https://www-ncbi-nlm-nih-gov.libproxy.berkeley.edu/pubmed/32151189

Conclusion

Majority of the expert research society has recognized non-thermal EMF effects for long time ago, but the minor group of scientists, which are exclusively appointed by the governmental authorities including European Commission for judgment of EMF health effects, is still of opinion that EMF may be of hazard only at high intensities. Of key importance is to stress that EMF effects depend on a number of physical (carrier frequency, modulation, polarization, stray magnetic fields …) and biological (sex, age, cell type and density, genotype …) variables (Belyaev 2010). This dependence can easily account for apparent inconsistency of published results, which in dependence on end-point show effects of low-intensity EMF in 50 – 90% of studies, while lack of EMF effects was observed in other 5 – 10% of studies, which all applied different variables (Huss et al. 2007; IARC 2013; Yakymenko et al. 2016).

There is therefore a clear reason why many States do not take into account the scientific evidence demonstrating the harmfulness of EMFs. Conflicts of interest? Yes, it's obvious. Some authors have already proven this (Carpenter 2013; Hardell 2017; Huss et al. 2007; Maisch 2006; Starkey 2016). While the Precautionary Principle should have been applied for a long time, not only it is not, but worse, the level of electromagnetic radiations is constantly increasing, principally because of RF, aggravating the health situation more and more.

Nevertheless, according to the documents obtained, it would seem that the financial aspect is not the main objective of this technological expansion.

Overall conclusion

It is very clear that States and World Health Organization, through the analytical agencies working for them, are not at all telling the truth about the health effects of electromagnetic fields and the real objectives of such a deployment of connected and wave-generating equipment all over the world.

In most countries, EMFs exposure standards are highly hazardous to health. In addition, the combination of wave-generating technologies and devices, as well as pro-wave legal laws, add up quickly and without prior health checks (example of 5G).

Faced with this, thousands of publications, hundreds of scientists and specialists, show that human health and the environment are in danger because of EMFs. While the precautionary principle should have been established a long time ago, the opposite is being put in place. The sole explanation of conflicts of interest, which have been demonstrated for a long time, does not appear to be sufficient.

Indeed, we can see that in the background (mainly military) have been conducted for years (just after the Second World War) a considerable amount of experimentation on a very large scale, particularly oriented on mind control as well as more recently on climate change. Many States, but also the United Nations, are aware of the reality of the problem related to the electromagnetic waves and have no decision-making power that is beneficial to health. It would seem that the deleterious impact of EMFs on biology is a side effect (useful for lobbies) of the real goal pursued, which would rather be oriented towards an attempt to control behaviour and climate.

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Effects of mobile phones electromagnetic radiation on patients with epilepsy: an EEG study

Azmy R, Reham S, Abdalla Farag NA, Elkholy S, Maher E. Effects of mobile phones electromagnetic radiation on patients with epilepsy: an EEG study. Egyptian Journal of Neurology Psychiatry and Neurosurgery. 56(1):36. Mar 16, 2020.

Background Recently, an exceptional increase was witnessed in cell phone users. The brain has greater exposure to the electromagnetic field (EMF) created during mobile phone use than the rest of the body, which may impair its function. In persons with epilepsy, the brain has more tendencies towards electrical instability.

Objectives The current study aims at investigating the effect of mobile phone radiation (MPR) on the electroencephalogram (EEG) of persons with epilepsy as well as healthy adults.

Subjects and methods Thirty patients with idiopathic epilepsy and 30 matching controls underwent EEG recording including 15 min of sham exposure followed by 30 min of real exposure to MPR and a final post-exposure recording for extra 15 min. The number of abnormal EEG events was counted during sham and real exposure for each subject. Correlation analysis was done between the number of epileptic events detected during the real exposure to MPR and the patients' clinical data

Results In the control group, the EEG under real MPR exposure showed no abnormal discharges. In persons with epilepsy, all those with abnormal EEG during sham exposure MPR (33%) showed an increase in the number of events with real exposure to MPR. One patient showed a change in the pattern of discharge from interictal changes to an ictal rhythm. Another patient with normal EEG during sham record developed temporal epileptiform discharges during real exposure.

Conclusion Mobile phone radiation shows recognizable effects on the brain rhythm of persons with epilepsy. These results should be confirmed by future studies to establish a recommendation addressing the use of such devices in epileptic patients.

Open access paper: https://ejnpn.springeropen.com/track/pdf/10.1186/s41983-020-00167-2

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Georeferencing of Personal Exposure to Radiofrequency Electromagnetic Fields from Wi-Fi in a University Area

Ramirez-Vazquez R, Arabasi S, Al-Taani H, Sbeih S, Gonzalez-Rubio J, Escobar I, Arribas E. Georeferencing of Personal Exposure to Radiofrequency Electromagnetic Fields from Wi-Fi in a University Area. Int J Environ Res Public Health. 2020 Mar 14;17(6). pii: E1898. doi: 10.3390/ijerph17061898.

Abstract

In the last two decades, due to the development of the information society, the massive increase in the use of information technologies, including the connection and communication of multiple electronic devices, highlighting Wi-Fi networks, as well as the emerging technological advances of 4G and 5G (new-generation mobile phones that will use 5G), have caused a significant increase in the personal exposure to Radiofrequency Electromagnetic Fields (RF-EMF), and as a consequence, increasing discussions about the possible adverse health effects. The main objective of this study was to measure the personal exposure to radiofrequency electromagnetic fields from the Wi-Fi in the university area of German Jordanian University (GJU) and prepare georeferenced maps of the registered intensity levels and to compare them with the basic international restrictions. Spot measurements were made outside the university area at German Jordanian University. Measurements were made in the whole university area and around two buildings. Two Satimo EME SPY 140 (Brest, France) personal exposimeters were used, and the measurements were performed in the morning and afternoon, and on weekends and weekdays. The total average personal exposure to RF-EMF from the Wi-Fi band registered in the three study areas and in the four days measured was 28.82 μW/m2. The average total exposure from the Wi-Fi band registered in the ten measured points of the university area of GJU was 22.97 μW/m2, the one registered in the eight measured points of building H was 34.48 μW/m2, and the one registered in the eight points of building C was 29.00 μW/m2. The maximum average values registered in the campus of GJU are below the guidelines allowed by International Commission on Non-ionizing Radiation Protection (ICNIRP). The measurement protocol used in this work has been applied in measurements already carried out in Spain and Mexico, and it is applicable in university areas of other countries.

Open access paper: https://www.mdpi.com/1660-4601/17/6/1898

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Environmental and Occupational Risk Factors of Amyotrophic Lateral Sclerosis: A Population-Based Case-Control Study

Filippini T, Tesauro M, Fiore M , Malagoli C, Consonni M, et al. Environmental and Occupational Risk Factors of Amyotrophic Lateral Sclerosis: A Population-Based Case-Control Study. Int J Environ Res Public Health. 2020 Apr 22;17(8):E2882; doi: 10.3390/ijerph17082882.

Abstract

Objectives: Amyotrophic lateral sclerosis (ALS) is a progressive and fatal neurodegenerative disease with still unknown etiology. We aimed at investigating the association between environmental and occupational factors with ALS risk.

Methods: We performed a population-based case-control study in four Italian provinces (Catania, Modena, Novara, and Reggio Emilia) by administration of tailored questionnaires to ALS cases (n = 95) and randomly selected population referents (n = 135). We estimated ALS risk by calculating the odds ratio (OR) with its 95% confidence interval (CI) using an unconditional logistic regression model.

Results: We found a positive association with disease risk for history of occupation in the agricultural sector (OR = 2.09, 95% CI 0.79-7.54), especially for longer than 10 years (OR = 2.72, 95% 1.02-7.20). Overall occupational exposure to solvents also suggested a positive association, especially for thinners (OR = 2.27, 95% CI 1.14-4.54) and paint removers (OR = 2.01, 95% CI 0.90-4.48). Both occupational and environmental exposure to electromagnetic fields show a slightly increased risk with OR = 1.69 (95% CI 0.70-4.09) and 2.41 (95% CI 1.13-5.12), respectively. Occupational but not environmental exposure to pesticides (OR = 1.22, 95% CI 0.63-2.37), particularly fungicides, and exposure to metals (OR = 4.20, 95% CI 1.88-9.38), particularly lead, mercury, and selenium, showed an imprecise but positive association. Finally, there was an indication of increased risk for living in proximity to water bodies.

Conclusions: Despite the caution that needs to be used due to some study limitations, such as the low number of exposed subjects and the possibility of recall bias, these results suggest the potential role of some environmental and occupational factors in ALS etiology.

Open access paper: https://www.mdpi.com/1660-4601/17/8/2882

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The influence of electromagnetic radiation of cell phones on the behavior of animals

Sultangaliyeva I, Beisenova R, Tazitdinova R, Abzhalelov A, Khanturin M. The influence of electromagnetic radiation of cell phones on the behavior of animals. Veterinary World, 13(3):549-555. March 2020. DOI: 10.14202/vetworld.2020.549-555.

Abstract

Background and Aim: The radiation emitted from cell phones has various deleterious effects on human health. The article considers the problem of the effects of electromagnetic radiation (EMR) of cell phones on the behavior of animals. The use of mobile phones is continually increasing throughout the world. All of the world population uses mobile phones widely; thus, having strong and daily effect on the brain. There is no restriction on the use of mobile phones. Getting more advantages and convenience of mobile communication, the population is trying not to hear the information about possible risks to their health, there is no element of self-restraint. The aim of this work was to study behavioral patterns in response to the influence of cell phones.

Materials and Methods: The experiments were carried out on 90 white outbred rats weighing 250-300 g. Experiments were carried out and the effect of EMR from Samsung Galaxy J1 mini and Xiaomi Redmi S2 phones on animal behavior was studied. Behavioral reactions were studied using the open field method.

Results: By the quality of the act of locomotion in the second experimental group is reduced by 30% and also in this group by the time of the act is 23% lower than in the control data. Vertical motor activity, a support stand, is also suppressed in the second experimental group: 61% lower in number and 47.2% lower in act time compared to the control group. Based on the data, we can conclude that the EMR of the phone Samsung Galaxy J1 Mini affects the behavior of animals to a greater extent than Xiaomi Redmi S2. By the frequency of the act, sniffing is 26% lower; by the time of the act, it remained at the level of control data in the second group. In the third group of the animals, the number and time of the act are 15% lower than the control data. The support stands as an indicator of research activity. In the second group the act of stand with support - by number was lower by 57% than the control data, this indicates that research activity is being suppressed.

Conclusion: According to the above changes under the action of EMR from the Samsung Galaxy J1 Mini and Xiaomi Redmi S2 phones, the motor component of behavior is suppressed. The research component of behavior in all groups of animals is enhanced due to high rates of sniffing. It is possible that in animals under

stress, the motivation to interact with the environment decreases, leading to an excessive self-accentuation of the animal.

Open access paper: http://www.veterinaryworld.org/Vol.13/March-2020/23.pdf

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Physical assessments of termites (Termitidae) under 2.45 GHz microwave irradiation

Yanagawa A, Kajiwara A, Nakajima H, Desmond-Le Quéméner E, Steyer JP, Lewis V, Mitani T. Physical assessments of termites (Termitidae) under 2.45 GHz microwave irradiation. Sci Rep. 2020 Mar 23;10(1):5197. doi: 10.1038/s41598-020-61902-6.

Abstract

Demands for chemical-free treatments for controlling insect pests are increasing worldwide. One such treatment is microwave heating; however, two critical issues arise when using microwaves as a heat source: intensive labor and excessive energy-consumption. Optimization is thus required to reduce energy consumption while effectively killing insects. Currently, the lethal effect of microwaves on insects is considered to be due to the temperature of the irradiated materials. This study examines how the conditions of irradiation, such as resonance or traveling mode, changed the conversion of electromagnetic energy into heat when 2.45 GHz microwaves penetrated the body of the termite, C. formosanus. Our results indicated that it is possible to heat and kill termites with microwaves under resonance condition. Termites were however found to be very tolerant to microwave irradiation as the permittivity of the insect was low compared with other reported insects and plants. Electron spin resonance revealed that termites contained several paramagnetic substances in their bodies, such as Fe3+, Cu2+, Mn2+, and organic radicals. Interestingly, irradiation with traveling microwaves hardly produced heat, but increased the organic radicals in termite bodies indicating non-thermal effects of microwaves.

https://www.ncbi.nlm.nih.gov/pubmed/32251346

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Clinical presentation of young people (10-24 years old) with brain tumors: results from the international MOBI-Kids study

Zumel-Marne A, Kundi M, Castaño-Vinyals G, Alguacil J, Petridou ET, et al. Clinical presentation of young people (10-24 years old) with brain tumors: results from the international MOBI-Kids study. J Neurooncol. 2020 Mar 3. doi: 10.1007/s11060-020-03437-4.

Abstract

INTRODUCTION: We used data from MOBI-Kids, a 14-country international collaborative case-control study of brain tumors (BTs), to study clinical characteristics of the tumors in older children (10 years or older), adolescents and young adults (up to the age of 24).

METHODS: Information from clinical records was obtained for 899 BT cases, including signs and symptoms, symptom onset, diagnosis date, tumor type and location.

RESULTS: Overall, 64% of all tumors were low-grade, 76% were neuroepithelial tumors and 62% gliomas. There were more males than females among neuroepithelial and embryonal tumor cases, but more females with meningeal tumors. The most frequent locations were cerebellum (22%) and frontal (16%) lobe. The most frequent symptom was headaches (60%), overall, as well as for gliomas, embryonal and 'non-neuroepithelial' tumors; it was convulsions/seizures for neuroepithelial tumors other than glioma, and visual signs and symptoms for meningiomas. A cluster analysis showed that headaches and nausea/vomiting was the only combination of symptoms that exceeded a cutoff of 50%, with a joint occurrence of 67%. Overall, the median time from first symptom to diagnosis was 1.42 months (IQR 0.53-4.80); it exceeded 1 year in 12% of cases, though no particular symptom was associated with exceptionally long or short delays.

CONCLUSIONS: This is the largest clinical epidemiology study of BT in young people conducted so far. Many signs and symptoms were identified, dominated by headaches and nausea/vomiting. Diagnosis was generally rapid but in 12% diagnostic delay exceeded 1 year with none of the symptoms been associated with a distinctly long time until diagnosis.

https://www.ncbi.nlm.nih.gov/pubmed/32124185

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Impacts of electromagnetic radiation from cellphones and Wi-Fi on spermatogenesis [Article in Chinese]

Zha XD, Wang WW, Xu S, Shang XJ. Impacts of electromagnetic radiation from cellphones and Wi-Fi on spermatogenesis [Review Article in Chinese] .Zhonghua Nan Ke Xue. 2019 May;25(5):451-455.

Abstract

With the development of Wi-Fi technology and widespread exposure to electromagnetic radiation (EMR), people are increasingly concerned about the health hazards caused by radiofrequency electromagnetic fields as from cellphones and Wi-Fi, particularly about the current decline in sperm concentration and increase in male infertility. Long-term exposure to EMR not only damages male reproductive organs, but also affects the number, morphology, motility and oocyte-binding ability of sperm, and indirectly increases the risk of infertility. However, EMR is not unavoidable. Low-intensity short-term or intermittent exposure to EMR has little adverse effect on reproductive organs and sperm. And many antioxidant and anti-free radical agents, such as vitamin E and melatonin, can protect some special populations from EMR. This review presents an overview of the impacts of EMR from cellphones and Wi-Fi on sperm, some countermeasures, and prospects of EMR protection.

https://www.ncbi.nlm.nih.gov/pubmed/32216233

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A review on combined biological effects of microwave and other physical or chemical agents

Tan S, Tan H, Wang R, Peng R. A review on combined biological effects of microwave and other physical or chemical agents, Int. J. Radiat. Res. 2018; 16 (2): 139-153.

Abstract

With the development of science and technology, microwave has been used in many fields such as industry, military, medicine and communication. People are living in a lapped and dynamic electromagnetic environment. Concerns about potential hazards of microwave are getting increasing attention. The single biological effects of microwave were widely discussed which was considered harmful. Relevant safety standards had been formulated and applied. However, the real environment was more complex. Microwave was not the only factor that organisms might be affected. Other physical or chemical factors, such as ionizing radiation [IR] , ultraviolet [UV] , magnetic field and chemical drugs, often existed with the microwave radiation. Even the microwave itself could create combined exposure situation, because the environment consisted different frequency microwaves. Nuclear weapons and high-power radar could produce microwave and ionizing radiation. The ultraviolet ray and magnetic field generated by the instrument's operation could act on the human bodies along with the microwaves. The combination of radiofrequency therapy and chemotherapeutic agents was also commonly used in cancer therapy. Therefore, the combined biological effects of microwaves and other physical or chemical factors were very important. This review had covered the original articles in this aspect. In order to better understand the combined biological effects the comparative studies of different frequency microwaves were also included. Differences in biological effects were found among different frequency microwaves, and the combined biological effects contained both hazards and benefits. Findings in combined biological effects were very practical for rational uses of microwave technologies.

Excerpt

In summary, the studies of combined biological effects of microwave and multiple factors were focused on several aspects, such as multiple frequencies microwave, microwave and IR, microwave and magnetic ield, microwave and UV, microwave and drugs. By now, most studies had con irmed the existence of combined biological effects, but failed to draw firm and unanimous conclusions. There were still many unsolved problems: 1. The experimental conditions in different papers were different, which made the results to be incomparable; 2. The research remained in exploration of existence of combined effects, there were blanks in dose-effect relationship research as well as mechanism research; 3. Many signaling pathways and molecules had been confirmed to participate in the injury process, but no sensitive biological indicators were found; 4. The diagnosis and protective measures for combined effects was incomplete.

In short, lots of beneficial explorations had been performed for combined biological effects of MW and multi-factors, but lots of effort still should be made in this field.

Open access paper: http://ijrr.com/article-1-2244-en.pdf

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Effects of a Single Head Exposure to GSM-1800 MHz Signals on the Transcriptome Profile in the Rat Cerebral Cortex: Enhanced Gene Responses Under Proinflammatory Conditions

Lameth J, Arnaud-Cormos D, Lévêque P, Boillée S, Edeline JM, Mallat M. Effects of a Single Head Exposure to GSM-1800 MHz Signals on the Transcriptome Profile in the Rat Cerebral Cortex: Enhanced Gene Responses Under Proinflammatory Conditions.
Neurotox Res. 2020 Mar 21. doi: 10.1007/s12640-020-00191-3.

Abstract

Mobile communications are propagated by electromagnetic fields (EMFs), and since the 1990s, they operate with pulse-modulated signals such as the GSM-1800 MHz. The biological effects of GSM-EMF in humans affected by neuropathological processes remain seldom investigated. In this study, a 2-h head-only exposure to GSM-1800 MHz was applied to (i) rats undergoing an acute neuroinflammation triggered by a lipopolysaccharide (LPS) treatment, (ii) age-matched healthy rats, or (iii) transgenic hSOD1G93A rats that modeled a presymptomatic phase of human amyotrophic lateral sclerosis (ALS). Gene responses were assessed 24 h after the GSM head-only exposure in a motor area of the cerebral cortex (mCx) where the mean specific absorption rate (SAR) was estimated to be 3.22 W/kg. In LPS-treated rats, a genome-wide mRNA profiling was performed by RNA-seq analysis and revealed significant (adjusted p value < 0.05) but moderate (fold changes < 2) upregulations or downregulations affecting 2.7% of the expressed genes, including genes expressed predominantly in neuronal or in glial cell types and groups of genes involved in protein ubiquitination or dephosphorylation. Reverse transcription-quantitative PCR analyses confirmed gene modulations uncovered by RNA-seq data and showed that in a set of 15 PCR-assessed genes, significant gene responses to GSM-1800 MHz depended upon the acute neuroinflammatory state triggered in LPS-treated rats, because they were not observed in healthy or in hSOD1G93A rats. Together, our data specify the extent of cortical gene modulations triggered by GSM-EMF in the course of an acute neuroinflammation and indicate that GSM-induced gene responses can differ according to pathologies affecting the CNS.

https://www.ncbi.nlm.nih.gov/pubmed/32200527

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Effect of mobile phone radiation on oxidative stress, inflammatory response, and contextual fear memory in Wistar rat

Singh KV, Gautam R, Meena R, Nirala JP, Jha SK, Rajamani P. Effect of mobile phone radiation on oxidative stress, inflammatory response, and contextual fear memory in Wistar rat. Environ Sci Pollut Res Int. 2020 Mar 24. doi: 10.1007/s11356-020-07916-z.

Abstract

In the present lifestyle, we are continuously exposed to radiofrequency electromagnetic field (RF-EMF) radiation generated mainly by mobile phones (MP). Among other organs, our brain and hippocampus in specific, is the region where effect of any environmental perturbation is most pronounced. So, this study was aimed to examine changes in major parameters (oxidative stress, level of pro-inflammatory cytokines (PICs), hypothalamic-pituitary-adrenal (HPA) axis hormones, and contextual fear conditioning) which are linked to hippocampus directly or indirectly, upon exposure to mobile phone radiofrequency electromagnetic field (MP-RF-EMF) radiation. Exposure was performed on young adult male Wistar rats for 16 weeks continuously (2 h/day) with MP-RF-EMF radiation having frequency, power density, and specific absorption rate (SAR) of 1966.1 MHz, 4.0 mW/cm2, and 0.36 W/kg, respectively. Another set of animals kept in similar conditions without any radiation exposure serves as control. Towards the end of exposure period, animals were tested for fear memory and then euthanized to measure hippocampal oxidative stress, level of circulatory PICs, and stress hormones. We observed significant increase in hippocampal oxidative stress ($p < 0.05$) and elevated level of circulatory PICs viz. IL-1beta ($p < 0.01$), IL-6 ($p < 0.05$), and TNF-alpha ($p < 0.001$) in experimental animals upon exposure to MP-RF-EMF radiation. Adrenal gland weight ($p < 0.001$) and level of stress hormones viz. adrenocorticotropic hormone (ACTH) ($p < 0.01$) and corticosterone (CORT) ($p < 0.05$) were also found to increase significantly in MP-RF-EMF radiation-exposed animals as compared with control. However,

alteration in contextual fear memory was not significant enough. In conclusion, current study shows that chronic exposure to MP-RF-EMF radiation emitted from mobile phones may induce oxidative stress, inflammatory response, and HPA axis deregulation. However, changes in hippocampal functionality depend on the complex interplay of several opposing factors that got affected upon MP-RF-EMF exposure.

https://www.ncbi.nlm.nih.gov/pubmed/32212071

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Effect of electromagnetic radiation on redox status, acetylcholine esterase activity and cellular damage contributing to the diminution of the brain working memory in rats

Sharma S, Shukla S. Effect of electromagnetic radiation on redox status, acetylcholine esterase activity and cellular damage contributing to the diminution of the brain working memory in rats. J Chem Neuroanat. 2020 Mar 20:101784. doi: 10.1016/j.jchemneu.2020.101784.

Abstract

Behavioral impairments are the most pragmatic outcome of long-term mobile uses but the underlying causes are still poorly understood. Therefore, the Aim of the present study to determine the possible mechanism of mobile induced behavioral alterations by observing redox status, cholinesterase activity, cellular, genotoxic damage and cognitive alterations in rat hippocampus. This study was carried out on 24 male Wistar rats, randomly divided into four groups (n = 6 in each group): group I consisted of sham-exposed (control) rats, group II-IV consisted of rats exposed to microwave radiation (900 MHz) at different time duration 1 h, 2 h, and 4 h respectively for 90 days. After 90 days of exposure, rats were assessing learning ability by using T-Maze. A significantly increased level of malondialdehyde (MDA) with concomitantly depleted levels of superoxide dismutase (SOD), catalase (CAT) and redox enzymes (GSH, GPX, GR, GST, G-6PDH) indicated an exposure of mobile emitted EMR induced oxidative stress by the depleted redox status of brain cells. The depletion in the acetylcholinesterase (AChE) level reveals altered neurotransmission in brain cells. Resultant cellular degeneration was also observed in the radiation-exposed hippocampus. Conclusively, the present study revealed that microwave radiation induces oxidative stress, depleted redox status, and causes DNA damage with the subsequent reduction in working memory in a time-dependent manner. This study provides insight over the associative reciprocity between redox status, cellular degeneration and reduced cholinergic activity, which presumably leads to the behavioral alterations following mobile emitted electromagnetic radiation.

https://www.ncbi.nlm.nih.gov/pubmed/32205214

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Assessment of electromagnetic fields, vibration and sound exposure effects from multiple transceiver mobile phones on oxidative stress levels in serum, brain and heart tissue

Usman JD, Isyaku UM, Rabiu AM, Fasanmade AA. Assessment of electromagnetic fields, vibration and sound exposure effects from multiple transceiver mobile phones on oxidative stress levels in serum, brain and heart tissue. Scientific African. Vol 7. March 2020. https://doi.org/10.1016/j.sciaf.2020.e00271.

Abstract

The present study evaluates oxidative stress markers in serum, brain and heart of albino Wistar rats after

exposure to multiple transceiver mobile phone electromagnetic radiation, vibration and sound. Forty five (45) male albino Wistar rats weighing 140–180 g were randomly selected into nine groups (n = 5) viz; A serving as the control without mobile phone; groups B1, B2…E1, E2 were continuously exposed to electromagnetic field from double (1) and triple (2) transceiver mobile phone kept in various modalities with at least 10 min call per day within 9:00–21:00 h. Groups B1 and B2 were in silence mode, C1 and C2 in vibration, D1 and D2 in ring tone (sound), while E1 and E2 were in sound and vibration mode. After six weeks of exposure, the animals were sacrificed; serum, brain and heart were taken for oxidative stress assessment. Results showed that electromagnetic field radiation, vibration and sound from double and triple transceiver mobile phone cause decrease in the levels of glutathione peroxidase, superoxide dismutase, and malondialdehyde in the serum, heart and the brain. Catalase was observed to decrease only in the brain. Nitric oxide activities increased in the brain and heart of the treatment groups exposed to both phone types. Exposure to double or triple transceiver mobile phone radiation, vibration and sound causes oxidative stress to serum, brain and the heart.

Open access paper: https://www.sciencedirect.com/science/article/pii/S2468227620300090

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Assessment of Genotoxicity in Human Cells Exposed to Modulated Electromagnetic Fields of Wireless Communication Devices

Schuermann D, Ziemann C, Barekati Z, Capstick M, Oertel A, Focke F, Murbach M, Kuster N, Dasenbrock C, Schär P. Assessment of Genotoxicity in Human Cells Exposed to Modulated Electromagnetic Fields of Wireless Communication Devices. Genes (Basel). 2020 Mar 25;11(4). pii: E347. doi: 10.3390/genes11040347.

Abstract

Modulated electromagnetic fields (wEMFs), as generated by modern communication technologies, have raised concerns about adverse health effects. The International Agency for Research on Cancer (IARC) classifies them as "possibly carcinogenic to humans" (Group 2B), yet, the underlying molecular mechanisms initiating and promoting tumorigenesis remain elusive. Here, we comprehensively assess the impact of technologically relevant wEMF modulations on the genome integrity of cultured human cells, investigating cell type-specificities as well as time- and dose-dependencies. Classical and advanced methodologies of genetic toxicology and DNA repair were applied, and key experiments were performed in two separate laboratories. Overall, we found no conclusive evidence for an induction of DNA damage nor for alterations of the DNA repair capacity in cells exposed to several wEMF modulations (i.e., GSM, UMTS, WiFi, and RFID). Previously reported observations of increased DNA damage after exposure of cells to GSM-modulated signals could not be reproduced. Experimental variables, presumably underlying the discrepant observations, were investigated and are discussed. On the basis of our data, we conclude that the possible carcinogenicity of wEMF modulations cannot be explained by an effect on genome integrity through direct DNA damage. However, we cannot exclude non-genotoxic, indirect, or secondary effects of wEMF exposure that may promote tumorigenesis in other ways.

Conclusions

We investigated the genotoxic potential of modulated RF-EMF as used in wireless technology (UMTS, GSM, WiFi, and RFID) on cultured human cells. Classical and advanced genotoxicity testing and DNA repair assessment produced no conclusive evidence for a disturbance of DNA integrity or changes in the DNA repair capacity, following wEMF exposure. These overall negative results are in contrast to some previously reported positive findings. Investigating the underlying reasons for this discrepancy, we identified cell culture conditions

and the CA methodology as likely relevant variables. In some experiments with UMTS exposure, we noticed small tendencies for wEMF exposure-associated changes in DNA damage levels and repair dynamics. In the absence of evidence for a direct DNA-damaging potential of wEMF, we interpret these to possibly be caused by an unspecific wEMF-induced cellular stress response. The nature of such an interaction between wEMF and cellular physiology, however, remains unclear and needs to be further investigated.

Open access paper: https://www.mdpi.com/2073-4425/11/4/347

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The effect of vitamin E and C on comet assay indices and apoptosis in power plant workers: A double blind randomized controlled clinical trial

Bagheri Hosseinabadi M, Khanjani N, Atashi A, Norouzi P, Mirbadie SR, Mirzaii M. The effect of vitamin E and C on comet assay indices and apoptosis in power plant workers: A double blind randomized controlled clinical trial. Mutat Res. 2020 Feb - Mar;850-851:503150. doi: 10.1016/j.mrgentox.2020.503150.

Abstract

Extremely low frequency electromagnetic fields have been classified as a possible human carcinogen by the International Agency for Research on Cancer and this has raised some concern about its health effects on employees extensively exposed to these fields at thermal power plants. In this study, the effect of using vitamin E and C supplements have been examined on employees working at a thermal power plant. In this randomized controlled, double-blind clinical trial, 81 employees from different parts of the thermal power plant were enrolled between July and November 2017, and divided into four groups: Group 1 received vitamin E (400 units/day), Group 2: vitamin C (1000 mg/day), Group 3: vitamin E + C and Group 4: no intervention. DNA damage was measured in peripheral blood lymphocytes using comet assay and apoptosis, using flow cytometry. Based on the results, tail intensity and tail length in the vitamin E group, and all comet assay indices in the vitamin E + C and vitamin C groups (except DNA damage index) significantly decreased after the intervention, while the comet assay indices did not change significantly in the control group. None of the flow cytometry indices including early apoptosis, late apoptosis and necrosis changed after intervention in either group. The use of antioxidant vitamins such as E and C, can increase the activity of the non-enzymatic antioxidant defense system, and protect DNA from damage caused by exposure to extremely low frequency magnetic fields. But, taking these vitamins has no effect on apoptosis. It seems that consumption of vitamin E affected all investigated comet assay indices and can be probably considered as the best intervention.

https://www.ncbi.nlm.nih.gov/pubmed/32247559

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Effect of a 50-Hz Electromagnetic Field at 500 μT on Parameters Related With the Cardiovascular System in Rats

Zhang Y, Li L, Liu X , Ding L, Wu X, et al. Examination of the Effect of a 50-Hz Electromagnetic Field at 500 μT on Parameters Related With the Cardiovascular System in Rats. Front Public Health. 2020 Apr 7;8:87. doi: 10.3389/fpubh.2020.00087.

Abstract

Background: Whether electromagnetic field (EMF) exposure affects the function of the cardiovascular system is under debate. The present study aimed to investigate the effects of 500 μT EMF exposure on the cardiovascular system in rats.

Methods: Forty-eight-week-old male Sprague-Dawley rats were randomly divided into two groups: the sham group and the exposure group. During 24-week EMF exposure (20 h per day), the blood pressure and pulse rate were recorded every 4 weeks. Before sacrifice, electrocardiography, echocardiography, and cardiac catheterization analysis were conducted to evaluate the cardiac function. Meanwhile, hematoxylin-eosin (HE) staining, Western blot, and real-time polymerase chain reaction (PCR) were performed to identify morphological and molecular changes indicative of cardiac remodeling.

Results: The heart rate, blood pressure, and pulse rate were not influenced by EMF exposure compared with the control group. In addition, HE staining showed no change in the morphology and arrangement of cardiomyocytes. Further, we found that the mRNA and protein levels of cardiac hypertrophy-related genes were not affected by EMF exposure. Finally, no significant difference was observed in cardiac function between the two groups by echocardiography and cardiac catheterization detection.

Conclusion: The 24-week exposure to EMF at 500 μT did not have apparent effects on the cardiovascular system in rats, at least for the variables studied.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7154052/

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Effect of static magnetic field on DNA synthesis: The interplay between DNA chirality and magnetic field left-right asymmetry.

Yang X, Li Z, Polyakova T, Dejneka A, Zablotskii V, Zhang X. Effect of static magnetic field on DNA synthesis: The interplay between DNA chirality and magnetic field left-right asymmetry. FASEB Bioadv. 2020 Mar 7;2(4):254-263. doi: 10.1096/fba.2019-00045.

Abstract

Interactions between magnetic fields (MFs) and living cells may stimulate a large variety of cellular responses to a MF, while the underlying intracellular mechanisms still remain a great puzzle. On a fundamental level, the MF - cell interaction is affected by the two broken symmetries: (a) left-right (LR) asymmetry of the MF and (b) chirality of DNA molecules carrying electric charges and subjected to the Lorentz force when moving in a MF. Here we report on the chirality-driven effect of static magnetic fields (SMFs) on DNA synthesis. This newly discovered effect reveals how the interplay between two fundamental features of symmetry in living and inanimate nature-DNA chirality and the inherent features of MFs to distinguish the left and right-manifests itself in different DNA synthesis rates in the upward and downward SMFs, consequently resulting in unequal cell proliferation for the two directions of the field. The interplay between DNA chirality and MF LR asymmetry will provide fundamental knowledge for many MF-induced biological phenotypes.

Open access paper: https://www.ncbi.nlm.nih.gov/pubmed/32259051

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Change in Geomagnetic Field Intensity Alters Migration-Associated Traits in a Migratory Insect

Wan G, Liu R, Li C, He J, Pan W, et al. Change in Geomagnetic Field Intensity Alters Migration-Associated Traits in a Migratory Insect. Biol Lett. 2020 Apr;16(4):20190940. 10.1098/rsbl.2019.0940. DOI: 10.1098/rsbl.2019.0940.

Abstract

Geomagnetic field (GMF) intensity can be used by some animals to determine their position during migration. However, its role, if any, in mediating other migration-related phenotypes remains largely unknown. Here, we simulated variation in GMF intensity between two locations along the migration route of a nocturnal insect migrant, the brown planthopper Nilaparvata lugens, that varied by approximately 5 μT in field intensity. After one generation of exposure, we tested for changes in key morphological, behavioural and physiological traits related to migratory performance, including wing dimorphism, flight capacity and positive phototaxis. Our results showed that all three morphological and behavioural phenotypes responded to a small difference in magnetic field intensity. Consistent magnetic responses in the expression of the phototaxis-related Drosophila-like cryptochrome 1 (Cry1) gene and levels of two primary energy substrates used during flight, triglyceride and trehalose, were also found. Our findings indicate changes in GMF intensity can alter the expression of phenotypes critical for insect migration and highlight the unique role of magnetoreception as a trait that may help migratory insects express potentially beneficial phenotypes in geographically variable environments.

https://pubmed.ncbi.nlm.nih.gov/32343935/

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Guidelines for Limiting Exposure to Electromagnetic Fields (100 kHz to 300 GHz)

International Commission on Non-Ionizing Radiation Protection (ICNIRP). Special Submission: Guidelines for Limiting Exposure to Electromagnetic Fields (100 kHz to 300 GHz). Health Physics. March 11, 2020. DOI: 10.1097/HP.0000000000001210.

Abstract

Radiofrequency electromagnetic fields (EMFs) are used to enable a number of modern devices, including mobile telecommunications infrastructure and phones, Wi-Fi, and Bluetooth. As radiofrequency EMFs at sufficiently high power levels can adversely affect health, ICNIRP published Guidelines in 1998 for human exposure to time-varying EMFs up to 300 GHz, which included the radiofrequency EMF spectrum. Since that time, there has been a considerable body of science further addressing the relation between radiofrequency EMFs and adverse health outcomes, as well as significant developments in the technologies that use radiofrequency EMFs. Accordingly, ICNIRP has updated the radiofrequency EMF part of the 1998 Guidelines. This document presents these revised Guidelines, which provide protection for humans from exposure to EMFs from 100 kHz to 300 GHz.

Open access paper: https://www.icnirp.org/cms/upload/publications/ICNIRPrfgdl2020.pdf

For a discussion of the problems with these guidelines see: ICNIRP's Exposure Guidelines for Radio Frequency Fields

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Adverse Effects of Wireless Radiation

Kostoff RN. Monograph. Adverse Effects of Wireless Radiation. School of Public Policy, Georgia Institute of Technology. 648 page monograph. 2019.

Abstract

This monograph identifies adverse effects of wireless radiation as reported in the premier biomedical literature. It shows that most of the laboratory experiments that have been performed are not designed to elicit the more severe adverse effects reflective of the real-life operating environment in which wireless radiation is embedded. The monograph includes a substantial bibliography of papers that present these adverse effects, and shows that what has been reported is the tip of the iceberg of the full spectrum of potential adverse effects from wireless radiation.

Open access paper: http://hdl.handle.net/1853/61946.

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Electrohypersensitivity as a Newly Identified and Characterized Neurologic Pathological Disorder: How to Diagnose, Treat, and Prevent It

Belpomme D, Irigaray P. Electrohypersensitivity as a Newly Identified and Characterized Neurologic Pathological Disorder: How to Diagnose, Treat, and Prevent It. Int J Mol Sci. 2020 Mar 11;21(6). pii: E1915. doi: 10.3390/ijms21061915.

Abstract

Since 2009, we built up a database which presently includes more than 2000 electrohypersensitivity (EHS) and/or multiple chemical sensitivity (MCS) self-reported cases. This database shows that EHS is associated in 30% of the cases with MCS, and that MCS precedes the occurrence of EHS in 37% of these EHS/MCS-associated cases. EHS and MCS can be characterized clinically by a similar symptomatic picture, and biologically by low-grade inflammation and an autoimmune response involving autoantibodies against O-myelin. Moreover, 80% of the patients with EHS present with one, two, or three detectable oxidative stress biomarkers in their peripheral blood, meaning that overall these patients present with a true objective somatic disorder. Moreover, by using ultrasonic cerebral tomosphygmography and transcranial Doppler ultrasonography, we showed that cases have a defect in the middle cerebral artery hemodynamics, and we localized a tissue pulsometric index deficiency in the capsulo-thalamic area of the temporal lobes, suggesting the involvement of the limbic system and the thalamus. Altogether, these data strongly suggest that EHS is a neurologic pathological disorder which can be diagnosed, treated, and prevented. Because EHS is becoming a new insidious worldwide plague involving millions of people, we ask the World Health Organization (WHO) to include EHS as a neurologic disorder in the international classification of diseases.

Conclusions

In summary, we showed that there are presently su fficient clinical, biological, and radiological data for EHS to be acknowledged as a well-defined, objectively identified, and characterized pathological neurologic disorder. As a result, patients who self-report they su ffer from EHS should be diagnosed and treated on the basis of presently available biological tests, including the detection of peripheral blood and urine biomarkers and the use of imaging techniques such as fMRI, TDU, and, when possible, UCTS. Moreover, because we showed for the first time that EHS is frequently associated with MCS and that both clinico-biological entities may be associated with a common physiopathological mechanism for genesis, it clearly appears that they can be identified as a unique neurologic pathological syndrome whatever their causal origin. Moreover; as it was shown that MCS genesis may be attributed to toxic chemical exposure, and EHS genesis to potentially

excessive EMF and/or chemical exposure; protective measures against these two environmental stressors should be taken. Whatever its causal origin and mechanism of action, EHS should therefore be from now on recognized as a new identified and characterized neurological pathological disorder. As it is already a real health plague potentially involving millions of people worldwide it should be acknowledged by WHO, and thus be included in the WHO ICD. As stated during the international scientific consensus meeting on EHS and MCS that we have organized in 2015 in Brussels, scientists unanimously asked WHO to urgently assume its responsibilities, by classifying EHS and MCS as separate codes in the ICD; so as to increase scientific awareness of these two pathological entities in the medical community and the general public, and to foster research and train medical practitioners to e ciently diagnose, treat, and prevent EHS and MCS–which in fact constitute a unique, well-defined, and identifiable new neurologic disease.

Open access paper: https://www.mdpi.com/1422-0067/21/6/1915

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Adverse Impacts of 5G Downlinks on Human Body

Nasim I, Kim S. Adverse Impacts of 5G Downlinks on Human Body. 2019 SoutheastCon. Huntsville, AL. 11-14 April 2019. DOI: 10.1109/SoutheastCon42311.2019.9020454

Abstract

The increasing demand for higher data rates and uninterrupted reliable service have made the frequency spectrum above 6 GHz a very promising candidate for future wireless communications because of its massive amount of raw bandwidth and extremely high data transfer capabilities. However, increasing concerns of communications at high frequencies on human health have gained international alarm that suggests more research before it is deployed successfully. In this context, this paper aims to investigate the human electromagnetic field (EMF) exposure from fifth-generation (5G) downlink communications and compare its impacts with the present cellular technologies considering the features that the 5G systems will likely adopt. Our simulation results suggest that while the impacts from 5G beamforming communications cross the regulatory borders at downlinks for a very short range between base stations (BSs) and user equipment (UE), the exposure level remains on a high throughout the entire network compared to the present systems. Also, this paper urges for more research on the exposure level from future communications to determine any possible threats below the existing guidelines. This paper also highlights the significance of considering SAR for the measurement of exposure compliance in downlinks.

Excerpt

... this paper urges the regulatory authorities to set SAR guidelines for 5G systems at far-field exposure also for frequencies above 6 GHz. Also, the minimum AP-UE [access point - user equipment] distance should be maintained at least 6 m [meters] for 5G and further space should be left for a conservative operation regarding human safety.

Conclusions

This paper has highlighted the significance of the human EMF exposure issue in the downlink of a cellular communications system. This paper measured the exposure level in terms of PD and SAR and compared them to those calculated in the 3.9G and 4G specifications. Distinguished from the prior art that studied uplinks only, this paper has found that the downlinks of a 5G can also yield a higher level of emissions in terms of SAR compared to concurrent cellular systems. Our results emphasized that this increase stems from more highly concentrated EMF energy per downlink RF beam due to the use of larger phased arrays within small cells of a

5G network. However, only skin effects are being taken into consideration for simplicity. This paper has also suggested the minimum AP-UE distance for human safety in cellular communications at high frequencies such as 28 GHz. To this end, this paper urges to investigate any possible threats at the exposure level shown in this work for future 5G systems before it is finally globalized.

https://ieeexplore.ieee.org/document/9020454

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Electromagnetic Radiation due to Cellular, Wi-Fi and Bluetooth technologies: How safe are we?

Naren, Elhance A, Chamola V. Guizani M. Electromagnetic Radiation due to Cellular, Wi-Fi and Bluetooth technologies: How safe are we? IEEE Access. 4:1-21. 2019. DOI 10.1109/ACCESS.2020.2976434

Abstract

The electromagnetic radiation (EMR) emitted out of wireless communication modules in various electronic devices have been identified by researchers as biologically hazardous to humans as well as other living beings. Different countries have different regulations to limit the radiation density levels caused by these devices. The radiation absorbed by an individual depends on various factors such as the device they use, the proximity of use, the type of antenna, the relative orientation of the antenna on the device, and many more. Several standards exist which have tried to quantify the radiation levels and come up with safe limits of EMR absorption to prevent human harm. In this work, we determine the radiation concern levels in several scenarios using a handheld radiation meter by correlating the findings with several international standards, which are determined based on thorough scientific evidence. This study also analyzes the EMR from common devices used in day to day life such as smartphones, laptops, Wi-Fi routers, hotspots, wireless earphones, smartwatches, Bluetooth speakers and other wireless accessories using a handheld radio frequency radiation measurement device. The procedure followed in this paper is so presented that it can also be utilized by the general public as a tutorial to evaluate their own safety with respect to EMR exposure. We present a summary of the most prominent health hazards which have been known to occur due to EMR exposure. We also discuss some individual and collective human-centric protective and preventive measures that can be undertaken to reduce the risk of EMR absorption. This paper analyses radiation safety in pre-5G networks and uses the insight gained to raise valuable concerns regarding EMR safety in the upcoming 5G networks.

Conclusions

People should be made aware that the EMR from using day to day cellular, Wi-Fi and Bluetooth devices are harmful to human health. The levels of radiation observed in most cases such as phone calls, internet browsing on laptops and smartphones, using wireless routers and hotspots, Bluetooth smartwatches and smartphones are unsafe when compared with radiations limits determined by medical bodies. According to current medical literature, various adverse health effects from exposure to RF EMR have been well documented. For now, wireless technologies must be avoided as much as possible. New and innovative wired solutions which provide the same level of user-friendliness should be encouraged. Intervention of government and medical bodies with the main purpose of protecting human health is of utmost necessity to ensure good economic development without compromising the health of the population. Countries must adopt the guide-lines suggested by medical bodies which take into account both thermal and non-thermal effects of EMR. At present, all individuals must take preventive and protective measures to protect themselves from harmful EMR exposure.

Open access paper: https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9016183

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A meta-analysis of in vitro exposures to weak radiofrequency radiation exposure from mobile phones (1990–2015)

Halgamuge MN, Skafida E, Davis D. A meta-analysis of in vitro exposures to weak radiofrequency radiation exposure from mobile phones (1990–2015). Environmental Research. Available online 13 February 2020, 109227. https://doi.org/10.1016/j.envres.2020.109227.

Highlights

• Address the question of the impact of radiofrequency radiation on living organisms in vitro studies using abstract data from 300 peer-reviewed scientific publications (1990–2015) describing 1127 experimental observations.
• Establish impacts of the cumulative effect as measured by SAR * exposure time) to estimate the cumulative energy absorption of RF exposure for their analysis.
• Observe that more mature lymphocytes and glial cells are less reactive to RF, while less mature and less differentiated cells such as epithelium and spermatozoa are more sensitive to RF.
• Observe human cells are less affected by the radiofrequency radiation than rat/mouse cells.

Abstract

To function, mobile phone systems require transmitters that emit and receive radiofrequency signals over an extended geographical area exposing humans in all stages of development ranging from in-utero, early childhood, adolescents and adults. This study evaluates the question of the impact of radiofrequency radiation on living organisms in vitro studies. In this study, we abstract data from 300 peer-reviewed scientific publications (1990–2015) describing 1127 experimental observations in cell-based in vitro models. Our first analysis of these data found that out of 746 human cell experiments, 45.3% indicated cell changes, whereas 54.7% indicated no changes ($p<0.001$). Realizing that there are profound distinctions between cell types in terms of age, rate of proliferation and apoptosis, and other characteristics and that RF signals can be characterized in terms of polarity, information content, frequency, Specific Absorption Rate (SAR) and power, we further refined our analysis to determine if there were some distinct properties of negative and positive findings associated with these specific characteristics. We further analyzed the data taking into account the cumulative effect (SAR exposure time) to acquire the cumulative energy absorption of experiments due to radiofrequency exposure, which we believe, has not been fully considered previously. When the frequency of signals, length and type of exposure, and maturity, rate of growth (doubling time), apoptosis and other properties of individual cell types are considered, our results identify a number of potential non-thermal effects of radiofrequency fields that are restricted to a subset of specific faster-growing less differentiated cell types such as human spermatozoa (based on 19 reported experiments, p-value 0.002) and human epithelial cells (based on 89 reported experiments, p-value 0.0001). In contrast, for mature, differentiated adult cells of Glia (p 0.001) and Glioblastoma (p 0.0001) and adult human blood lymphocytes (p 0.0001) there are no statistically significant differences for these more slowly reproducing cell lines. Thus, we show that RF induces significant changes in human cells (45.3%), and in faster-growing rat/mouse cell dataset (47.3%). In parallel with this finding, further analysis of faster-growing cells from other species (chicken, rabbit, pig, frog, snail) indicates that most undergo significant changes (74.4%) when exposed to RF. This study confirms observations from the REFLEX project, Belyaev and others that cellular response varies with signal properties. We concur that differentiation of cell type thus constitutes a critical piece of information and should be useful as a reference for

many researchers planning additional studies. Sponsorship bias is also a factor that we did not take into account in this analysis.

Conclusion

In this review, we perform a meta-analysis of data from 300 peer-reviewed scientific publications (1990-2015) with 1127 in vitro experimental observations carried out in the literature that discussed using different experimental techniques (cytogenetic, gene and protein expression analysis) and different cell types (cultured rodent, human cells and human blood lymphocytes) due to non-thermal radio-frequency electromagnetic exposure. In this paper, we directly differentiated the cumulative effect (SAR exposure time) to acquire the cumulative energy absorption of experiments due to RF exposure, which we believe, has not been fully considered previously. Several studies have reported, based on different experimental techniques that RF exposures comparable to those of a mobile phone induce a range of genetic and other damage including (cytogenetic, gene, and protein expression analysis). Non-thermal radiofrequency electromagnetic exposure in a range of cells/tissues that may not be associated with potentially harmful health consequences; in contrast, other studies have reported no apparent effects related to radiofrequency radiation. Our observation showed that 45.3% experiments concluded that an increase in such potential effects on cells exposed to radiofrequency radiation, while 54.7% showed no such effects ($p = 0.001$). Specific subtypes of cells show a much clearer cellular response. When radiofrequency, exposure and individual cell types are considered, potential non-thermal effects of radio-frequency radiation on cell types, such as human spermatozoa (based on 19 reported experiments, p-value = 0.002) and human epithelial cells (based on 89 reported experiments, p-value < 0.0001) may exist whereas for Glia ($p = 0.001$), Glioblastoma ($p < 0.0001$) and human blood lymphocytes ($p < 0.0001$) the evidence suggests that there are no statistically significant differences.

Fundamentally the validity of any exercise such as this depends on whether studies are carried out with parallel methods and levels of quality assurance and quality control for the biological materials that are employed. The widely varying results we report here could well reflect failures of scientific rigor and consistency, as Portelli and Barnes (2013) [9] have suggested plague in vitro studies. Despite the lack of uniformity in responses, certain patterns are evident. **It appears that more mature lymphocytes and glial cells are less reactive to RF, while less mature and less differentiated cells such as epithelium and spermatozoa are more sensitive to RF. In addition, it appears that frequencies that are higher and pulsed have more biological impact than those that are continuous and of lower frequency.**

A simple glance at our findings could imply that human cells are less affected by the radiofrequency radiation than rat/mouse cells. However, due to the inconsistency of results, it may be safer to look at other possible explanation. One possibility is that the experimental procedure is not consistently followed throughout the majority of these studies, or it could be due to the experimental design guidelines not being able to account for all the variables we may or may not be aware of. Consequently, it allows an inconsistency set of results due to small fluctuation in different studies. Nevertheless, this study should be useful as a reference for many researchers supporting epidemiological studies and in vivo experiments using whole organism animal models.

https://www.sciencedirect.com/science/article/abs/pii/S0013935120301195

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Main Regularities and Health Risks from Exposure to Non-Thermal Microwaves of Mobile Communication

Belyaev I. Main Regularities and Health Risks from Exposure to Non-Thermal Microwaves of Mobile Communication. 2019 14th International Conference on Advanced Technologies, Systems and Services in Telecommunications (TELSIKS). Nis Serbia. 23-25 Oct. 2019. DOI: 10.1109/TELSIKS46999.2019.9002324.

Abstract

Various responses to non-thermal microwaves (MW) from mobile communication including adverse health effects related to electrohypersensitivity, cancer risks, neurological effects, and reproductive impacts have been reported while some studies reported no such effects. This presentation provides an overview of the complex dependence of the MW effects on various physical and biological variables, which account for, at least partially, an apparent inconsistence in the published data. Among other variables, dependencies on carrier frequency, polarization, modulation, intermittence, electromagnetic stray fields, genotype, physiological traits, and cell density during exposure were reported. Nowadays, biological and health effects of 5G communication, which will use microwaves of extremely high frequencies (millimeter waves MMW, wavelength 1- 10 mm), are of significant public concern. It follows from available studies that MMW, under specific conditions of exposure at very low intensities below the ICNIRP guidelines, can affect biological systems and human health. Both positive and negative effects were observed in dependence on exposure parameters. In particular, MMW inhibited repair of DNA damage induced by ionizing radiation at specific frequencies and polarizations. To what extend the 5G technology and the Internet of Things will affect the biota and human health is definitely not known. However, based on possible fundamental role of MMW in regulation of homeostasis and almost complete absence of MMW in atmosphere due to effective absorption, which suggests the lack of adaptation to this type of radiation, the health effects of chronic MMW exposures may be more significant than for any other frequency range.

Conclusions

To what extent the 5G technology and the Internet of Things will affect the human health is definitely not known. However, based on possible fundamental role of MMW in regulation of homeostasis [72] and almost complete absence of MMW in atmosphere due to effective absorption, which suggests the lack of adaptation to this type of radiation, the health effects of chronic MMW exposures may be more significant than for any other frequency range. From the health perspectives, implementation of the 5G technology is premature. Extended research with chronic exposure of human cells, animals and man is needed to exclude potentially harmful 5G signals.

https://ieeexplore.ieee.org/document/9002324

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A real-world quality assessment study in six ExpoM-RF measurement devices

Eeftens M,Dongus S, Bürgler A, Röösl M, ACCEDERA team. A real-world quality assessment study in six ExpoM-RF measurement devices. Environmental Research. Vol.182, March 2020, 109049. https://doi.org/10.1016/j.envres.2019.109049

Highlights

• We compared 6 ExpoM-RF personal measurement devices for radiofrequency electromagnetic fields (RF-EMF).
• The vast majority (84%) of variability in RF-EMF exposure levels was explained by the environment.
• Systematic differences between devices and calibrations were detectable, but relatively small.

• This supports the validity of studies which characterize personal and environmental RF-EMF using exposimeters.
• If systematic differences are corrected, we recommend adjusting for device ID and calibration session.

Abstract

Exposimeters measuring radiofrequency electromagnetic fields (RF-EMF) are commonly used to assess personal exposure to RF-EMF in real-life environments. They are usually calibrated in an anechoic chamber using single, well-defined signals such as the center frequency of each band, and standardized orientations, but it is not clear how different devices compare in the real environment where complex mixtures of signals from all directions are present. We thus tested the comparability of six ExpoM-RF exposimeters before and after calibration in an anechoic chamber by varying their position and orientation while repeatedly measuring 15 microenvironments (9 walking routes, 4 tram routes and 2 bus routes) on 6 different days. We modelled the geometric mean levels of RF-EMF as a function of orientation, position, device ID, whether the device was recently calibrated, correcting for the microenvironment in which each measurement took place. We found that systematic differences introduced by device ID, calibration, day of the week, orientation and position are relatively small compared to exposure differences between microenvironments. Any corrections (if desired) should include both device ID and calibration session, but would have a small impact considering the negligible differences between devices. This supports the validity of previous exposure measurement studies relying on ExpoM-RF devices, which did not correct for device ID. We further found that summarizing the exposure per microenvironment as geometric means results in better models than arithmetic means and medians, and recommend that further exposure assessment studies report observed levels as geometric means.

https://www.sciencedirect.com/science/article/abs/pii/S0013935119308461

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A novel pilot study of automatic identification of EMF radiation effect on brain using computer vision and machine learning

Singh A, Singh N, Jinda T, Rosado-Muñoz, A, Kishore Dutta M. A novel pilot study of automatic identification of EMF radiation effect on brain using computer vision and machine learning. Biomedical Signal Processing and Control. Vol. 57, March 2020, 101821. https://doi.org/10.1016/j.bspc.2019.101821.

Highlights

• This work presents automated identification of the effect of EMF radiations on brain.
• Changes in brain morphology due to EMF exposure were analyzed considering drosophila melanogaster as a specimen.
• The geometrical features were extracted from the microscopic segmented brain image of drosophila.
• Machine learning techniques were used for identification of EMF exposure on drosophila brain.

Abstract

Electromagnetic field (EMF) radiations from mobile phones and cell tower affect brain of humans and other organisms in many ways. Exposure to EMF could lead to neurological changes causing morphological or chemical changes in the brain and other internal organs. Cellular level analysis to measure and identify the effect of mobile radiations is an expensive and long process as it requires preparing the cell suspension for the

analysis. This paper presents a novel pilot study to identify changes in brain morphology under EMF exposure considering drosophila melanogaster as a specimen. The brain is automatically segmented, obtaining microscopic images from which discriminatory geometrical features are extracted to identify the effect of EMF exposure. The geometrical features of the microscopic segmented brain image of drosophila are analyzed and found to have discriminatory properties suitable for machine learning. The most prominent discriminatory features were fed to four different classifiers: support vector machine, naïve bayes, artificial neural network and random forest for classification of exposed / non-exposed microscopic image of drosophila brain. Experimental results indicate that all four classifiers provide good classification results up to 94.66% using discriminatory features selected by feature selection method. The proposed method is a novel approach to identify the effect of EMF exposure automatically and with low time complexity thus providing an efficient image processing framework based on machine learning.

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The radio-protective effect of rosmarinic acid against mobile phone and Wi-Fi radiation-induced oxidative stress in the brains of rats

Asl JF, Goudarzi M, Shoghi H. The radio-protective effect of rosmarinic acid against mobile phone and Wi-Fi radiation-induced oxidative stress in the brains of rats. Pharmacol Rep. 2020 Mar 3. doi: 10.1007/s43440-020-00063-9.

Abstract

BACKGROUND: Rosmarinus officinalis L. is an aromatic perennial herb from which rosmarinic acid (RA) can be extracted. This research was conducted to assess the effectiveness of RA against radio frequency (RF) radiation-induced oxidative stress due to 915 MHz (mobile phone) and 2450 MHz (Wi-Fi) frequencies in rats.

METHODS: The animals were separated into six groups, including group 1 receiving normal saline (NS), group 2 (NS/Wi-Fi) and group 4 (NS/mobile), which received NS plus 60 min/day of exposure to the electromagnetic radiation (EMR) for 1 month, group 3 (RA/Wi-Fi) and group 5 (RA/mobile) received RA (20 mg/kg/day, po) plus 60 min/day of EMR, and group 6 (RA) received only RA.

RESULTS: There was a significant elevation of protein carbonylation (PC), nitric oxide (NO) and malondialdehyde (MDA) and significant reduction in glutathione (GSH), glutathione peroxidase (GPx), total antioxidant capacity (TAC), superoxide dismutase (SOD) and catalase (CAT) in the RF radiation-exposed rats' brain compared to the control group. RA reduced the levels of NO, PC and MDA and it also elevated the TAC, GPx, SOD, CAT and GSH levels in the rats' brains in the RA/Wi-Fi and RA/mobile groups compared to the NS/Wi-Fi and NS/mobile groups, respectively.

CONCLUSION: It can be concluded that RA can be considered a useful candidate for protecting brain tissues against RF radiation-induced oxidative stress at 915 and 2450 MHz frequencies through ameliorative effects on the antioxidant enzyme activities and oxidative stress indices.

https://www.ncbi.nlm.nih.gov/pubmed/32128712

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The Effects of Mobile Phone Radiofrequency Radiation on Cochlear Stria Marginal Cells in Sprague-Dawley Rats

Yang H, Zhang Y, Wang Z, Zhong S, Hu G, Zuo W. The Effects of Mobile Phone Radiofrequency Radiation on Cochlear Stria Marginal Cells in Sprague-Dawley Rats. Bioelectromagnetics. 2020 Feb 18. doi: 10.1002/bem.22255.

Abstract

To investigate the possible mechanisms for biological effects of 1,800 MHz mobile radiofrequency radiation (RFR), the radiation-specific absorption rate was applied at 2 and 4 W/kg, and the exposure mode was 5 min on and 10 min off (conversation mode). Exposure time was 24 h short-term exposure. Following exposure, to detect cell DNA damage, cell apoptosis, and reactive oxygen species (ROS) generation, the Comet assay test, flow cytometry, DAPI (4',6-diamidino-2-phenylindole dihydrochloride) staining, and a fluorescent probe were used, respectively. Our experiments revealed that mobile phone RFR did not cause DNA damage in marginal cells, and the rate of cell apoptosis did not increase ($P > 0.05$). However, the production of ROS in the 4 W/kg exposure group was greater than that in the control group ($P < 0.05$). In conclusion, these results suggest that mobile phone energy was insufficient to cause cell DNA damage and cell apoptosis following short-term exposure, but the cumulative effect of mobile phone radiation still requires further confirmation. Activation of the ROS system plays a significant role in the biological effects of RFR.

Conclusion

The RFR emitted from mobile phones was insufficient to cause cell DNA damage and cell apoptosis following short-term exposure, but intracellular ROS levels in the 4 W/kg exposure group were significantly increased than in the control group,indicating that activation of the ROS system plays a crucial role in the biological effects of RFR. The cumulative effect of mobile phone radiation requires investigation.

https://www.ncbi.nlm.nih.gov/pubmed/32072661

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Assessment of the Cellphone Radiation Effects on Anti-oxidative and Renal Parameters in Rat

Eslami E, Fatahian S, Shahanipour K. Assessment of the Cellphone Radiations Effects on Anti-oxidative and Renal Parameters in Rat. Toxicology and Environmental Health Sciences. 11(4):278-282. Dec 2019.

Objective: In the present study an attempt is to assess the cellphones waves effects on the stress oxidative activities as well as renal parameters in rat.

Methods: 30 mature male Wister rats were divided into 3 groups of 10. Group 1 (control) was kept in normal laboratory conditions. Groups 2 and 3 were exposed with two and four cellphones in opposite sides of the cage, respectively. Blood samples were collected directly from the rat's heart 15 and 30 days post exposure and the activity of anti-oxidative factors including Glutathione Peroxidase, Superoxide Dismutase, Catalase, Glutathione Peroxidase, Paraoxonase and Malondialdehyde as well as renal parameters (Urea, Uric acid and Creatinine) were measured.

Results: Activity of catalase, superoxide dismutase and paraoxonase enzymes in all treated groups, 15 and 30 days post cellphone exposure were significantly increased in comparison with control. The activity of glutathione peroxidase enzyme in all treated groups, 15 and 30 days post cellphone exposure was decreased in comparison with control. Malondialdehyde and creatinine activity did not show any significant changes. Uric acid and urea were significantly increased in the group just exposed with four cellphones, 30 days post exposure.

Conclusion: According to the results, many changes were seen in biochemical parameters due to the cellphone exposure during a month. Therefore it can be concluded that radio frequency devices could be destructive and have many negative effects on the tissues and enzyme function.

https://link.springer.com/article/10.1007/s13530-019-0414-4

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Effects of acute exposure to ultra-wideband pulsed electromagnetic fields on the liver and kidneys of mice

Guo K, Zhang Y, Fang X, Fan P, Shang S, Fan F, Wu H, Man M, Xie Y, Lu X. Effects of acute exposure to ultra-wideband pulsed electromagnetic fields on the liver and kidneys of mice. Electromagn Biol Med. 2020 Mar 12:1-14. doi: 10.1080/15368378.2020.1737806.

Abstract

The biosafety of ultra-wideband (UWB) pulses, which are characterized by simultaneously high power and a high bandwidth ratio, has gained increasing attention. Although there is substantial prior literature on the biological effects of UWB pulses on both cells and animals, an explicit, unequivocal and definite pattern of the corresponding biological responses remains elusive, and the systemic secondary consequences are also still not fully understood. In this study, we found that exposing mice to UWB pulses resulted in the alteration of several biochemical blood parameters, which further prompted us to investigate changes in the liver and kidneys of mice exposed to UWB pulses with different field intensities and different durations. The data demonstrated that exposure to UWB pulses significantly increased the levels of ALT and AST, increased oxidative stress, and could even induce the accumulation of lipid droplets in hepatocytes. The total number of pulses under the tested acute exposure regiment contributed most to the observed hepatic and rental dysfunction. Notably, the physiological and molecular changes recovered approximately 72 hours after exposure. These results imply the potential risk of acute exposure to UWB pulses, and highlight the meaningful targets for further long-term study of chronic exposure.

https://www.ncbi.nlm.nih.gov/pubmed/32164469

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Design and Dosimetric Analysis of an Exposure Facility for Investigating Possible Effects of 2.45 GHz Wi-Fi Signals on Human Sleep

Schmid G, Hirtl R, Bueno-Lopez A, Dorn H, Eggert T, Danker-Hopfe H. Design and Dosimetric Analysis of an Exposure Facility for Investigating Possible Effects of 2.45 GHz Wi-Fi Signals on Human Sleep. Bioelectromagnetics. 2020 Feb 27. doi: 10.1002/bem.22256.

Abstract

A new head exposure system for double-blind provocation studies investigating possible effects of 2.45 GHz Wi-Fi exposure on human sleep was developed and dosimetrically analyzed. The exposure system includes six simultaneously radiating directional antennas arranged along a circle (radius 0.6 m) around the test subject's head, and enables a virtually uniform head exposure, i.e. without any preferred direction of incidence, during sleep. The system is fully computer-controlled and applies a real wireless local area network (WLAN) signal representing different transmission patterns as expected in real WLAN scenarios, i.e. phases of "beacon only" as well as phases of different data transmission rates. Sham and verum are applied in a double-blind crossover study design and all relevant exposure data, i.e. forward and reverse power at all six antenna inputs, are continuously recorded for quality control. For a total antenna input power (sum of all antennas) of 220 mW, typical specific absorption rate (SAR) in cortical brain regions is approximately 1-2 mW/kg (mass average SAR over respective brain region), which can be seen as a realistic worst-case exposure level in real WLAN scenarios. Taking into account variations of head positions during the experiments, the resulting exposure of different brain regions may deviate from the given average SAR levels up to 10 dB. Peak spatial 10 g average SAR in all brain and all head tissues is between 1.5-3.5 and 10.4-25 mW/kg, respectively.

https://www.ncbi.nlm.nih.gov/pubmed/32104921

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Antibacterial Susceptibility Pattern of the Pseudomonas aeruginosa and Staphylococcus aureus after Exposure to Electromagnetic Waves Emitted from Mobile Phone Simulator

Movahedi MM, Nouri F, Tavakoli Golpaygani A, Ataee L, Amani S, Taheri M. Antibacterial Susceptibility Pattern of the Pseudomonas aeruginosa and Staphylococcus aureus after Exposure to Electromagnetic Waves Emitted from Mobile Phone Simulator. J Biomed Phys Eng. 2019 Dec 1;9(6):637-646. doi: 10.31661/jbpe.v0i0.1107.

Abstract

Background: The increasing use of telecommunication devices such as Wi-Fi modems and mobile phones in the recent years can change the cellular structure of microorganisms so the generation of electromagnetic waves has led to concern in the community whenever be exposed to these fields and may have harmful effects on human health.

Material and Methods: In this experimental study, standard strains of bacteria were prepared on Mueller-Hinton agar for bacterial growth to obtain 0.5 McFarland turbidity (1.5 × 108 CFU) of bacteria. Antibiotic susceptibility test using the Kirby-Bauer disk diffusion method was done. For Staphylococcus aureus and Pseudomonas aeruginosa, antibiotics susceptibility test was conducted. The test group was exposed to electromagnetic waves emitted by mobile phone simulator with a frequency of 900 MHz and the control group were not exposed.

Results: The results revealed that increasing duration of exposure to electromagnetic waves emitted by the mobile simulators with a frequency of 900 MHz especially after 24 h of exposure, can increase bacterial resistance in S. aureus, and P. aeruginosa.

Conclusion: Several factors can cause bacterial resistance against antibiotics. One of these factors is the

electromagnetic waves emitted from mobile simulator with a frequency of 900 MHz, which can increase the permeability of the cell wall of bacteria.

https://www.ncbi.nlm.nih.gov/pubmed/32039094

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Dynamic changes in cytoskeleton proteins of olfactory ensheathing cells induced by radiofrequency electromagnetic fields

Grasso R, Pellitteri R, Caravella SA, Musumeci F, Raciti G, Scordino A, Sposito G, Triglia A, Campisi A. Dynamic changes in cytoskeleton proteins of olfactory ensheathing cells induced by radiofrequency electromagnetic fields. J Exp Biol. 2020 Feb 10. pii: jeb.217190. doi: 10.1242/jeb.217190.

Abstract

Several evidences have suggested the ability of radio frequency electromagnetic fields to influence biological systems, even if the action mechanisms are not well understood. Only few data have reported about the effect of radio frequency electromagnetic fields on self-renewal of neural progenitor cells. A particular glial type, which shows characteristics of stem cells, are Olfactory Ensheathing Cells (OECs). Herein, we assessed the non-thermal effects induced on Olfactory Ensheathing Cells through radio frequency electromagnetic fields changing the envelope of the electromagnetic wave. Primary OEC cultures were exposed to continuous or amplitude modulated 900 MHz electromagnetic fields, in far field condition and at different exposition times (10, 15, 20 min). The expression of Olfactory Ensheathing Cells markers (S-100 and Nestin), cytoskeletal proteins (GFAP and Vimentin), apoptotic pathway activation by Caspase-3 cleavage and cell viability were evaluated.Our results highlight that 20 min of exposure to continuous or amplitude modulated 900 MHz electromagnetic fields induced a different and significant decrease in cell viability. In addition, according to the electromagnetic fields waveform, diverse dynamic changes in the expression of the analysed markers in Olfactory Ensheathing Cells and activation of apoptotic pathway were observed. The data suggest that radio frequency electromagnetic fields might play different and important role in the self-renewal of OEC stem cells, which are involved in nervous system repair.

https://www.ncbi.nlm.nih.gov/pubmed/32041804

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Lipid Oxidation Induced by RF Waves and Mediated by Ferritin Iron Causes Activation of Ferritin-Tagged Ion Channels

Hernández-Morales M, Shang T, Chen J, Han V, Liu C. Lipid Oxidation Induced by RF Waves and Mediated by Ferritin Iron Causes Activation of Ferritin-Tagged Ion Channels. Cell Rep. 2020 Mar 10;30(10):3250-3260.e7. doi: 10.1016/j.celrep.2020.02.070.

Abstract

One approach to magnetogenetics uses radiofrequency (RF) waves to activate transient receptor potential channels (TRPV1 and TRPV4) that are coupled to cellular ferritins. The mechanisms underlying this effect are unclear and controversial. Theoretical calculations suggest that the heat produced by RF fields is likely orders of magnitude weaker than needed for channel activation. Using the FeRIC (Ferritin iron Redistribution to Ion

Channels) system, we have uncovered a mechanism of activation of ferritin-tagged channels via a biochemical pathway initiated by RF disturbance of ferritin and mediated by ferritin-associated iron. We show that, in cells expressing TRPVFeRIC channels, RF increases the levels of the labile iron pool in a ferritin-dependent manner. Free iron participates in chemical reactions, producing reactive oxygen species and oxidized lipids that ultimately activate the TRPVFeRIC channels. This biochemical pathway predicts a similar RF-induced activation of other lipid-sensitive TRP channels and may guide future magnetogenetic designs.

https://www.ncbi.nlm.nih.gov/pubmed/32160534

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Possible Mechanism for Synchronized Detection of Weak Magnetic Fields by Nerve Cells

Barnes F, Greenebaum B. Possible Mechanism for Synchronized Detection of Weak Magnetic Fields by Nerve Cells. Bioelectromagnetics. Published online Jan 28, 2020. https://doi.org/10.1002/bem.22251

Abstract

We propose that biological systems may detect static and slowly varying magnetic fields by the modification of the timing of firing of adjacent nerve cells through the local influence of the magnetic field generated by current from one cell's firing on its nearest neighbors. The time delay of an adjacent nerve cell pulse with respect to the initial clock nerve cell pulse could serve as a signal for sensing the magnitude and direction of the magnetic field in a direction perpendicular to the current flows in the cells. It has been shown that changes in static magnetic fields modify concentrations of reactive oxygen species, calcium, pH, the growth rates of fibrosarcoma cells, and membrane potentials. These are linked to changes in membrane potentials that can either inhibit or accelerate the firing rate of pacemaker or clock cells. This mechanism may have applications to animals' use of magnetic fields for navigation or other purposes, possibly in conjunction with other mechanisms.

https://onlinelibrary.wiley.com/doi/abs/10.1002/bem.22251

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Assessment of Low-Frequency Magnetic Fields Emitted by DC Fast Charging Columns

Trentadue G, Pinto R, Salvetti M, Zanni M, Pliakostathis K, Scholz H, Martini G. Assessment of Low-Frequency Magnetic Fields Emitted by DC Fast Charging Columns. Bioelectromagnetics. 2020 Feb 11. doi: 10.1002/bem.22254.

Abstract

The expected imminent widespread use of electromobility in transport systems draws attention to the possible effects of human exposure to magnetic fields generated inside electric vehicles and during their recharge. The current trend is to increase the capacity of the battery inside the vehicles to extend the available driving range and to increase the power of recharging columns to reduce the time required for a full recharge. This leads to higher currents and potentially stronger magnetic fields. The Interoperability Center of the Joint Research Center started an experimental activity focused on the assessment of low-frequency magnetic fields emitted by five fast-charging devices available on the market in recharge and standby conditions. The aim of this study was to contribute to the development of a standard measurement procedure for the assessment of magnetic fields emitted by direct current charging columns. The spectrum and amplitudes of the magnetic field, as well as exposure indices according to guidelines for the general public and occupational exposure, were recorded

by means of a magnetic field probe analyzer. The worst-case scenario for instantaneous physical direct and indirect effects was identified. Measurements within the frequency range of 25 Hz-2 kHz revealed localized magnetic flux density peaks above 100 μT at the 50 Hz frequency in three out of five chargers, registered in close proximity during the recharge. Beyond this distance, exposure indices were recorded showing values below 50% of reference levels.

https://www.ncbi.nlm.nih.gov/pubmed/32043629

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Natural ELF fields in the atmosphere and in living organisms

Price C, Williams E, Elhalel G, Sentman D. Natural ELF fields in the atmosphere and in living organisms. Int J Biometeorol. 2020 Feb 8. doi: 10.1007/s00484-020-01864-6.

Abstract

Most electrical activity in vertebrates and invertebrates occurs at extremely low frequencies (ELF), with characteristic maxima below 50 Hz. The origin of these frequency maxima is unknown and remains a mystery. We propose that over billions of years during the evolutionary history of living organisms on Earth, the natural electromagnetic resonant frequencies in the atmosphere, continuously generated by global lightning activity, provided the background electric fields for the development of cellular electrical activity. In some animals, the electrical spectrum is difficult to differentiate from the natural background atmospheric electric field produced by lightning. In this paper, we present evidence for the link between the natural ELF fields and those found in many living organisms, including humans.

https://www.ncbi.nlm.nih.gov/pubmed/32034466

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Relationship between distance to overhead power lines and calculated fields in two studies

Amoon AT, Swanson J, Vergara X, Kheifets LI. Relationship between distance to overhead power lines and calculated fields in two studies. J Radiol Prot. 2020 Feb 17. doi: 10.1088/1361-6498/ab7730.

Abstract

There is some evidence that both distance from transmission lines and measured or calculated magnetic fields are associated with childhood leukemia. Because distance is a key component when calculating the magnetic field generated by power lines, distance from lines and calculated fields based on lines tend to be highly correlated. Socioeconomic status (SES) and dwelling type are also associated with magnetic field exposure. We used exposure data from two large studies of childhood leukemia and other cancers, in the US and the UK, to describe a relationship between distance and magnetic fields across the population within 100 meters (m) of power lines as a whole and evaluate potential modifiers such as SES and type of dwelling. There were 387 subjects living within 100 m of an overhead power line. There was no significant difference in mean calculated fields nor distance to 200+ kV lines within 100 m by study. Within the range where the power line field is expected to be significant compared to other sources, which we take as 100 m, distance to high voltage lines predicted MF variation in both studies better than other functions of distance tested in both linear and logistic regression. There were no differences between high and low SES nor dwelling types (single-family home vs

other). In conclusion, we found that calculated fields do appear to diminish linearly with increasing distance from overhead power lines, up to 100 m, particularly those 200+ kV and above. These results are stronger in the UK study. Within 100 m, distance to high voltage lines continues to be highly correlated with calculated magnetic fields and each can be a proxy for the other.

https://www.ncbi.nlm.nih.gov/pubmed/32066122

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The inverse relation between mitochondrial transmembrane potential and proteins α-helix in neuronal-like cells under static magnetic field and the role of VDAC

Calabrò E, Magazù S, Currò M, Ientile R. The inverse relation between mitochondrial transmembrane potential and proteins α-helix in neuronal-like cells under static magnetic field and the role of VDAC. Electromagn Biol Med. 2020 Mar 9:1-7. doi: 10.1080/15368378.2020.1737808.

Abstract

In this study, a correlation between cell channel α-helices displacement and the mitochondrial transmembrane potential after exposure of 3, 7, 15 and 24 h of neuronal-like cells to a uniform magnetic field at the intensity of 2 mT was shown. Fourier Transform Infrared (FTIR) Spectroscopy and fluorescence techniques were used to analyze the secondary structure of protein content and mitochondrial transmembrane potential, respectively. The main result of this study was represented by a significant inverse relation between the mitochondrial transmembrane potential and the intensity of the Amide I band that can be associated with time exposure. Given that mitochondrial transmembrane potential should be related to the gating state of voltage-dependent anion channel (VDAC) in mitochondrial membrane, this result could have a relevant role in medicine. Indeed, VDAC's irregular behavior can be associated with several varieties of mitochondria-associated pathologies and various forms of cancer and neurodegeneration.

https://www.ncbi.nlm.nih.gov/pubmed/32149540

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Radiofrequency Interference in the Clinical Laboratory

Badizadegan ND, Greenberg S, Lawrence H, Badizadegan K. Radiofrequency Interference in the Clinical Laboratory. Am J Clin Pathol. 2019 Apr 2;151(5):522-528. doi: 10.1093/ajcp/aqy174.

Abstract

OBJECTIVES: Radiofrequency interference (RFI) is a known medical device safety issue, but there are no documented cases of interference resulting in erroneous laboratory results.

METHODS: We investigated unexpected failure of a hematology analyzer resulting in erroneous WBC counts. Hardware failure was initially suspected, but temporal association with increased power output from a nearby antenna prompted investigation for RFI.

RESULTS: Power output from an antenna located approximately 4 feet from the analyzer was increased to

ensure sufficient signal for emergency communications in the building. Interference from the antenna resulted in aberrant side scatter and abnormal WBC counts. Powering down the antenna returned the instrument to normal working conditions.

CONCLUSIONS: We have shown RFI as the root cause of erroneous WBC counts in a hematology analyzer. We propose that RFI should be on the list of potential interfering mechanisms when clinical laboratory instruments generate inconsistent or unreliable results.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6445342/

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Electric and magnetic senses in marine animals, and potential behavioral effects of electromagnetic surveys

Nyqvist D, Durif C, Johnsen MG, De Jong K, Forland TN, Sivle LD. Electric and magnetic senses in marine animals, and potential behavioral effects of electromagnetic surveys. Mar Environ Res. 2020 Mar;155:104888. doi: 10.1016/j.marenvres.2020.104888.

Abstract

Electromagnetic surveys generate electromagnetic fields to map petroleum deposits under the seabed with unknown consequences for marine animals. The electric and magnetic fields induced by electromagnetic surveys can be detected by many marine animals, and the generated fields may potentially affect the behavior of perceptive animals. Animals using magnetic cues for migration or local orientation, especially during a restricted time-window, risk being affected by electromagnetic surveys. In electrosensitive animals, anthropogenic electric fields could disrupt a range of behaviors. The lack of studies on effects of the electromagnetic fields induced by electromagnetic surveys on the behavior of magneto- and electrosensitive animals is a reason for concern. Here, we review the use of electric and magnetic fields among marine animals, present data on survey generated and natural electromagnetic fields, and discuss potential effects of electromagnetic surveys on the behavior of marine animals.

https://www.ncbi.nlm.nih.gov/pubmed/32072990

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A sense of place: Pink salmon use a magnetic map for orientation

Putman NF, Williams CR, Gallagher EP, Dittman AH. A sense of place: Pink salmon use a magnetic map for orientation. J Exp Biol. 2020 Feb 6. pii: jeb.218735. doi: 10.1242/jeb.218735. [Epub ahead of print]

Abstract

The use of "map-like" information from Earth's magnetic field for orientation has been shown in diverse taxa, but questions remain regarding the function of such maps. We used a "magnetic displacement" experiment to demonstrate that juvenile pink salmon (Oncorhynchus gorbuscha) use magnetic cues to orient. The experiment was designed to simultaneously explore whether their magnetic map is used to direct fish (i) homeward, (ii) toward the center of their broad oceanic range, or (iii) along their oceanic migratory route. The

headings adopted by these navigationally naïve fish coincided remarkably well with the direction of the juveniles' migration inferred from historical tagging and catch data. This suggests that the large-scale movements of pink salmon across the North Pacific may be driven largely by their innate use of geomagnetic map cues. Key aspects of the oceanic ecology of pink salmon and other marine migrants might therefore be predicted from magnetic displacement experiments.

https://www.ncbi.nlm.nih.gov/pubmed/32029460

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On the biophysical mechanism of sensing upcoming earthquakes by animals

Panagopoulos DJ, Balmori A, Chrousos GP. On the biophysical mechanism of sensing upcoming earthquakes by animals. Sci Total Environ. 2020 Jan 29;717:136989. doi: 10.1016/j.scitotenv.2020.136989.

Abstract

It is documented that a few days or weeks before major Earthquakes (EQs) there are changes in animal behavior within distances up to 500 km from the seismic epicenter. At the same time Seismic Electric Signals (SES), geomagnetic and ionospheric perturbations, are detected within similar distances. SES consist of single unipolar pulses, and/or groups of such pulses called "SES activities" with an average frequency between successive pulses on the order of ~0.01 Hz and electric field intensity on the order of ~10-5-10-4 V/m (Frazer-Smith et al., 1990; Rikitake, 1998; Varotsos et al., 1993, 2011, 2019; Hayakawa et al., 2013; Grant et al., 2015). We show that the SES activities can be sensed by living organisms through the "Ion Forced-Oscillation Mechanism" for the action of Electromagnetic Fields (EMFs) on cells, according to which polarized EMFs can cause irregular gating of electro-sensitive ion channels on the cell membranes with consequent disruption of the cell electrochemical balance (Panagopoulos et al., 2000, 2002, 2015). This can be sensed by sensitive animals as discomfort in cases of weak and transient exposures, and may even lead to DNA damage and serious health implications in cases of intense exposure conditions (as in certain cases of man-made EMF exposures). Moreover, we show that the geomagnetic and ionospheric perturbations cannot be sensed through this mechanism. The same mechanism has explained meteoropathy, the sensing of upcoming thunderstorms by sensitive individuals, through the action of the EMFs of lightning discharges (Panagopoulos and Balmori, 2017). The present study shows that centuries-long anecdotal rumors of animals sensing intense upcoming EQs and displaying unusual behavior, lately documented by systematic studies, are now explained for the first time on the basis of the electromagnetic nature of all living organisms, and the electromagnetic signals emitted prior to EQs.

https://www.ncbi.nlm.nih.gov/pubmed/32070887

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Gray whales strand more often on days with increased levels of atmospheric radio-frequency noise

Granger J, Walkowicz L, Fitak R, Johnsen S. Gray whales strand more often on days with increased levels of atmospheric radio-frequency noise. Curr Biol. 2020 Feb 24;30(4):R155-R156. doi: 10.1016/j.cub.2020.01.028.

Abstract

Evidence from live gray whale strandings suggests that their navigation may be disrupted by increased radio frequency noise generated by solar storms, suggesting the potential for magnetoreception in this species.

https://www.ncbi.nlm.nih.gov/pubmed/32097638

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Adverse health effects of 5G mobile networking technology under real-life conditions

Kostoff RN, Heroux P, Aschner M, Tsatsakis A. Adverse health effects of 5G mobile networking technology under real-life conditions. Toxicology Letters. Published online Jan 25, 2020. https://doi.org/10.1016/j.toxlet.2020.01.020.

Highlights

• Identifies wide-spectrum of adverse health effects of non-ionizing non-visible radiation
• Most laboratory experiments were not designed to identify the more severe adverse effects reflective of real-life conditions
• Many experiments do not include the real-life pulsing and modulation of the carrier signal
• Vast majority of experiments do not account for synergistic adverse effects of other toxic stimuli with wireless radiation
• 5G mobile networking technology will affect not only the skin and eyes, but will have adverse systemic effects as well

Abstract

This article identifies adverse effects of non-ionizing non-visible radiation (hereafter called wireless radiation) reported in the premier biomedical literature. It emphasizes that most of the laboratory experiments conducted to date are not designed to identify the more severe adverse effects reflective of the real-life operating environment in which wireless radiation systems operate. Many experiments do not include pulsing and modulation of the carrier signal. The vast majority do not account for synergistic adverse effects of other toxic stimuli (such as chemical and biological) acting in concert with the wireless radiation. This article also presents evidence that the nascent 5 G mobile networking technology will affect not only the skin and eyes, as commonly believed, but will have adverse systemic effects as well.

https://www.sciencedirect.com/science/article/abs/pii/S037842742030028X?fbclid=IwAR2-J0fi_XJVnJ-pFvfmlBtvkJVd0mVCjLgia89IKv6IpNrCFDQmizoSDZU

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Appeals that matter or not on a moratorium on the deployment of the fifth generation, 5G, for microwave radiation

Hardell L, Nyberg R. [Comment] Appeals that matter or not on a moratorium on the deployment of the fifth generation, 5G, for microwave radiation. Molecular and Clinical Oncology. Published online January 22, 2020.

Abstract

Radiofrequency (RF) radiation in the frequency range of 30 kHz-300 GHz is classified as a 'possible' human carcinogen, Group 2B, by the International Agency for Research on Cancer (IARC) since 2011. The evidence has since then been strengthened by further research; thus, RF radiation may now be classified as a human

carcinogen, Group 1. In spite of this, microwave radiations are expanding with increasing personal and ambient exposure. One contributing factor is that the majority of countries rely on guidelines formulated by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), a private German non-governmental organization. ICNIRP relies on the evaluation only of thermal (heating) effects from RF radiation, thereby excluding a large body of published science demonstrating the detrimental effects caused by non-thermal radiation. The fifth generation, 5G, for microwave radiation is about to be implemented worldwide in spite of no comprehensive investigations of the potential risks to human health and the environment. In an appeal sent to the EU in September, 2017 currently >260 scientists and medical doctors requested for a moratorium on the deployment of 5G until the health risks associated with this new technology have been fully investigated by industry-independent scientists. The appeal and four rebuttals to the EU over a period of >2 years, have not achieved any positive response from the EU to date. Unfortunately, decision makers seem to be uninformed or even misinformed about the risks. EU officials rely on the opinions of individuals within the ICNIRP and the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR), most of whom have ties to the industry. They seem to dominate evaluating bodies and refute risks. It is important that these circumstances are described. In this article, the warnings on the health risks associated with RF presented in the 5G appeal and the letters to the EU Health Commissioner since September, 2017 and the authors' rebuttals are summarized. The responses from the EU seem to have thus far prioritized industry profits to the detriment of human health and the environment.

https://www.spandidos-publications.com/10.3892/mco.2020.1984

Excerpt

In conclusion, this article demonstrates that the EU has given mandate to a 13-member, non-governmental private group, the ICNIRP, to decide upon the RF radiation guidelines. The ICNIRP, as well as SCENIHR, are well shown not to use the sound evaluation of science on the detrimental effects of RF radiation, which is documented in the research which is discussed above (9,10,21-24,54,55). These two small organizations are producing reports which seem to deny the existence of scientific published reports on the related risks. It should perhaps be questioned whether it is in the realm of protecting human health and the environment by EU and whether the safety of EU citizens and the environment can be protected by not fully understanding the health-related risks.

Open access paper: https://www.spandidos-publications.com/10.3892/mco.2020.1984/download

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Limiting liability with positioning to minimize negative health effects of cellular phone towers

Pearce JM. Limiting liability with positioning to minimize negative health effects of cellular phone towers. Environmental Research. Available online 29 November 2019, 108845.

Highlights

• Cellular phone networks demand widespread human exposure to radio-frequency radiation (RFR).
• Cellular phone base stations density & power output increasing global human RFR exposure.
• Already enough medical-scientific evidence to warrant long-term liability concerns.
• To protect cell phone tower firms, companies should seek to minimize human RFR exposure.

Abstract

The use of cellular phones is now ubiquitous through most of the adult global population and is increasingly common among even young children in many countries (e.g. Finland, where the market for smart phones is nearly saturated). The basic operation of cellular phone networks demands widespread human exposure to radio-frequency radiation (RFR) with cellular phone base stations providing cellular coverage in most areas. As the data needs of the population increase from the major shift in the source of Internet use from personal computers to smart phones, this coverage is widely predicted to increase. Thus, both the density of base stations and their power output is expected to increase the global human RFR exposure. Although direct causation of negative human health effects from RFR from cellular phone base stations has not been finalized, there is already enough medical and scientific evidence to warrant long-term liability concerns for companies deploying cellular phone towers. In order to protect cell phone tower firms from the ramifications of the failed paths of other industries that have caused unintended human harm (e.g. tobacco) this Current Issue summarizes the peer-reviewed literature on the effects of RFR from cellular phone base stations. Specifically the impacts of siting base stations are closely examined and recommendations are made for companies that deploy them to minimize their potential future liability.

https://www.ncbi.nlm.nih.gov/pubmed/31791710

Excerpts

A review article of the health effects near base stations concluded that deployment of base stations should be kept as efficient as possible to minimize exposure of the public to RFR and should not be located less than 500m from the population, and at a height of 50m (Levitt and Lai, 2010)....

There are several first steps a cellular phone company can take to minimize human exposure particularly of the most vulnerable populations. First, voluntarily restrictions can be made on the placement of cellular phone base stations within 500m of schools and hospitals....

The second technical hurdle is more challenging. Ideally, all cell phone users would have coverage while minimizing the population density near cellular phone base stations (thus minimizing health impacts) ....

The cell phone industry should also consider cell splitting, small cell deployment, beam and null steering antennae as possible technical means for reducing RF exposure. Moreover, more research on cognitive radio should also be conducted, so that the overall RF exposure is reduced....

Finally, exposed companies should consider funding large-scale epidemiological studies with personal dosimeters for strict dose measurement and straight-forward tissue exposure. By quantifying the human medical threat themselves, more appropriate long-term planning can be made to minimize the risk of liability from unintended human harm due to cellular phone base station siting.

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Cancer statistics, 2020: **Brain and other nervous system cancer incidence and death rates**

Siegel RL, Miller KD, Jemal A. Cancer statistics, 2020. CA: A Cancer Journal for Clinicians. doi: 10.3322/caac.21590.

Cancer incidence

The American Cancer Society estimates that there will be 23,890 new cases of brain & other nervous system (ONS) cancers this year in the U.S. and 18,020 people will die from these types of cancer (Table 1). Leukemia is the most common childhood (birth to 19 years of age) cancer, accounting for 28% of cases, followed by brain & ONS cancers (26%), greater than one-quarter of which are benign/borderline malignant (Table 12).In adolescents, brain & ONS cancers are most common (21%), greater than one-half of which are benign/borderline malignant, followed closely by lymphoma (20%). (p. 18)

Cancer deaths

Death rates increased over the past decade for brain & ONS cancers (p. 13). Brain & ONS cancers are the first leading cause of cancer death among men aged younger than 40 years and women aged younger than 20 years. These cancers are the fourth leading cause of cancer death among women aged 20 to 39 years and the fifth leading cause of cancer death among men aged 40 to 59 years (Table 8).

Open access paper: https://acsjournals.onlinelibrary.wiley.com/doi/full/10.3322/caac.21590

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An experimental study on effects of radiofrequency electromagnetic fields on sleep in healthy elderly males and females: Gender matters!

Danker-Hopfe H, Dorn H, Sauter C, Schmid G, Eggert T. An experimental study on effects of radiofrequency electromagnetic fields on sleep in healthy elderly males and females: Gender matters! Environmental Research. 183, April 2020, 109181

https://doi.org/10.1016/j.envres.2020.109181

Highlights

• First paper to investigate gender specific RF-EMF effects in elderly subjects.
• RF-EMF affects approximately 10% of the sleep variables directly.
• RF-EMF affects approximately 12% of the sleep variables differently in men and women.
• Women are more affected than men.
• None of the observed effects is indicative of a disturbed sleep.

Abstract

Background Results from human experimental studies investigating possible effects of radiofrequency electromagnetic fields (RF-EMF) on sleep are heterogeneous. So far, there is no study on possible sex-differences in RF-EMF effects.

Objectives The present study aimed at analyzing differences in RF-EMF effects on the macrostructure of sleep between healthy elderly males and females.

Methods With a double-blind, randomized, sham-controlled cross-over design effects of two RF-EMF exposures (GSM900 and TETRA) on sleep were investigated in samples of 30 elderly healthy male and 30 healthy elderly female volunteers. Participants underwent each of the three exposure conditions on three occassions following an individually randomized order resulting in a total of nine study nights per participant. Exposure was delivered for 30 min prior to sleep and for the whole night (7.5 h) by a head worn antenna

specifically designed for the projects. The peak spatial absorption rate averaged over time in head tissues (psSAR10g) was 6 W/kg for TETRA and 2 W/kg for GSM900. Thirty variables characterising the macrostructure of sleep and arousals as well as four subjective sleep variables were considered for statistical analyses.

Results Multivariate analyses revealed that exposure to GSM900 and/or TETRA resulted in a significant reduction in arousals, a shorter latency to sleep stage N3, and a shorter self-reported time awake after sleep in both males and females. Exposure effects depending on sex (significant interactions) were observed. Latency to sleep stage R was shorter in females and tended to be longer in males under both exposures. Latency to stage N3 was shorter in females under TETRA exposure and almost not affected in males. The time awake within the sleep period under TETRA exposure was shorter in females and only slightly longer in males. Under GSM exposure, the self-rated total sleep time tended to be longer in females and to be shorter in males. Finally, the number of awakenings was lower only in females and tended to be higher in males under GSM exposure.

Discussion With regard to RF-EMF effects on human sleep it seems that gender matters since GSM900 and TETRA led to significantly more exposure effects in females. Regardless of gender, none of the observed changes is indicative of a sleep disturbing effect of RF-EMF exposure. Observed effects might be mediated by skin related thermoregulatory mechanisms.

https://www.sciencedirect.com/science/article/abs/pii/S0013935120300736

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Dimensionless coefficients for assessing human exposure to radio-frequency electromagnetic fields indoors and outdoors in urban areas

Paniagua JM, Rufo M, Jiménez A, Antolín A. Dimensionless coefficients for assessing human exposure to radio-frequency electromagnetic fields indoors and outdoors in urban areas. Environmental Research. 183, April 2020, 109188.

Highlights

• Residential areas were measured indoors and outdoors with a personal exposimeter.
• Different protocols were used for indoor and outdoor measurements.
• Electric field was systematically detected in the FM and downlink mobile phone bands.
• Median exposure quotient was 2.5 10−6 outdoors and 1.6 10−6 indoors.
• Exposure quotient: FM radio > downlink > DECT and WIFI.

Abstract

The main objective of this work was to evaluate human exposure to electromagnetic fields in a city of about one hundred thousand inhabitants, both inside and outside dwellings, using exposure quotients. To this end, a personal exposure meter was used, collecting data in different frequency bands, including radio and television broadcasting, mobile telephony, cordless telephones, and wireless communication networks. The indoor measurements were made with the exposure meter in a static position. Those outdoor were made by walking around the building with the exposure meter held by the operator. The median electric field was 0.200 V/m outdoors and 0.102 V/m indoors. The median of the ICNIRP exposure quotients for multiple-frequency sources was 25 x 10−6 outside and 16 x 10−6 inside. The proximity of the operator's body caused the readings of the

electric field in the FM band to be overestimated by a factor of 1.35, and in the mobile telephony bands by factors from 0.76 to 1.02. The standard deviation of the measurements repeated inside a dwelling over five days was of the order of the exposure meter's standard uncertainty of calibration, but the spatial dispersion at the scale of a dwelling and of the city was much greater. The two main contributors to the exposure were FM radio followed by the “downlink” mobile telephony bands. Inside the dwellings, the DECT and WIFI bands contributed less. Exposure quotients are dimensionless parameters that characterize exposure, and reflect the relative weight of each service to that exposure.

https://www.ncbi.nlm.nih.gov/pubmed/32032813

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Spatial and temporal assessment of radiofrequency electromagnetic fields emitted by smart meters and smart meter banks in urban environments

Aerts S, Van den Bossche M, Vergara X, Odie S, Verloock L, Martens L, WoutJ. Spatial and temporal assessment of radiofrequency electromagnetic fields emitted by smart meters and smart meter banks in urban environments. Environmental Research. 183. Apr 2020. 109196.

Highlights

• We present a method to assess spatiotemporal RF-EMF exposure to AMI smart meters.

• Measurements of smart meter(s) (banks) were performed in a densely populated area.

• Maximum field levels at 0.3 m were 13 V/m (1 m) and 38 V/m (>20 m).

• Duty cycles were between 0.01% (1 m) and 14% (81-m bank).

• The maximum time-averaged exposure level was 9.43% of the ICNIRP reference level.

Abstract

This paper describes radiofrequency (RF) electromagnetic field (EMF) measurements in the vicinity of single and banks of advanced metering infrastructure (AMI) smart meters. The measurements were performed in a meter testing and distribution facility as well as in-situ at five urban locations. The measurements consisted of gauging the RF environment at the place of assessment, evaluating the worst-case electric-field levels at various positions around the assessed AMI meter configuration (spatial assessment), which ranged from a single meter to a bank of 81 m, and calculating the duty cycle of the system, i.e. the fraction of time that the AMI meters were actually transmitting (12-h temporal assessment). Both in-situ and in the meter facility, the maximum field levels at 0.3 m from the meter configurations were 10–13 V/m for a single meter and 18–38 V/m for meter banks with 20–81 m. Furthermore, 6-min average duty cycles of 0.01% (1 m) up to 13% (81-m bank) were observed. Next, two general statistical models (one for a single meter and one for a meter bank) were constructed to predict the electric-field strength as a function of distance to any configuration of the assessed AMI meters. For all scenarios, the measured exposure levels (at a minimum distance of 0.3 m) were well below the maximum permissible exposure limits issued by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), the U.S. Federal Communications Commission (FCC), and the Institute of Electrical and Electronics Engineers (IEEE). Indeed, the worst-case time-average exposure level at a distance of 0.3 m from an AMI installation was 5.39% of the FCC/IEEE and 9.43% of the ICNIRP reference levels.

https://www.sciencedirect.com/science/article/abs/pii/S0013935120300888

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Pulsed high-power microwaves do not impair the functions of skin normal and cancer cells in vitro: A short-term biological evaluation

Mumtaz S, Bhartiya P, Kaushik N, Adhikari M, Lamichhane P, Lee S-J, Kaushik NK, Choi EH. Pulsed high-power microwaves do not impair the functions of skin normal and cancer cells in vitro: A short-term biological evaluation. J Advance Research. 22: 47-55. Mar 2020.

Highlights

• Pulsed high power microwave (MW) at a frequency 3.5 GHz was generated.
• MW did not induce cell death in skin fibroblast normal cells and melanoma cells.
• MW did not alter the morphology of melanoma cells.
• Gene expression related to ATP synthesis and proliferation can get altered by MW.
• MW selectively stimulated viability and proliferation of only melanoma cells.

Abstract

Over the past few decades, microwave (MW) radiation has been widely used, and its biological effects have been extensively investigated. However, the effect of MW radiation on human skin biology is not well understood. We study the effects of pulsed high-power microwaves (HPMs) on melanoma (G361 and SK-Mel-31) and normal human dermal fibroblast (NHDF) cells. A pulsed power generator (Chundoong) was used to generate pulsed HPMs (dominant frequency: 3.5 GHz). For treatment 1, 5, 15, and 45 shots are given to cells in which the electromagnetic energy of 0.6 J was delivered to the cells at each trigger shot. Cell viability, proliferation rate, apoptosis, cell death, metabolic activity, and oxygen-free radical regulation were evaluated after the MW exposure at low and high doses. MW exposure increased the viabilities and proliferation rates of both melanoma cell lines in a dose-dependent manner, while no significant effects on the fibroblast cells were observed. We found an elevated level of ATP and mitochondrial activity in melanoma cells. Also, it was observed that MW exposure did not affect cell death in melanoma and fibroblast cells. A polymerase chain reaction analysis indicated that the MWs induced dose-dependent proliferation markers without affecting the cell cycle and apoptotic genes in the melanoma cells. Our findings show the differential effects ofthe MW radiation on the melanoma cells, compared to those on the fibroblast cells.

Conclusion

This study reveals that the MW exposure led to increased cell growth and proliferation specific to melanoma after 24 h, which could be attributed to the increased mitochondrial activity by the increased ATP level. The MW exposure did not affect the normal fibroblast cells at the considered doses, while it altered the melanoma cell physiology in a cell-type specific manner. Therefore, MW exposure may be utilized with mitotic inhibitory chemotherapeutic drugs for melanoma cells and should be considered while analyzing melanoma cells in vitro.Further investigations are required to study the cellular signaling upon MW exposure.

Open access paper: https://doi.org/10.1016/j.jare.2019.11.007

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RF-induced temperature increase in a stratified model of the skin for plane-wave exposure at 6-100 GHz

Christ A, Samaras T, Neufeld E, Kuster N. RF-induced temperature increase in a stratified model of the skin for plane-wave exposure at 6-100 GHz. Radiat Prot Dosimetry. 2020 Jan 16. pii: ncz293. doi: 10.1093/rpd/ncz293.

Abstract

This study assesses the maximum temperature increase induced by exposure to electromagnetic fields

between 6 and 100 GHz using a stratified model of the skin with four or five layers under plane wave incidence. The skin model distinguishes the stratum corneum (SC) and the viable epidermis as the outermost layers of the skin. The analysis identifies the tissue layer structures that minimize reflection and maximize the temperature increase induced by the electromagnetic field. The maximum observed temperature increase is 0.4°C for exposure at the present power density limit for the general population of 10 W m -2 . This result is more than twice as high as the findings reported in a previous study. The reasons for this difference are identified as impedance matching effects in the SC and less conservative thermal parameters. Modeling the skin as homogeneous dermis tissue can underestimate the induced temperature increase by more than a factor of three.

https://www.ncbi.nlm.nih.gov/pubmed/31950182

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Effects of electromagnetic fields from (4G) long-term evolution on awake electroencephalogram in healthy humans

Nakatani-Enomoto S, Yamazaki M, Nishiura K, Enomoto H, Ugawa Y. Effects of electromagnetic fields from long-term evolution on awake electroencephalogram in healthy humans. Neurosci Res. 2020 Jan 25. pii: S0168-0102(20)30036-5. doi: 10.1016/j.neures.2020.01.010.

Abstract

Mobile phones are indispensable for daily life, and the adverse effects of the electromagnetic field (EMF) emitted by mobile phones have been a great concern. We studied the effects of long-term evolution (LTE) -like EMF for 30 min on an awake electroencephalogram (EEG). Thirty-eight healthy volunteers, aged 20 to 36 years old, participated in this study. The maximum local SAR (specific absorption rate) averaged over 10-g mass was 2.0 W/kg. The EEG was recorded before and after real or sham exposures. The effects of exposure conditions (real or sham) and the recording time (before, during, and after exposure) on each EEG power spectrum of θ, α, and β frequency ranges were analyzed. The θ and α band waves were enhanced after both exposure conditions. These results may be explained by the participants' drowsiness during the EEG recording in both exposures. We conclude that an LTE-like exposure for 30 min in this study showed no detectable harmful effects on awake EEGs in healthy humans.

https://www.ncbi.nlm.nih.gov/pubmed/31991204

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Investigation of SAR (Specific Absorption Rate) in Different Head Models Placed in Shielded Space

Psenakova Z, Benova M, Mydlova J. Investigation of SAR (Specific Absorption Rate) in Different Head Models Placed in Shielded Space. 2019 IEEE 20th International Conference on Computational Problems of Electrical Engineering (CPEE).15-18 Sept. 2019**.**

Abstract

This article deals with effects of electromagnetic (EM) fields to different types of numerical models of human head. There are differences between specific absorption rate (SAR) near human head model inside shielded space like in elevator or non-shielded space (open area). In the presented approach, the investigation is focused on modelling of EM field proceeded on the finite integration method. The simulations were carried out

for specific scenario where a person/passenger was placed in the shielded space using a cellular phone. The results were evaluated in terms of the SAR values – the determination of EM energy absorption inside the human head. The dipole antenna with a frequency of 900 MHz was designed and working as radio frequency source. In the proposed matching method, two models of human head - SAM homogenous human head model and AustinMan model - were chosen to model three different distances of the cellular phone from the human head surface. Both have the dielectric properties determined to the evaluated frequency of source. The numerical results have shown that the obtained maximal SAR values in shielded/enclosure (such as the elevator) is higher than are maximum values determined according to maximum SAR in European standards limit. Additionally, the obtained SAR values are higher than the results achieved by the open space simulations.

Conclusions

In this paper, the study of the electromagnetic energy absorption changes caused to the human head models in different situations-open and shielded space was proposed. The near-field exposure results from have shown that the SAR values vary for the antenna distance and space, where is the antenna placed as well as to the use of human head model. The changes of EM fields relate to the above-mentioned process – occurrence of EM fields reflection from the surface of iron shielded space. This reflected wave interferes with the primary wave from the radiation source, resulting in increased wave amplitude. In a shaded environment, this affects the object by absorbing direct waves from the source in the tissue as well as reflected waves, resulting in a higher SAR value.

In some cases of our simulation scenarios, the SAR values results are not within the limits for public radio-frequency EM field exposure by ICNIRP. However, it could be caused by setting the specific parameters of our simulations – such as dielectric parameters of materials, number of voxels, boundary conditions in each space and model of human head. On the other hand, the cases presented in this paper, represent a risk for long-term exposure of human body, especially of human head, to EM field.

In this article we would like to show differences between open space and shielded space, which could be some vehicles like train, car and another shielded spaces with low signal from base station like underground park places or elevators. Mobile phone has highest power in this types of spaces and places, which was proven in our simulations. [12]

https://ieeexplore.ieee.org/document/8949133

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Variation in Reported Human Head Tissue Electrical Conductivity Values

McCann H, Pisano G, Beltrachini L. Variation in Reported Human Head Tissue Electrical Conductivity Values. Brain Topogr. 2019 Sep;32(5):825-858. doi: 10.1007/s10548-019-00710-2.

Abstract

Electromagnetic source characterisation requires accurate volume conductor models representing head geometry and the electrical conductivity field. Head tissue conductivity is often assumed from previous literature, however, despite extensive research, measurements are inconsistent. A meta-analysis of reported human head electrical conductivity values was therefore conducted to determine significant variation and subsequent influential factors. Of 3121 identified publications spanning three databases, 56 papers were included in data extraction. Conductivity values were categorised according to tissue type, and recorded alongside methodology, measurement condition, current frequency, tissue temperature, participant pathology

and age. We found variation in electrical conductivity of the whole-skull, the spongiform layer of the skull, isotropic, perpendicularly- and parallelly-oriented white matter (WM) and the brain-to-skull-conductivity ratio (BSCR) could be significantly attributed to a combination of differences in methodology and demographics. This large variation should be acknowledged, and care should be taken when creating volume conductor models, ideally constructing them on an individual basis, rather than assuming them from the literature. When personalised models are unavailable, it is suggested weighted average means from the current meta-analysis are used. Assigning conductivity as: 0.41 S/m for the scalp, 0.02 S/m for the whole skull, or when better modelled as a three-layer skull 0.048 S/m for the spongiform layer, 0.007 S/m for the inner compact and 0.005 S/m for the outer compact, as well as 1.71 S/m for the CSF, 0.47 S/m for the grey matter, 0.22 S/m for WM and 50.4 for the BSCR.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6708046/

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A Theoretical Study on the Biophysical Mechanisms by Which Tumor Treating Fields Affect Tumor Cells during Mitosis

Li X, Yang F, Rubinsky B. A Theoretical Study on the Biophysical Mechanisms by Which Tumor Treating Fields Affect Tumor Cells during Mitosis. IEEE Trans Biomed Eng. 2020 Jan 13. doi: 10.1109/TBME.2020.2965883.

Abstract

OBJECTIVE: A theoretical study on the mechanisms through which Tumor Treating Fields (TTFields) affect dividing tumor cells.

METHODS: Numerical analysis was used to revisit two previously proposed mechanisms and introduce a third. We examine the previous hypotheses that: a) TTFields generate a moment that affects microtubule assembly during early mitosis, and b) dielectrophoretic (DEP) forces cause neutral particles to move toward the cleavage furrow during the telophase stage. We further introduce a new hypothesis that TTFields modify cell membrane potential in dividing tumor cells.

RESULTS: a) The Brownian energy is several orders of magnitude larger than the moment induced by TTFields on tubulin dimers. b) Adding Stokes drag forces to DEP forces shows that the motion of the particles in the cytoplasm is very slow, approximately 0.003 μm/s, and therefore, unless the duration of the telophase is long enough there will be no substantial effect from the DEP forces. c) The Schwan equation shows that electric fields at the frequencies of clinical TTFields can cause a 10% - 17% change in tumor cell membrane potential.

CONCLUSION: Our studies find limited support for the previously suggested hypotheses and suggest that the TTFields effect on cell membrane potential by affecting ion channels could be a mechanism of tumor cell death.

SIGNIFICANCE: Previously suggested mechanisms of tumor cell death from TTFields are found lacking. The effect of TTFields on the tumor cell membrane potential warrants further research.

https://www.ncbi.nlm.nih.gov/pubmed/31940516

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A Critical Review and Synthesis of Clinical and Neurocognitive Effects of Noninvasive Neuromodulation Antidepressant Therapies.

McClintock SM, Kallioniemi E, Martin DM, Kim JU, Weisenbach SL, Abbott CC. A Critical Review and Synthesis of Clinical and Neurocognitive Effects of Noninvasive Neuromodulation Antidepressant Therapies. Focus (Am Psychiatr Publ). 2019 Jan;17(1):18-29. doi: 10.1176/appi.focus.20180031.

Abstract

There is a plethora of current and emerging antidepressant therapies in the psychiatric armamentarium for the treatment of major depressive disorder. Noninvasive neuromodulation therapies are one such therapeutic category; they typically involve the transcranial application of electrical or magnetic stimulation to modulate cortical and subcortical brain activity. Although electroconvulsive therapy (ECT) has been used since the 1930s, with the prevalence of major depressive disorder and treatment-resistant depression (TRD), the past three decades have seen a proliferation of noninvasive neuromodulation antidepressant therapeutic development. The purpose of this critical review was to synthesize information regarding the clinical effects, neurocognitive effects, and possible mechanisms of action of noninvasive neuromodulation therapies, including ECT, transcranial magnetic stimulation, magnetic seizure therapy, and transcranial direct current stimulation. Considerable research has provided substantial information regarding their antidepressant and neurocognitive effects, but their mechanisms of action remain unknown. Although the four therapies vary in how they modulate neurocircuitry and their resultant antidepressant and neurocognitive effects, they are nonetheless useful for patients with acute and chronic major depressive disorder and TRD. Continued research is warranted to inform dosimetry, algorithm for administration, and integration among the noninvasive neuromodulation therapies and with other antidepressant strategies to continue to maximize their safety and antidepressant benefit.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6493152/

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The role of radiation induced oxidative stress as a regulator of radio-adaptive responses

Sisakht M, Darabian M, Mahmoodzadeh A, Bazi A, Shafiee SM, Mokarram P, Khoshdel Z. The role of radiation induced oxidative stress as a regulator of radio-adaptive responses. Int J Radiat Biol. 2020 Jan 24:1-40. doi: 10.1080/09553002.2020.1721597.

Abstract

Purpose: Various sources of radiation including radiofrequency, electromagnetic radiation (EMR), low- dose X-radiation, low-level microwave radiation and ionizing radiation (IR) are indispensable parts of modern life. In the current review, we discussed the adaptive responses of biological systems to radiation with a focus on the impacts of radiation-induced oxidative stress (RIOS) and its molecular downstream signaling pathways.

Materials and methods: A comprehensive search was conducted in Web of Sciences, PubMed, Scopus, Google Scholar, Embase, and Cochrane Library. Keywords included Mesh terms of "radiation", "electromagnetic radiation", "adaptive immunity", "oxidative stress", and "immune checkpoints". Manuscript published up until December 2019 were included.

Results: RIOS induces various molecular adaptors connected with adaptive responses in radiation exposed cells. One of these adaptors includes p53 which promotes various cellular signaling pathways. RIOS also activates the intrinsic apoptotic pathway by depolarization of the mitochondrial membrane potential and activating the caspase apoptotic cascade. RIOS is also involved in radiation-induced proliferative responses through interaction with mitogen-activated protein kinases (MAPks) including p38 MAPK, ERK, and c-Jun N-terminal kinase (JNK). Protein kinase B (Akt)/phosphoinositide 3-kinase (PI3K) signaling pathway has also been reported to be involved in RIOS-induced proliferative responses. Furthermore, RIOS promotes genetic instability by introducing DNA structural and epigenetic alterations, as well as attenuating DNA repair mechanisms. Inflammatory transcription factors including macrophage migration inhibitory factor (MIF), nuclear factor κB (NF-κB), and signal transducer and activator of transcription-3 (STAT-3) paly major role in RIOS-induced inflammation.

Conclusion: In conclusion, RIOS considerably contributes to radiation induced adaptive responses. Other possible molecular adaptors modulating RIOS-induced responses are yet to be divulged in future studies.

https://www.ncbi.nlm.nih.gov/pubmed/31976798

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National observatory of electromagnetic fields: National telemetric network for the measurement of high-frequency electromagnetic fields in Greece

Karastergios I, Gialofas A, Karabetsos E. National observatory of electromagnetic fields: National telemetric network for the measurement of high-frequency electromagnetic fields in Greece. Radiat Prot Dosimetry. 2020 Feb 5. pii: ncz301. doi: 10.1093/rpd/ncz301.

Abstract

At the end of 2015, the operation of the National Observatory of Electromagnetic Fields (established in 2012) has started. The National Observatory of Electromagnetic Fields is a network of 500 fixed (480 broadband and 20 frequency selective) and 13 mobile (vehicle mounted frequency selective) measurement stations throughout Greece that continuously monitor the electromagnetic field levels from all kinds of antenna stations in the frequency range 100kHz-7GHz. The results of this national monitoring network, which is operated and controlled by the Greek Atomic Energy Commission (EEAE), are presented through an interactive web portal (https://paratiritirioemf.eeae.gr), in which data are constantly updated with the latest station measurements. This paper presents the operational aspects and the measurement results of the first 3 years of operation (2016-2018). The measurement results revealed that all values were well below the reference levels for general public exposure, as defined by the Greek legislation.

https://www.ncbi.nlm.nih.gov/pubmed/32022239

Conclusions

The scope of this study is to present the NOEF's measurement data of the broadband measurement stations for the first 3 years of its operation. The measurement sample consists of 489 annual average and maximum values from all frequency bands of the broadband monitoring stations, 100kHz–7GHz, and the three sub-bands, 925–960 MHz, 1805–1880 MHz and 2110–2170 MHz.

It is concluded that 100% of the annual average and maximum values, from all four aforementioned frequency bands, are lower than 10 V/m (equivalent to 0.2653 W/m^2), which is well below the Greek reference levels for general public exposure. It should be noted that the established Greek safety limits for general public exposure in the vicinity of antenna stations are set in general to 70% of the 1999 EU Council's Recommendation and the 1998 ICNIRP guidelines for basic restrictions and reference level values and to 60% of them for stations located closer than 300 meters from the perimeter of schools, kindergartens, hospitals or eldercare facilities. The comparison of the NOEF's measurements data is performed with the 60% of the EU Recommendation reference levels in all cases, as this is the strictest Greek exposure limit.

Also, 91% of the annual average values of the 100kHz–7GHz frequency band are lower than 2 V/m (or 0.0106 W/m^2), while 92% of the annual average values for both 925–960 MHz–1805–1880 MHz sub-bands are below 1 V/m (or 0.00265 W/m^2), and 91% of the annual average values of the 2110–2170 MHz sub-band are below 1 V/m (or 0.00265 W/m^2).

Regarding the annual maximum values, the statistics are similar; 80% of the annual maximum values of the 100kHz–7GHz frequency band are below 2 V/m (or 0.0106 W/m^2); 83% of the annual maximum values of the 925–960 MHz frequency band are below 1 V/m (or 0.00265 W/m^2); 79% of the annual maximum values of the 1805–1880 MHz frequency band are below 1 V/m (or 0.00265 W/m^2); 80% of the annual maximum values of the 2110–2170 MHz frequency band are below 1 V/m (or 0.00265 W/m^2).

It is to be noted that, as expected, at the lower value intervals of electrical field strength, there is a higher concentration of average values than at the higher value intervals.

Also, the standard deviation values of the annual average values are below 0.5 V/m for the majority of the measurement locations. This is due to the normal daily fluctuations of the telecommunication networks traffic which results to variations of the measured electromagnetic fields levels.

Moreover, at locations with higher-than-normal standard deviation values, a change of the electromagnetic fields background levels has been observed within the 3-year period of the study which was verified with in situ measurements with handheld frequency selective EMF measuring equipment.

It should also be mentioned that the aforementioned results show higher exposure levels when compared to the results from the international radiofrequency exposure surveys[13] that mostly concern ground-level measurements. This is expected since all the NOEF's fixed measuring stations are installed on rooftops, and so, measurement results represent 'worst-case' general public exposure conditions. Rooftop measurements are also performed by the telemetric networks mentioned in [7, 8] and Table 1. Hence, the NOEF's results are similar to those of the abovementioned telemetric networks.

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Apoptotic Effect of 1800 MHz Electromagnetic Radiation on NIH/3T3 Cells

Li DY, Song JD, Liang ZY, Oskouei K, Xiao XQ, Hou WZ, Li JT, Yang YS, Wang ML, Murbach M. Apoptotic Effect of 1800 MHz Electromagnetic Radiation on NIH/3T3 Cells. Int J Environ Res Public Health. 2020 Jan 28;17(3). pii: E819. doi: 10.3390/ijerph17030819.

Abstract

To investigate the effect of 1800 MHz electromagnetic radiation (EMR) on apoptosis, we exposed NIH/3T3 cells at 1800 MHz with a specific absorption rate (SAR) of 2 W/kg intermittently for 12, 24, 36, and 48 h. After exposure, Cell Counting Kit-8 (CCK-8) and flow cytometry were used to detect cell viability and apoptosis; the expression of p53, a molecule with the key role in apoptosis, was measured by real-time qPCR, western blot,

and immunofluorescence; and images of the structure of the mitochondria, directly reflecting apoptosis, were captured by electron microscopy. The results showed that the viability of cells in the 12, 36, and 48 h exposure groups significantly decreased compared with the sham groups; after 48 h of exposure, the percentage of late apoptotic cells in the exposure group was significantly higher. Real-time qPCR results showed that p53 mRNA in the 48 h exposure group was 1.4-fold of that in the sham group; significant differences of p53 protein fluorescence expression were observed between the exposure groups and the sham groups after 24 h and 48 h. The mitochondrial swelling and vesicular morphology were found in the electron microscopy images after 48 h exposure. These findings demonstrated 1800 MHz, SAR 2 W/kg EMR for 48 h may cause apoptosis in NIH/3T3 cells and that this apoptosis might be attributed to mitochondrial damage and upregulation of p53 expression.

Open access paper: https://www.mdpi.com/1660-4601/17/3/819

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Electromagnetic field modulates aggregation propensity of amyloid peptides

Todorova N, Bentvelzen A, Yarovsky I. Electromagnetic field modulates aggregation propensity of amyloid peptides. J Chem Phys. 2020 Jan 21;152(3):035104. doi: 10.1063/1.5126367.

Abstract

Nonthermal effects of the electromagnetic (EM) field in the radio and microwave frequency ranges on basic biological matter are difficult to detect and thus remain poorly understood. In this work, all-atom nonequilibrium molecular dynamics simulations were performed to investigate the molecular mechanisms of an amyloidogenic peptide response to nonionizing radiation of varying field characteristics. The results showed that the EM field induced peptide conformations dependent on the field frequency and strength. At the high field strength (0.7 V/nmrms), the peptide explored a wider conformational space as the frequency increased from 1.0 to 5.0 GHz. At the intermediate strength fields (0.07-0.0385 V/nmrms), the frequencies of 1.0 and 2.5 GHz resulted in the peptide being trapped in specific conformations, with 1.0 GHz enabling both fibril-forming and fibril-inhibiting conformations, while 2.5 GHz led to formation of mostly fibril-forming conformations. In contrast, the 5.0 GHz frequency caused increased peptide dynamics and more extended conformations with fibril-enabling aromatic side-chain arrangement akin to the structures formed under ambient conditions. All the simulated frequencies at low strength fields (0.007-0.0007 V/nmrms) resulted in the formation of amyloid-prone hairpin conformations similar to those formed under the weak static electric field and ambient conditions. These results suggest that specific ranges of EM field parameters produce peptide conformations unfavorable for formation of amyloid fibrils, a phenomenon that can be exploited in treatment and prevention of amyloid diseases. Alternatively, EM field parameters can be selected to modulate the formation of well-ordered peptide assemblies as a rational design strategy for engineering biocompatible materials.

Open access paper: https://aip.scitation.org/doi/10.1063/1.5126367

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Comparison of statistic methods for censored personal exposure to RF-EMF data

Najera A, Ramirez-Vazquez R, Arribas E, Gonzalez-Rubio J. Comparison of statistic methods for censored personal exposure to RF-EMF data. Environ Monit Assess. 2020 Jan 2;192(2):77. doi: 10.1007/s10661-019-8021-z.

Abstract

Several studies have characterized personal exposure to RF-EMF, which allows possible effects on health to be studied. All equipment has a detection limit, below which we obtain nondetects or censored data. This problem is a challenge for researchers as it makes the analysis of such data complex. We suggest reconsidering the statistical protocols of the nondetects analysis by comparing four different methods. Three of them substitute censored data using different approaches: regression on order of statistics (ROS) to simulate data below the detection limit (Method 1), substituting nondetect values by the detection limit divided by 2 (Method 2), a naïve calculation (Method 3) using the detection limit as a valid measurement. The fourth method consists of considering censored data to be missing values (Method 4). This article examines how these methods affect the quantification of personal exposure. We considered data from 14 frequency bands from FM to WiMax measured in Albacete (Spain) for 76 days every 10 s by a personal exposimeter (PEM) Satimo EME Spy 140.Methods 3 and 2 gave similar mean and median values to Method 1, but both underestimated the mean values when high nondetects records occurred, which conditioned the physical description of the real situation. The mean values calculated by Method 4 differed from those obtained by Method 1 but were similar when the percentage of nondetects was below 20%.Our comparison suggests that nondetects can be neglected when the percentage of censored data is low to provide a more realistic physical situation.

https://www.ncbi.nlm.nih.gov/pubmed/31897614

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Radio-Frequency Electromagnetic Field Exposure of Western Honey Bees

Thielens A, Greco MK, Verloock L, Martens L, Joseph W. Radio-Frequency Electromagnetic Field Exposure of Western Honey Bees. Sci Rep. 2020 Jan 16;10(1):461. doi: 10.1038/s41598-019-56948-0.

Abstract

Radio-frequency electromagnetic fields (RF-EMFs) can be absorbed in all living organisms, including Western Honey Bees (Apis Mellifera). This is an ecologically and economically important global insect species that is continuously exposed to environmental RF-EMFs. This exposure is studied numerically and experimentally in this manuscript. To this aim, numerical simulations using honey bee models, obtained using micro-CT scanning, were implemented to determine RF absorbed power as a function of frequency in the 0.6 to 120 GHz range. Five different models of honey bees were obtained and simulated: two workers, a drone, a larva, and a queen. The simulations were combined with in-situ measurements of environmental RF-EMF exposure near beehives in Belgium in order to estimate realistic exposure and absorbed power values for honey bees. Our analysis shows that a relatively small shift of 10% of environmental incident power density from frequencies below 3 GHz to higher frequencies will lead to a relative increase in absorbed power of a factor higher than 3.

Conclusions

Exposure of Western Honey Bees (*apis mellifera*) to radio-frequency (RF) electromagnetic fields was studied using a combination of *in-situ* exposure measurements near bee hives in Belgium and numerical simulations. The simulations use the finite-difference time-domain technique to determine the electromagnetic fields in and around five honey bee models exposed to plane waves at frequencies from 0.6 GHz up to 120 GHz. These simulations lead to a quantification of the whole-body averaged absorbed radio-frequency power (P_{abs}) as a

function of frequency. The average P_{abs} increases by factors 16 to 121, depending on the considered phantom, when the frequency is increased from 0.6 GHz to 6 GHz for a fixed incident electric field strength. A relatively small decrease in P_{abs} is observed for all studied honey bees between 12 and 120 GHz. RF exposure measurements were executed on ten sites near five different locations with bee hives in Belgium. These measurements resulted in an average total incident RF field strength of 0.06 V/m, which was in excellent agreement with literature. This value was used to assess P_{abs} for those honey bees at those measurement sites. A realistic P_{abs} is estimated to be between 0.1 and 0.7 nW for the studied honey bee models. Assuming that 10% of the incident power density would shift to frequencies higher than 3 GHz would lead to an increase of this absorption between 390–570%. Such a shift in frequencies is expected in future networks.

Open access paper: https://www.nature.com/articles/s41598-019-56948-0

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Testing of behavioral and cognitive development in rats after prenatal exposure to 1800 and 2400 MHz radiofrequency fields

Li ZQ, Zhang Y, Wan YM, Zhou Q, Liu C, Wu HX, Mu YZ, He YF, Rauniyar R, Wu XN. Testing of behavioral and cognitive development in rats after prenatal exposure to 1800 and 2400 MHz radiofrequency fields. J Radiat Res. 2020 Jan 11. pii: rrz097. doi: 10.1093/jrr/rrz097.

Abstract

The objective of the study was to explore the effects of behavioral and cognitive development in rats after prenatal exposure to 1800 and 2400 MHz radiofrequency fields. Pregnant female rats were exposed to radiofrequency fields beginning on the 21st day of pregnancy. The indicators of physiological and behavioral development were observed and measured in the offspring rats: Y maze measured at 3-weeks postnatal, open field at 7-weeks postnatal, and the expression of N-methyl-D-aspartate receptors (NMDARs) measured by reverse transcription-PCR in the hippocampus at 9-weeks postnatal. The body weight of the 1800 MHz group and the 1800 MHz + WiFi group showed a downward trend. The eye opening time of newborn rats was much earlier in the WiFi group than in the control group. Compared to the control group, the overall path length of the 1800 MHz + WiFi group was shortened and the stationary time was delayed. The path length of the WiFi group was shortened and the average velocity was increased in the error arm. The 1800 MHz + WiFi group displayed an increased trend in path length, duration, entry times and stationary time in the central area. In both the 1800 MHz + WiFi and WiFi groups, NR2A and NR2B expression was down-regulated, while NR2D, NR3A and NR3B were up-regulated. Moreover, NR1 and NR2C in the WiFi group were also up-regulated. Prenatal exposure to 1800 MHz and WiFi radiofrequency may affect the behavioral and cognitive development of offspring rats, which may be associated with altered mRNA expression of NMDARs in the hippocampus

https://www.ncbi.nlm.nih.gov/pubmed/31927574

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Radioprotection in prenatal care using a nonwoven fabric with electromagnetic shielding property

Sahmelikoglu, AG, Karakas S, Tellioglu AM, Acer, N, Bilgen M. Radioprotection in prenatal care using a nonwoven fabric with electromagnetic shielding property. Erciyes Medical Journal. 41(4):444-449.Dec 2019.

Abstract

Objective: Electromagnetic shielding fabrics (EMSFs) have been marketed by several manufacturers within the past few years. However, their efficacies in protecting living organisms against the harmful effects of EM noise have yet to be established. The aim of the present study was to accomplish this task with novel in vivo experiments where fetal development and the pathological consequences of wearing protective fabric against EM radiation during pregnancy were investigated.

Materials and Methods: Nine pregnant rats were equally divided into three groups. Sham controls were kept unexposed, but the remaining six were subjected to EM radiation at 900 MHz for 1 h daily throughout the pregnancy. However, three of the rats were protected by a nonwoven fabric manufactured locally and characterized previously. After birth, the kidneys of newborns were extracted and evaluated by histopathology. Histometry data were analyzed statistically.

Results: EM exposure affected the kidney structure and morphology as revealed by the disruption of glomerular basement membrane continuity, increased Bowman capsule and proximal tubule sizes (from 15.01 +/- 2.56 mu m to 29.94 +/- 4.42 mu m), and thickened cortex and medulla (from 261.13 +/- 4.10 mu m to 284.57 +/- 10.93 pm for cortex and from 594.25 +/- 23.48 pm to 732.61 +/- 20.46 mu m for medulla). However, the effects were significantly attenuated in those kidneys placed behind the fabric.

Conclusion: EMSF effectively protects the fetal kidney against EM radiation at 900 MHz during the developmental phase and possibly at other frequencies and for other organs. It is advisable to wear such fabrics during pregnancy when EM pollution is of significant concern.

Open access paper: https://www.journalagent.com/erciyesmedj/pdfs/EMJ_41_4_444_449.pdf

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Radio frequency-induced superoxide accumulation affected the growth and viability of Saccharomyces cerevisiae (baker's yeast)

Li Q, Tian M, Teng J, Gao P, Tang BQ, Wu H. Radio frequency-induced superoxide accumulation affected the growth and viability of Saccharomyces cerevisiae. Int Microbiol. 2020 Jan 2. doi: 10.1007/s10123-019-00111-2.

Abstract

With the development of the electric technologies, the biological effects of electromagnetic fields (EMF) were widely studied. However, the results remain controversial and the biophysical mechanisms are still unknown. To our knowledge, little studies pay attention to the radio frequency (RF) of 2.6-5 MHz. In the present study, we investigated the effect of these radio frequencies on the growth and cell viability of Saccharomyces cerevisiae at very low power density below 0.1 mT. The result appeared to be time-dependent. The growth of the yeast cells was obviously affected by the RF-EMF with a 43.5% increase when exposed for 30 h, and the growth-promoting effect decreased along with the radiation time and eventually turned to an inhibiting effect retarding growth by 20.7% at 89 h. The cell viability was improved to 70.1% at 8 h and reduced by 33.5% at 28 h. The superoxide accumulated in exposed cells as radiation time increased which may lead to the inhibition of viability and growth of the cells. However, the efficient frequency, power density, and exposure dosage await further investigation. Nevertheless, the wave band studied in this research is effective to produce biological effect, and therefore, it may provide an optional new radio frequency which is valuable for the development and utilization in therapy technique and medical use.

https://www.ncbi.nlm.nih.gov/pubmed/31898034

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In vitro study of effects of ELF-EMF on testicular tissues of roe

Koziorowska A, Depciuch J, Kozioł K, Nowak S, Lach K. In vitro study of effects of ELF-EMF on testicular tissues of roe deer (Capreolus capreolus) - FTIR and FT-Raman spectroscopic investigation. Anim Reprod Sci. 2020 Feb;213:106258. doi: 10.1016/j.anireprosci.2019.106258. Epub 2019 Dec 14.

Abstract

Electromagnetic fields (EMF) are classified as an environmental factor affecting living organisms. The aim of the study was to evaluate the effect of EMF at different frequencies (50 and 120 Hz), durations of treatment (2 and 4 h) and with the magnetic induction of 8 m T on testicular tissues of roe deer (Capreolus capreolus) in vitro by comparison with the control samples. Fourier Transform Raman Spectroscopy (FT-Raman) and Fourier Transform Infrared Spectroscopy (FTIR) were utilized in this study to identify the chemical changes in the testicular tissues. The FTIR and FT-Raman spectroscopy methods were used to evaluate differences in spectra of the treated tissues compared to the control group. The results from the analysis of the spectra indicated there were characteristic differences in the testicular tissue compared with the control samples. There was identification of peaks attributed to different biochemical components. Comparing the spectra for different frequencies and treatment times, there was a greater intensity of peaks originating from most of the functional groups in the tissues evaluated. With the FTIR spectra, there were five of 15 peaks, while with the FT-Raman spectra, there were six of ten peaks that were shifted. For FTIR and FT-Raman analyzed spectral ranges, results from the PCA analysis indicate there was no similarity between control groups (2 and 4 h) and samples treated with EMF at a frequency of 120 Hz for 2 and 4 h. In conclusion, therefore, EMF is an environmental factor affecting the testis of roe deer.

https://www.ncbi.nlm.nih.gov/pubmed/31987319

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Effects of Long-Term Exposure to Low-Power 915 MHz Unmodulated Radiation on Phaseolus vulgaris L.

Surducan V, Surducan E, Neamtu C, Mot AC, Ciorîță A. Effects of Long-Term Exposure to Low-Power 915 MHz Unmodulated Radiation on Phaseolus vulgaris L. Bioelectromagnetics. 2020 Feb 6. doi: 10.1002/bem.22253.

Abstract

The morphophysiological response of Phaseolus vulgaris L. to low-power electromagnetic radiation was investigated in order to assess the potential harmful effects of long-term continuous exposure. The plants were grown in two separate electromagnetic field (EMF) shielded rooms, in a controlled, greenhouse-like environment. One batch was continuously irradiated during the growth period (from sowing to maturity) and the other one was used as a reference. An unmodulated signal at 915 MHz (the central frequency between the uplink and downlink of the GSM900 mobile communications band) was used, with a maximum power density of 10 mW/m2 measured near the plants. The plants were analyzed using ultraviolet-visible, statistical, morphometric, and electron microscopy methods. Significant differences were observed regarding the height of the plants, number of inflorescences, and chlorophyll and carotenoid content, all closely connected with the ultrastructural changes observed in the leaves. The irradiated batch grew higher (19% increase in plant height, 20% increase in stem and leaves' dry mass), with 18% fewer inflorescences, and extremely long roots (34% increase in dry mass). The ultrastructure of the irradiated leaves showed irregular cells and a higher content of

plastoglobules in the chloroplasts. All results indicate that the irradiated plants suffered significant morphological modifications during their long-term exposure to the specific EM radiation.

https://www.ncbi.nlm.nih.gov/pubmed/32030775

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Notes on parliament hearing in Tallinn, Estonia June 4, 2019 as regards the deployment of the fifth generation, 5G, of wireless communication

Hardell L. Notes on parliament hearing in Tallinn, Estonia June 4, 2019 as regards the deployment of the fifth generation, 5G, of wireless communication. World Academy of Sciences Journal. November 18, 2019 pp. 1-8. https://doi.org/10.3892/wasj.2019.28

Abstract

The fifth generation (5G) for wireless communication is about to be deployed worldwide in spite of no thorough studies being made on the potential risks to human health and the environment. The implementation seems to be driven mainly by business interests, not considering mounting public anxiety on the associated risks. In Estonia, an appeal on a moratorium was signed by 1,122 subjects, forcing a hearing in the Social Affairs Commission and the Environment Commission of Estonian Parliament on June 4, 2019. The hearing lasted for 1 h and 40 min. The whole hearing may be found on the web. It clearly demonstrated that decision-making bodies base their decisions and act on expert statements that tend to be biased and formed by a cartel of members instead of their own science-based evaluation. Thus, the hearing revealed a lack of knowledge among the Commission members on the risks involved with the use of 5G wireless communication that is exemplified herein. This may create negative consequences for human health and the environment in the future.

Open access paper: https://www.spandidos-publications.com/10.3892/wasj.2019.28/download

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Discussion on Spatial and Time Averaging Restrictions Within the Electromagnetic Exposure Safety Framework in the Frequency Range Above 6 GHz for Pulsed and Localized Exposures

Neufeld E, Samaras T, Kuster N. Discussion on Spatial and Time Averaging Restrictions Within the Electromagnetic Exposure Safety Framework in the Frequency Range Above 6 GHz for Pulsed and Localized Exposures. Bioelectromagnetics. 2019 Dec 30. doi: 10.1002/bem.22244.

Abstract

Both the current and newly proposed safety guidelines for local human exposure to millimeter-wave frequencies aim at restricting the maximum local temperature increase in the skin to prevent tissue damage. In this study, we show that the application of the current and proposed limits for pulsed fields can lead to a temperature increase of 10°C for short pulses and frequencies between 6 and 30 GHz. We also show that the proposed averaging area of 4 cm2 , that is greatly reduced compared with the current limits, does not prevent high-temperature increases in the case of narrow beams. A realistic Gaussian beam profile with a 1 mm radius can result in a temperature increase about 10 times higher than the 0.4°C increase the same averaged power density would produce for a plane wave. In the case of pulsed narrow beams, the values for the time and

spatial-averaged power density allowed by the proposed new guidelines could result in extreme temperature increases.

https://www.ncbi.nlm.nih.gov/pubmed/31885092

Excerpts

.... In this letter, we look at limits, such as those currently proposed or recently approved for the revised ICNIRP guidelines and IEEE standard, and investigate whether such limits are consistent with the stated goals of the exposure safety frameworks of preventing excessive heating in the case of pulsed and/or localized radiation. In cases when they are not consistent, we discuss how consistency can be achieved. In line with the abovementioned safety standards and exposure guidelines, the presented analysis focuses exclusively on the magnitude of the tissue temperature increase as a risk factor and does not consider other aspects, such as the thermoelastic effect related to the rapidity of temperature increase.....

In conclusion, the results presented above demonstrate that, in the case of very short pulses, pulse-duration-independent limits imposed on transmitted energy density (fluence) alone cannot preclude the induction of high-temperature increases in the skin. Pulse-duration-dependent limits should be applied also for pulses less than 1 s and possibly less than 30 GHz as well. Even though the amplifiers of the currently developed consumer devices will not allow the full exploitation of the limits of the guidelines, the guidelines should not implicitly rely on this, as they will be used to develop exposure assessment standards with the aim of ensuring safety of any future technology, e.g. IEC/IEEE 63195 [2018]. Accordingly, either assumption must be explicitly stated in the guidelines, or the limits should be adapted to be intrinsically safe. In the absence of limitations applied to the peak-to-average power ratio of pulses, it is possible to deliver to the body large amounts of energy within a very short time interval. For millimeter-wave frequencies, where the absorption is superficial, this results in fast and dramatic temperature rises, as the step response function is proportional to the rapidly rising rather than the commonly encountered for deeper heating. As far as spatial averaging is concerned, it has been shown that an averaging area smaller than 4 cm^2 should be introduced in order to avoid peak PDs in narrow beams [Neufeld and Kuster, 2018] that overheat the tissues. With increasing beam radius, e.g. at larger distances from the antenna(s), the tolerable averaging area increases rapidly, provided that there are no sharp exposure peaks. Duration-independent limits on the fluence of pulses are not suitable. They should either be replaced by duration-dependent fluence limits for pulses or by limits on the (temporal) peak exposure. In both cases, the limits should be set after taking narrow-beam exposures into consideration. These limits will depend on the chosen spatial and temporal averaging schemes and the maximum temperature increase deemed acceptable. Forward-looking knowledge about the technical needs and priorities of the industry could allow for selecting the balance between thresholds (averaging time and area, peak-to-average ratio, PD) to minimally impact the technological potential using the same limit-setting framework.

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Special Issue: “Electric, Magnetic, and Electromagnetic Fields in Biology and Medicine: From Mechanisms to Biomedical Applications”

Scarfì MR, Mattsson M-O, Simkó M, Zeni O. Editorial. Special Issue: “Electric, Magnetic, and Electromagnetic Fields in Biology and Medicine: From Mechanisms to Biomedical Applications." Int. J. Environ. Res. Public Health 2019, 16(22): 4548; https://doi.org/10.3390/ijerph16224548

1. Special Issue Rationale

The last decades have seen a huge increase in applications and devices using and emitting non-ionizing radiation, otherwise referred to as “electromagnetic fields” (EMF). This includes, e.g., the distribution and use of electricity and information and communication technologies. Present and foreseeable future technologies employ different parts of the electromagnetic (EM) spectrum, from static electric and magnetic fields, via low frequency fields to high frequency EMF encompassing millimeter waves and THz fields. Thus, humans are exposed to various electric, magnetic, and EMF in the course of everyday life. In addition, these kinds of non-ionizing radiation are also successfully employed in biomedical applications, for both diagnostic and therapeutic purposes, causing exposure in specific occupational environments. As a consequence, public and scientific concern with respect to the possible adverse health effects of EMF occurring after exposure to levels below those inducing known acute effects has been rising. A large body of literature dealing with experimental as well as clinical and population-based investigations into the biological and health effects of such fields has yielded inconsistent and often conflicting information. Moreover a comprehensive understanding of the mechanisms of interaction remains to be elucidated. Therefore, there is great interest in evaluating the induced biological responses from the point of view of the associated interaction mechanisms.

2. About the Papers of This Special Issue

The call for articles on “Electric, Magnetic, and Electromagnetic Fields in Biology and Medicine: From Mechanisms to Biomedical Applications” resulted in a total of 14 accepted manuscripts: 10 regular papers, one communication and three review papers. On the whole, the following issues were addressed:

(1) EMF Exposure Assessment

In the characterization of human exposure to EMF, children’s exposure to extremely low frequency (ELF) magnetic fields has been a matter of debate since several meta-analyses reported on an increased risk of childhood leukemia’s for daily average exposure above 0.4 μT without any causal relationship. This issue was covered in two papers by the same research group. Bonato et al. [1] propose a new method for the characterization of children’s exposure, which relies on personal measurements and employs a stochastic approach based on segmentation that resulted in the identification of the parameters most affecting the level of children’s exposure. Tognola et al. [2], acharacterized a real-life ELF exposure scenario by applying a machine learning approach on personal exposure measurements from 977 children in France. The impact of only outdoor sources of exposure was considered.

The measurements of personal exposure to radiofrequency (RF) EMF is a challenging task in epidemiological studies and was covered in two papers and one review article. Zeleke et al. [3] recorded and analyzed measurements of personal RF-EMF exposure levels from a wide range of frequency bands from 63 participants over a range of 27.4 ± 4.5 h. Liu et al. [4] investigated the applicability of an efficient whole-body individual modelling method for the assessment of RF exposure in the case of patient exposure under MRI examination. Chiaramello et al. [5] presented an overview of the papers published in the last ten years and address RF-EMF exposure assessment from different sources in indoor environments.

(2) Biological Effects of EMF Exposure and Health Risk Evaluation

An in vitro study by Sannino et al. [6] indicated a possible involvement of DNA repair mechanisms in the RF-induced adaptive response, a phenomenon by which pre-exposure of different cell cultures to RF fields under specific conditions is capable of reducing the damage induced by subsequent treatment with genotoxic agents.

Three studies report on the results of in vivo investigations carried out on laboratory animals. In particular, Guo et al. [7] investigated the effects of one-month exposure to a 220 MHz pulsed modulated RF field at the power density of 50 W/m2 on the sperm quality in male adult rats, which was found to be impaired by the exposure. These exposure conditions were chosen by the authors since they are realistic under certain occupational conditions in which workers are exposed to high intensity RF fields.

The Medaka fish was chosen in the paper by Sun et al. [8] to address the effect of long term (entire development period) static magnetic field exposure at the mT level on embryo development and behavioral response. Development was not affected whereas swimming velocity was reduced in the exposed group.

Sienkiewicz and van Rongen [9] reviewed the evidence on the effects of exposure to RF fields, mostly associated with mobile phone technology, on the cognitive behavior of laboratory animals. Vornoli et al. [10] reviewed the currently available evidence from in vivo studies on carcinogenicity and reproductive toxicity studies in order to summarize the contribution of experimental research to the prevention of the adverse effects of RF radiation on human health.

Two studies were carried out on human volunteers. In Loughran et al. [11], the influence of RF-EMF on electroencephalogram (EEG) readings was investigated in 36 healthy adults participating in a randomized, double-blind provocation study with the aim to find out if a thermal mechanism is involved in nervous system responses to RF-EMF. Indeed, the results suggest such an involvement.

Vecsei et al. [12] studied the effects of acute exposure from long term evolution (LTE) mobile phone EMF on the thermal pain threshold in healthy young adults and no effects of exposure were seen.

A couple of other relevant papers are collected in this special issue that address the topic of the extrapolation of the outcome of animal studies to humans [13], and the identification and description of methods using non-ionizing radiation (NIR) such as EMF and optical radiation in Swedish health care [14]. Specifically, Kodera and Hirata computationally estimated the thermal time constants of temperature elevation in human head and rat models exposed to dipole antennas at 3–10 GHz [13], while Hansson Mild and coworkers identified three applications in Swedish health care (magnetic resonance imaging (MRI), transcranial magnetic stimulation (TMS), and electrosurgery) where acute effects at existing exposure levels could not be ruled out [14].

Open access paper: https://www.mdpi.com/1660-4601/16/22/4548/htm

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Genetic susceptibility may modify the association between cell phone use and thyroid cancer: A population-based case-control study in Connecticut

Luo J, Li H, Deziel NC, Huang H, Zhao N, Ma S, Nie X, tUdelsman R, Zhang Y. Genetic susceptibility may modify the association between cell phone use and thyroid cancer: A population-based case-control study in Connecticut. Environmental Research. Available online 6 December 2019, 109013. https://doi.org/10.1016/j.envres.2019.109013.

Highlights

• The interaction between cell phone use and genetic variants on thyroid cancer was investigated in this study.
• When some genetic variants were present, cell phone use was significantly associated with thyroid cancer.

• The association increased when cell phone use duration and frequency increased.

• Genetic susceptibility may modify the association between cell phone use and thyroid cancer.

Abstract

Emerging studies have provided evidence on the carcinogenicity of radiofrequency radiation (RFR) from cell phones. This study aims to test the genetic susceptibility on the association between cell phone use and thyroid cancer. Population-based case-control study was conducted in Connecticut between 2010 and 2011 including 440 thyroid cancer cases and 465 population-based controls with genotyping information for 823 single nucleotide polymorphisms (SNPs) in 176 DNA genes. We used multivariate unconditional logistic regression models to estimate the genotype-environment interaction between each SNP and cell phone use and to estimate the association with cell phone use in populations according to SNP variants. Ten SNPs had $P < 0.01$ for interaction in all thyroid cancers. In the common homozygote groups, no association with cell phone use was observed. In the variant group (heterozygotes and rare homozygotes), cell phone use was associated with an increased risk for rs11070256 (odds ratio (OR): 2.36, 95% confidence interval (CI): 1.30–4.30), rs1695147 (OR: 2.52, 95% CI: 1.30–4.90), rs6732673 (OR: 1.59, 95% CI: 1.01–2.49), rs396746 (OR: 2.53, 95% CI: 1.13–5.65), rs12204529 (OR: 2.62, 95% CI: 1.33–5.17), and rs3800537 (OR: 2.64, 95% CI: 1.30–5.36) with thyroid cancers. In small tumors, increased risk was observed for 5 SNPs (rs1063639, rs1695147, rs11070256, rs12204529 and rs3800537), In large tumors, increased risk was observed for 3 SNPs (rs11070256, rs1695147, and rs396746). Our result suggests that genetic susceptibilities modify the associations between cell phone use and risk of thyroid cancer. The findings provide more evidence for RFR carcinogenic group classification.

https://www.sciencedirect.com/science/article/abs/pii/S0013935119308102

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Wireless Wearables and Implants: A Dosimetry Review

Guido K, Kiourti A. Bioelectromagnetics. Wireless Wearables and Implants: A Dosimetry Review. 2020 Jan;41(1):3-20. doi: 10.1002/bem.22240.

Abstract

Wireless wearable and implantable devices are continuing to grow in popularity, and as this growth occurs, so too does the need to consider the safety of such devices. Wearable and implantable devices require the transmitting and receiving of electromagnetic waves near and through the body, which at high enough exposure levels may damage proximate tissues. The specific absorption rate (SAR) is the quantity commonly used to enumerate exposure levels, and various national and international organizations have defined regulations limiting exposure to ensure safe operation. In this paper, we comprehensively review dosimetric studies reported in the literature up to the year 2019 for wearables and implants. We discuss antenna designs for wearables and implants as they relate to SAR values and field and thermal distributions in tissue, present designs that have made steps to reduce SAR, and then review SAR considerations as they relate to applied devices. As compared with previous review papers, this paper is the first review to focus on dosimetry aspects relative to wearable and implantable devices.

https://www.ncbi.nlm.nih.gov/pubmed/31854006

Conclusions

This paper presents a comprehensive overview of the dosimetry aspects relevant to wearable and implantable antennas. Placing radiators close to or within the body poses challenges for both radiation efficiency and device safety. The primary indicator of dosimetry for such increasingly prevalent devices, SAR, manifests as a temperature increase within body tissues. When SAR peaks outside of the safe limits outlined by the IEEE, ICNIRP, and FCC, damage to the surrounding tissues, usually those located closest to the device, can occur. As such, designers of wearable and implantable devices are taking steps to reduce SAR levels while maintaining the radiation characteristics of the antenna. Both designers of wearable devices and designers of implantable devices share many of the methods used to reduce SAR, such as metamaterials and other ground plane alterations, and all methods seek to reduce peak areas of the electric field. As these devices continue to grow in popularity, designers must not only consider the safety of their own device but also the combined safety of the other devices that may be implemented on/in the same person.

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RF Exposure Due to Mobile Devices Operated Close to the Human Body

Fernández-Rodríguez C, Bulla G, de Salles AA. RF Exposure Due to Mobile Devices Operated Close to the Human Body. Proceedings of the 49th European Microwave Conference. Paris, France. 1-3 October 2019. pp. 264-267.

Abstract

The SAR (Specific Absorption Rate) simulations due to mobile devices operated in close range to the human head and body are described in this paper. The FDTD (Finite- Difference Time-Domain) numerical method together with realistic children, adolescents and adults' models are employed to estimate the 1 g and the 10 g SAR in different biological tissues. Typical mobile phones, laptops, tablets and virtual reality glasses were considered and the alternatives to reduce the SAR are discussed. The need of new dosimetric parameters and skin and nervous system models for 5G and millimetric waves exposure are also addressed.

VII. DISCUSSION AND CONCLUSIONS

The SAR for some typical mobile phones, laptops, tablets and virtual reality glasses were simulated and results were compared to the available recommended exposure guidelines. It was observed that when some of these devices are operated very close to the head or body the simulated results can be above the exposure limits. This is particularly the case for the children models and for particular tissues (e.g. hippocampus and cerebellum). Then the methods to determine regulatory compliance for wireless devices should be re-examined.

Antennas now used in portable devices are monopole, helix, PIFA or other planar structures (generally without ground plane) and they radiate the EMF almost to all directions. Since these devices can be operated close to the head or body, directional antennas radiating the EMF to the direction opposite to the head and body should be developed in order to reduce the SAR in these tissues. This can also contribute to reduce antenna input impedance mismatching when the device is operated close to the body. New antenna techniques including a back plane, electromagnetic band gap (EBG) and artificial magnetic conductor (AMC) could be adequate alternatives aiming to reduce the SAR in the user's head and body. There is also an urgent need for research to evaluate the risks to the eye from use of cell phones in virtual reality applications.

Also, in the near future the use of mm-waves (e.g. 26 GHz and above) will be widespread to carry new

services on the 5 G network. Then, the need for new quantities of interest, metrics and exposure limits adequate for these frequencies, as well as modelling new structures, such as the skin and the nervous system, are suggested.

It is very important to remark that the recommendations and the standards usually adopted in different countries only consider the health effects of short time exposure. However, the mobile phones, notebooks, tablets and virtual reality glasses may be used for long time very close to the user's body. Then the long-time health effects must be taken into consideration in order to evaluate the health risks. Meanwhile the Precautionary Principle should be adopted in order to reduce health risks.

https://ieeexplore.ieee.org/document/8910925

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Monitoring the Risk of the Electric Component Imposed on a Pilot During Light Aircraft Operations in a High-Frequency Electromagnetic Field

Michałowska J, Tofil A, Józwik J, Pytka J, Legutko S, Siemiątkowski Z, Łukaszewicz A. Monitoring the Risk of the Electric Component Imposed on a Pilot During Light Aircraft Operations in a High-Frequency Electromagnetic Field. Sensors (Basel). 2019 Dec 14;19(24). pii: E5537. doi: 10.3390/s19245537.

Abstract

High-frequency electromagnetic fields can have a negative effect on both the human body and electronic devices. The devices and systems utilized in radio communications constitute the most numerous sources of electromagnetic fields. The following research investigates values of the electric component of electromagnetic field intensification determined with the ESM 140 dosimeter during the flights of four aircrafts-Cessna C152, Cessna C172, Aero AT3 R100, and Robinson R44 Raven helicopter-from the airport in Depultycze Krolewskie near Chelm, Poland. The point of reference for the obtained results were the normative limits of the electromagnetic field that can affect a pilot in the course of a flight. The maximum value registered by the dosimeter was E = 3.307 V/m for GSM 1800 frequencies.

Excerpt

Although the results obtained confirm that the measured values of the electromagnetic fields in the tested aircraft did not exceed the permissible values, there is a risk related to the high load on the pilot's body, especially the instructor, who performed a significant number of flights per day. As such, the radiation doses add up and this may cause premature fatigue and other negative effects on the instructor's mental condition. Bearing in mind the need to increase the level of flight operations safety, it is reasonable to undertake research and development activities to develop a system for monitoring electromagnetic radiation and its impact on pilots during a flight. The authors' idea is an onboard electromagnetic field monitoring system, shown schematically in Figure 23.
Open access paper: https://www.mdpi.com/1424-8220/19/24/5537

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Whole-body exposures to radiofrequency-electromagnetic energy can cause DNA damage in mouse spermatozoa via an oxidative mechanism

Houston BJ, Nixon B, McEwan KE, Martin JH, King BV, Aitken RJ, De Iuliis GN. Whole-body exposures to radiofrequency-electromagnetic energy can cause DNA damage in mouse spermatozoa via an oxidative mechanism. Sci Rep. 2019 Nov 25;9(1):17478. doi: 10.1038/s41598-019-53983-9.

Abstract

Artificially generated radiofrequency-electromagnetic energy (RF-EME) is now ubiquitous in our environment owing to the utilization of mobile phone and Wi-Fi based communication devices. While several studies have revealed that RF-EME is capable of eliciting biological stress, particularly in the context of the male reproductive system, the mechanistic basis of this biophysical interaction remains largely unresolved. To extend these studies, here we exposed unrestrained male mice to RF-EME generated via a dedicated waveguide (905 MHz, 2.2 W/kg) for 12 h per day for a period of 1, 3 or 5 weeks. The testes of exposed mice exhibited no evidence of gross histological change or elevated stress, irrespective of the RF-EME exposure regimen. By contrast, 5 weeks of RF-EME exposure adversely impacted the vitality and motility profiles of mature epididymal spermatozoa. These spermatozoa also experienced increased mitochondrial generation of reactive oxygen species after 1 week of exposure, with elevated DNA oxidation and fragmentation across all exposure periods. Notwithstanding these lesions, RF-EME exposure did not impair the fertilization competence of spermatozoa nor their ability to support early embryonic development. This study supports the utility of male germ cells as sensitive tools with which to assess the biological impacts of whole-body RF-EME exposure.

Open access paper: https://www.nature.com/articles/s41598-019-53983-9

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Prenatal Effects of a 1,800-MHz Electromagnetic Field on Rat Livers

Tumkaya L, Yilmaz A, Akyildiz K, Mercantepe T, Yazici ZA, Yilmaz H. Prenatal Effects of a 1,800-MHz Electromagnetic Field on Rat Livers. Cells Tissues Organs. 2019 Dec 4:1-9. doi: 10.1159/000504506.

Abstract

The use of devices, including mobile phones, generating electromagnetic fields (EMF) is widespread and is progressively increasing. It has also been shown that EMF may have detrimental effects. This is the first study to investigate the postnatal biochemical and histological effects of prenatal exposure of rat livers to 1,800-MHz EMF at different time intervals in uteroplacental life. The 3 EMF groups of rats were exposed to 1,800-MHz EMF for 6, 12, or 24 h daily for 20 days. Unexposed rats served as control group. All rats were subjected to anesthesia, and on postnatal day 60, the livers were excised, and blood was collected for histological and biochemical analyses. Malondialdehyde levels were significantly higher in the exposed groups than the unexposed controls ($p < 0.05$). In contrast, EMF-exposed groups had lower liver tissue glutathione levels than controls ($p < 0.05$). Serum Ca2+, alanine transaminase, and aspartate aminotransferase levels were higher in EMF-exposed groups than controls ($p < 0.05$). In addition, liver tissue total oxidant status levels were increased ($p < 0.05$), and liver tissue total antioxidant status levels were decreased ($p < 0.05$) compared to the control group. Furthermore, in the EMF groups, extensive vacuolation and degeneration of the hepatocytes in the portal area, as well as those surrounding the sinusoids, were evident. Affected hepatocytes had polygonally shaped nuclei and vacuolic cytoplasm imparting eosinophilic staining. Loss of cellular membrane integrity and invaginations, as well as picnotic nuclei, was prominent. This study has shown that intrauterine liver damage caused by 1,800-MHz EMF exposure persists into puberty in rats.

https://www.ncbi.nlm.nih.gov/pubmed/31801129

Excerpt

Three of the pregnant rats served as untreated controls, while the others were exposed to mobile phone radiation, which was adjusted to talking and Wi-Fi mode, for 6-, 12-, and 24-h/day for 20 consecutive days [Çetin et al., 2014; Meral et al., 2014; Ragy and Ragy, 2015; Schmid and Kuster, 2015; Mugunthan et al., 2016; Bahreyni Toossi et al., 2018; Ertilav et al., 2018]. The emitter of the EMF device (Anritsu MG3670 B type, Japan), which generates 1,800-MHz frequency radiation, was placed centrally under the cage [Bedir et al., 2018]. The SAR (specific absorption rate) value was calculated according to the study by Qin et al. [2012], which was 0.12 W/kg.

Eight newborn rats were allocated to each group. The newborn rats were not exposed to EMF. They were reared for 2 months under the aforementioned conditions. Blood was sampled, and livers were removed on the 60th day postpartum as detailed below.

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Does Exposure of Smart Phones during Pregnancy Affect the Offspring's Ovarian Reserve? A Rat Model Study

Calis P, Seymen M, Soykan Y, Delen K, Aral BS, Take Kaplanoglu G, Karcaaltincaba D. Does Exposure of Smart Phones during Pregnancy Affect the Offspring's Ovarian Reserve? A Rat Model Study.
Fetal Pediatr Pathol. 2019 Dec 10:1-11. doi: 10.1080/15513815.2019.1692112.

Abstract

Objective: We investigated the effect of prenatal exposure to smart phone radiation and the protective effect of omega-3 on ovarian reserve of offspring. Methods: 24 pregnant Wistar albino rats were divided into four groups. Group-I received neither radiofrequency (RF) radiation nor omega-3, group-II received RF, group-III received RF radiation and 300 mg omega-3 and group-IV received RF radiation and 600 mg Omega-3 till birth. At 42 days, bilateral oophorectomy was performed on all female offspring for follicle count and immunohistochemical staining (GDF9, FOXO1 and TUNEL). Results: Group-II had significantly lower mean number of primordial ($p = 0.006$), secondary follicles($p = 0.003$) and a higher atresia score. Group-III variables were comparable with group-I variables. Group-IV had statistically higher median number of atretic follicles than group-I ($p = 0.023$). Conclusions: Ovarian reserve of offspring diminished with RF exposure during pregnancy. Omega-3 supplementation during pregnancy may reduce the potential premature ovarian failure.

https://www.ncbi.nlm.nih.gov/pubmed/31820670

Excerpts

RF exposure in the experiment resulted in a whole body average SAR of 0.23 W/kg with an E_{RMS} field of 17.25 V/m. This SAR value could be accepted as non-thermal SAR level for RF radiation, because it is known that 4 W/kg SAR leads to 1 °C increase in the temperature of the exposed tissue. RF exposure was applied at the same time of the day at whole pregnancy for 1 hour/day.

In conclusion, RF appears to negatively alter ovarian reserve in a rat model when exposed throughout pregnancy. However, low dose of Omega-3 supplementation might be a preventive strategy to minimize atresia in such cases. Before extrapolating those results to clinical practice, current findings should be confirmed with human data.

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Biochemical, immunohistochemical and morphometrical investigation of the effect of thymoquinone on the rat testis following exposure to a 900-MHz electromagnetic field

Yahyazadeh A, Altunkaynak BZ, Kaplan S. Biochemical, immunohistochemical and morphometrical investigation of the effect of thymoquinone on the rat testis following exposure to a 900-MHz electromagnetic field. Acta Histochem. 2019 Nov 26:151467. doi: 10.1016/j.acthis.2019.151467.

Abstract

Long-term use of cell phones emitting electromagnetic fields (EMFs) have raised concerns regarding public health in recent year. We aimed to investigate the possible effects of 900 MHz EMF exposure (60 min/day for 28 days) on the rat testis. Another objective was to determine whether the deleterious effect of EMF radiation would be reduced by the administration of thymoquinone (TQ) (10 mg/kg/day). Twenty-four male adult Wistar albino rats were randomly selected, then assigned into four groups as followControl, EMF, TQ and EMF + TQ. Testicular samples were analyzed using histological, stereological, biochemical and immunohistochemical techniques. Total numbers of primary spermatocytes and spermatids as well as Leydig cells were significantly decreased in the EMF group compared to the Control group ($p < 0.05$). In the EMF + TQ group, the total number of primary spermatocytes was significantly increased compared to the EMF group ($p < 0.05$). Superoxide dismutase (SOD) activity was significantly increased in the EMF group compared to the Control group ($p < 0.05$). Also, serum testosterone levels and wet weight of testes were significantly decreased in the EMF group compared to the Control group ($p < 0.05$). Our findings suggested that exposure to a 900 MHz EMF had adverse effects on rat testicular tissue and that the administration of TQ partially mitigated testicular oxidative damages caused by EMF radiation.

https://www.ncbi.nlm.nih.gov/pubmed/31784235

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Effects of co-exposure to 900 MHz radiofrequency electromagnetic fields and high-level noise on sleep, weight, and food intake parameters in juvenile rats

Bosquillon de Jenlis A, Del Vecchio F, Delanaud S, Bach V, Pelletier A. Effects of co-exposure to 900 MHz radiofrequency electromagnetic fields and high-level noise on sleep, weight, and food intake parameters in juvenile rats. Environ Pollut. 2019 Oct 25:113461. doi: 10.1016/j.envpol.2019.113461.

Abstract

OBJECTIVE: Electrohypersensitive people attribute various symptoms to exposure of radiofrequency electromagnetic fields (RF-EMF); sleep disturbance is the most frequently cited. However, laboratory experiments have yielded conflicting results regarding sleep alterations. Our hypothesis was that exposure to RF-EMF alone would lead to slight or non-significant effects but that co-exposure to RF-EMFs and other environmental constraints (such as noise) would lead to significant effects.

METHODS: 3-week-old male Wistar rats (4 groups, n = 12 per group) were exposed for 5 weeks to continuous RF-EMF (900 MHz, 1.8 V/m, SAR = 30 mW/kg) in the presence or absence of high-level noise (87.5 dB, 50-20000 Hz) during the rest period. After 5 weeks of exposure, sleep (24 h recording), food and water intakes, and body weight were recorded with or without RF-EMF and/or noise. At the end of this recording period, sleep

was scored during the 1 h resttime in the absence of noise and of RF-EMF exposure.

RESULTS: Exposure to RF-EMF and/or noise was associated with body weight gain, with hyperphagia in the noise-only and RF-EMF + noise groups and hypophagia in the RF-EMF-only group. Sleep parameters recording over 24 h highlighted a higher frequency of active wakefulness in the RF-EMF-only group and a lower non-rapid eye movement/rapid eye movement sleep ratio during the active period in the noise-only group. There were no differences in sleep duration in either group. During the 1-h, constraint-free sleep recording, sleep rebound was observed in the noise-only group but not in the RF-EMF-only and RF-EMF + noise groups.

CONCLUSION: Our study showed effects of RF-EMF, regardless of whether or not the animals were also exposed to noise. However, the RF-EMF + noise group presented no exacerbation of those effects. Our results did not support the hypothesis whereby the effects of RF-EMF on physiological functions studied are only visible in animals exposed to both noise and RF-EMF.

https://www.ncbi.nlm.nih.gov/pubmed/31706765

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Impact of Cerebral Radiofrequency Exposures on Oxidative Stress and Corticosterone in a Rat Model of Alzheimer's Disease

Bouji M, Lecomte A, Gamez C, Blazy K, Villégier AS. Impact of Cerebral Radiofrequency Exposures on Oxidative Stress and Corticosterone in a Rat Model of Alzheimer's Disease. J Alzheimers Dis. 2019 Nov 25. doi: 10.3233/JAD-190593.

Abstract

BACKGROUND: Alzheimer's disease (AD) is the most common type of neurodegenerative disease leading to dementia. Several studies suggested that mobile phone radiofrequency electromagnetic field (RF-EMF) exposures modified AD memory deficits in rodent models.

OBJECTIVE: Here we aimed to test the hypothesis that RF-EMF exposure may modify memory through corticosterone and oxidative stress in the Samaritan rat model of AD.

METHODS: Long-Evans male rats received intracerebroventricular infusion with ferrous sulphate, amyloid-beta 1-42 peptide, and buthionine-sufloximine (AD rats) or with vehicle (control rats). To mimic cell phone use, RF-EMF were exposed to the head for 1 month (5 days/week, in restraint). To look for hazard thresholds, high brain averaged specific absorption rates (BASAR) were tested: 1.5W/Kg (15min), 6W/Kg (15min), and 6W/Kg (45min). The sham group was in restraint for 45min. Endpoints were spatial memory in the radial maze, plasmatic corticosterone, heme oxygenase-1 (HO1), and amyloid plaques.

RESULTS: Results indicated similar corticosterone levels but impaired memory performances and increased cerebral staining of thioflavine and of HO1 in the sham AD rats compared to the controls. A correlative increase of cortical HO1 staining was the only effect of RF-EMF in control rats. In AD rats, RF-EMF exposures induced a correlative increase of hippocampal HO1 staining and reduced corticosterone.

DISCUSSION: According to our data, neither AD nor control rats showed modified memory after RF-EMF exposures. Unlike control rats, AD rats showed higher hippocampal oxidative stress and reduced corticosterone with the higher BASAR. This data suggests more fragility related to neurodegenerative disease toward RF-EMF exposures.

https://www.ncbi.nlm.nih.gov/pubmed/31796670

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Microwaves from mobile phone induce reactive oxygen species but not DNA damage, preleukemic fusion genes and apoptosis in hematopoietic stem/progenitor cells

Durdik M, Kosik P, Markova E, Somsedikova A, Gajdosechova B, Nikitina E, Horvathova E, Kozics K, Davis D, Belyaev I. Microwaves from mobile phone induce reactive oxygen species but not DNA damage, preleukemic fusion genes and apoptosis in hematopoietic stem/progenitor cells. Sci Rep. 2019 Nov 7;9(1):16182. doi: 10.1038/s41598-019-52389-x.

Abstract

Exposure to electromagnetic fields (EMF) has been associated with the increased risk of childhood leukemia, which arises from mutations induced within hematopoietic stem cells often through preleukemic fusion genes (PFG). In this study we investigated whether exposure to microwaves (MW) emitted by mobile phones could induce various biochemical markers of cellular damage including reactive oxygen species (ROS), DNA single and double strand breaks, PFG, and apoptosis in umbilical cord blood (UCB) cells including CD34+ hematopoietic stem/progenitor cells. UCB cells were exposed to MW pulsed signals from GSM900/UMTS test-mobile phone and ROS, apoptosis, DNA damage, and PFG were analyzed using flow cytometry, automated fluorescent microscopy, imaging flow cytometry, comet assay, and RT-qPCR. In general, no persisting difference in DNA damage, PFG and apoptosis between exposed and sham-exposed samples was detected. However, we found increased ROS level after 1 h of UMTS exposure that was not evident 3 h post-exposure. We also found that the level of ROS rise with the higher degree of cellular differentiation. Our data show that UCB cells exposed to pulsed MW developed transient increase in ROS that did not result in sustained DNA damage and apoptosis.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6838175/

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Immunotropic effects in cultured human blood mononuclear cells exposed to a 900 MHz pulse-modulated microwave field

Szymański Ł, Sobiczewska E, Cios A, Szymanski P, Ciepielak M, Stankiewicz W. Immunotropic effects in cultured human blood mononuclear cells exposed to a 900 MHz pulse-modulated microwave field. J Radiat Res. 2019 Dec 12. pii: rrz085. doi: 10.1093/jrr/rrz085.

Abstract

The specific biological effect of electromagnetic field (EMF) remains unknown even though devices present in our daily lives, such as smartphones and Wi-Fi antennae increase the environmental level of electromagnetic radiation. It is said that the human immune system is able to react to discrete environmental stimuli like EMF.

To investigate the effect of 900 MHz microwave stimulation on the immune system our research aimed to analyze lymphocyte proliferation and observe and assess the basic immunoregulatory activities using a newly developed and improved anechoic chamber. Samples of mononuclear cells (PBMC) isolated from the blood of healthy donors were exposed to 900 MHz pulse-modulated radiofrequency radiation (20 V/m, SAR 0.024 W/kg) twice (15 min each) or left without irradiation (control group). Subsequently, the control and exposed cells were set up to determine several parameters characterizing T cell immunocompetence and monocyte immunogenic activity. Although the microcultures of PBMC exposed to radiofrequency radiation demonstrated higher immunogenic activity of monocytes (LM index) and T-cell response to concanavalin A than control cultures after first exposure, this parameter decreased after a second stimulation. Saturation of the interleukin-2 (IL-2) receptor rose significantly after the second day of exposure. On the other hand, response to mitogen dropped after EMF stimulation. The results suggest that PBMC are able to overcome stress caused by mitogens after stimulation with 900 MHz radiation.

https://www.ncbi.nlm.nih.gov/pubmed/31832654

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Comparative cyto- and genotoxicity of 900 MHz and 1800 MHz electromagnetic field radiations in root meristems of Allium cepa

Kumar A, Kaur S, Chandel S, Singh HP, Batish DR, Kohli RK. Comparative cyto- and genotoxicity of 900 MHz and 1800 MHz electromagnetic field radiations in root meristems of Allium cepa. Ecotoxicol Environ Saf. 2019 Nov 4;188:109786. doi: 10.1016/j.ecoenv.2019.109786.

Abstract

In the last few decades, tremendous increase in the use of wireless electronic gadgets, particularly the cell phones, has significantly enhanced the levels of electromagnetic field radiations (EMF-r) in the environment. Therefore, it is pertinent to study the effect of these radiations on biological systems including plants. We investigated comparative cytotoxic and DNA damaging effects of 900 and 1800 MHz EMF-r in Allium cepa (onion) root meristematic cells in terms of mitotic index (MI), chromosomal aberrations (CAs) and single cell gel electrophoresis (comet assay). Onion bulbs were subjected to 900 and 1800 MHz (at power densities 261 ± 8.50 mW m-2 and 332 ± 10.36 mW m-2, respectively) of EMF-r for 0.5 h, 1 h, 2 h, and 4 h. Root length declined by 13.2% and 12.3%, whereas root thickness was increased by 46.7% and 48.3% after 4 h exposure to 900 MHz and 1800 MHz, respectively. Cytogenetic studies exhibited clastogenic effect of EMF-r as depicted by increased CAs and MI. MI increased by 36% and 53% after 2 and 4 h exposure to 900 MHz EMF-r, whereas it increased by 41% and 67% in response to 1800 MHz EMF-r. Aberration index was increased by 41%-266% and 14%-257% during 0.5-4 h of exposure to 900 MHz and 1800 MHz, respectively, over the control. EMF-r exposure decreased % head DNA (DNAH) and increased % tail DNA (DNAT) and olive tail moment (OTM) at both 900 and 1800 EMF-r. In 4 h exposure treatments, head DNA (%) declined by 19% and 23% at 900 MHz and 1800 MHz, respectively. DNAT and OTM were increased by 2.3 and 3.7 fold upon exposure to 900 MHz EMF-r over that in the control, whereas 2.8 and 5.8 fold increase was observed in response to 1800 MHz EMF-r exposure for 4 h and the difference was statistically significant. The study concludes that EMF-r in the communication range (900 and 1800 MHz) adversely affect root meristems in plants and induce cytotoxic and DNA damage. EMF-r induced DNA damage was more pronounced at 1800 MHz than that at 900 MHz.

https://www.ncbi.nlm.nih.gov/pubmed/31698176

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Comments on the "Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure"

Vijayalaxmi, Foster KR, Miyakoshi J, Verschaeve L. Comments on the "Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure" by Smith-Roe at al. [online, open access, Environmental and Molecular Mutagenesis, 2019]. Environ Mol Mutagen. 2019 Dec 27. doi: 10.1002/em.22353.

No abstract

https://www.ncbi.nlm.nih.gov/pubmed/31883146

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Environmental radiofrequency electromagnetic field levels in a department of pediatrics

Besset D, Selmaoui B, Tourneux P, Leke A, Delanaud S, de Seze R, Stephan Blanchard E. Environmental radiofrequency electromagnetic field levels in a department of pediatrics. Environ Res. 2019 Nov 6:108894. doi: 10.1016/j.envres.2019.108894.

Abstract

Preterm neonates constitute a vulnerable population that is highly sensitive to its environment. Given the increased use of wireless communication devices (mobile and digital enhanced cordless telecommunications, WiFi networks, etc.), neonates hospitalized in a department of pediatrics are potentially exposed to radiofrequency electromagnetic fields (RF-EMF). Strikingly, data on RF-EMF levels in pediatric units have not previously been published. The objective of the present study was thus to quantify the RF-EMF levels in a 34-bed tertiary department of pediatrics with a neonatal critical care unit (NCCU) and a neonatal intensive care unit (NICU). To this end, we used triaxle antenna dosimeters to map the RF-EMF levels in the environment and to measure spot emissions from medical devices. In a first set of experiments, RF-EMF levels at 144 points in the staff area and in the children's rooms in the NCCU and NICU were evaluated over a 24-h period. In a second set of measurements performed in a Faraday chamber, we measured the RF-EMF levels emitted by the medical devices to which neonates are potentially exposed in the department of pediatrics. The RF-EMF levels were significantly higher in the NCCU than in the NICU ($p < 0.05$). Although the two units did not differ significantly with regard to the average maximum values, the single greatest value recorded in the NCCU (6 V/m GSM + UMTS 900 (UL) frequency band, in the staff area) was more than twice that recorded in the NICU (3.70 V/m in the UMTS 2100 (UL) frequency band, in the children's rooms). The NCCU and NICU did not differ significantly with regard to the time during which the RF-EMF level at each measurement point was more than two standard deviations above its mean. The RF-EMF level was significantly higher during the day than during the night ($p < 0.001$). The various medical devices used in the NICU did not emit detectable amounts of RF. Overall, RF-EMF levels in the NCCU and NICU were very low. It is probable that the RF-EMFs measured here were primarily generated by the parents' and staff members' activities, rather than by medical devices. However, a combination of low-level, chronic exposure with transient, elevated peak values in a vulnerable population of preterm neonates may be of particular concern. In a department of pediatrics, decreasing preterm neonates' exposure to RF-EMFs should primarily involve a limitation on the use of wireless communication devices by staff members and parents.

https://www.ncbi.nlm.nih.gov/pubmed/31740038

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Patients with pacemakers or defibrillators do not need to worry about e-Cars: An observational study

Lennerz C, Horlbeck L, Weigand S, Grebmer C, Blazek P, Brkic A, Semmler V, Haller B, Reents T, Hessling G, Deisenhofer I, Lienkamp M, Kolb C, O'Connor M. Technol Health Care. 2019 Nov 8. doi: 10.3233/THC-191891.

Abstract

BACKGROUND: Electric cars are increasingly used for public and private transportation and represent possible sources of electromagnetic interference (EMI). Potential implications for patients with cardiac implantable electronic devices (CIED) range from unnecessary driving restrictions to life-threatening device malfunction. This prospective, cross-sectional study was designed to assess the EMI risk of electric cars on CIED function.

METHODS: One hundred and eight consecutive patients with CIED presenting for routine follow-up between May 2014 and January 2015 were enrolled in the study. The participants were exposed to electromagnetic fields generated by the four most common electric cars (Nissan Leaf, Tesla Model S, BMW i3, VW eUp) while roller-bench test-driving at Institute of Automotive Technology, Department of Mechanical Engineering, Technical University, Munich. The primary endpoint was any abnormalities in CIED function (e.g. oversensing with pacing-inhibition, inappropriate therapy or mode-switching) while driving or charging electric cars as assessed by electrocardiographic recordings and device interrogation.

RESULTS: No change in device function or programming was seen in this cohort which is representative of contemporary CIED devices. The largest electromagnetic field detected was along the charging cable during high current charging (116.5 μT). The field strength in the cabin was lower (2.1-3.6 μT).

CONCLUSIONS: Electric cars produce electromagnetic fields; however, they did not affect CIED function or programming in our cohort. Driving and charging of electric cars is likely safe for patients with CIEDs.

Open access paper: https://content.iospress.com/articles/technology-and-health-care/thc191891

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Evaluation of Wi-Fi Radiation Effects on Antibiotic Susceptibility, Metabolic Activity and Biofilm Formation by Escherichia Coli 0157H7, Staphylococcus Aureus and Staphylococcus Epidermis

Said-Salman IH, Jebali FA, Yusef HH, Mustafa ME. Evaluation of Wi-Fi Radiation Effects on Antibiotic Susceptibility, Metabolic Activity and Biofilm Formation by Escherichia Coli 0157H7, Staphylococcus Aureus and Staphylococcus Epidermis. J Biomed Phys Eng. 2019 Oct 1;9(5):579-586. doi: 10.31661/jbpe.v0i0.1106.

Abstract

Background: The radiation emitted from electromagnetic fields (EMF) can cause biological effects on prokaryotic and eukaryotic cells, including non-thermal effects.

Objective: The present study evaluated the non-thermal effects of wireless fidelity (Wi-Fi) operating at 2.4 GHz part of non-ionizing EMF on different pathogenic bacterial strains (*Escherichia coli* 0157H7, *Staphylococcus aureus, and Staphylococcus epidermis*). Antibiotic resistance, motility, metabolic activity and biofilm formation were examined.

Material and Methods:In this case-control, a Wi-Fi router was used as a source of microwaves and also bacterial cells were exposed to Wi-Fi radiation continuously for 24 and 48 hours. The antibiotic susceptibility was carried out using a disc diffusion method on Müller Hinton agar plates. Motility of *Escherichia coli* 0157H7 was conducted on motility agar plates. Cell metabolic activity and biofilm formation were performed using 3-(4, 5-Dimethylthiazol-2yl)-2, 5-diphenyltetrazolium bromide (MTT) assay and crystal violet quantification, respectively.

Results: The exposure to Wi-Fi radiation altered motility and antibiotic susceptibility of *Escherichia coli* 0157H7. However, there was no effect Wi-Fi radiation on antibiotic susceptibility of *Staphylococcus aureus and Staphylococcus epidermis*. On the other hand, the exposed cells, as compared to the unexposed control, showed an increased metabolic activity and biofilm formation ability in *Escherichia coli* 0157H7, *Staphylococcus aureus and Staphylococcus epidermis*.

Conclusion: These results proposed that Wi-Fi exposure acted on bacteria in stressful manner by increasing antibiotic resistance and motility of *Escherichia coli* 0157H7, as well as enhancing biofilm formation by *Escherichia coli* 0157H7, *Staphylococcus aureus and Staphylococcus epidermis*. The findings may have implications for the management of serious diseases caused by these infectious bacteria.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6820025/

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The effect of Wi-Fi electromagnetic waves on neuronal response properties in rat barrel cortex

Sistani S, Fatemi I, Shafeie SA, Kaeidi A, Azin M, Shamsizadeh A. The effect of Wi-Fi electromagnetic waves on neuronal response properties in rat barrel cortex. Somatosens Mot Res. 2019 Nov 13:1-6. doi: 10.1080/08990220.2019.1689116. [Epub ahead of print]

Abstract

There is a growing number of studies on the possible biological effects of Wi-Fi radiations on nervous system. In this study we investigated the effect of Wi-Fi exposure on single neuron responses to natural stimuli by using whisker to barrel pathway. This study was done on 29 male Wistar rats. Neuronal spontaneous activity and ON and OFF responses to displacement of principal whisker (PW), adjacent whisker (AW) and combination of PW-AW stimulation (as natural stimuli) were recorded in barrel cortex of anaesthetised rats. A D-link Wi-Fi device was used for 1 h exposure to 2.4 GHz microwaves in data mode (18.2 dBm and 44% for power and duty cycle). A condition test ratio (CTR) was calculated for assessing neuronal integrative properties. Wi-Fi radiations decreased CTR for ON responses. However, neuronal spontaneous activity and ON and OFF responses were not significantly changed following exposure to Wi-Fi signals. The results of this study demonstrated that exposure to Wi-Fi radiation could modulate integrative responses to natural stimuli in barrel cortex.

https://www.ncbi.nlm.nih.gov/pubmed/31718372

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The Effect of Prenatal Exposure to 2.4 GHz Radio Frequency on the Histology and Expression of the osteocalcin and RUNX2 Gene of the Forelimb in an NMRI Mouse

Amandokht Saghezchi S, Azad N, Heidari R, Jajarmi V, Abdi S, Abaszadeh HA, Sadjadpour SS, Neikoei N, Heidari MH, Abdollahifar MA. The Effect of Prenatal Exposure to 2.4 GHz Radio Frequency on the Histology and Expression of the osteocalcin and RUNX2 Gene of the Forelimb in an NMRI Mouse. J Lasers Med Sci. 2019 Fall;10(4):283-289. doi: 10.15171/jlms.2019.46.

Abstract

Introduction: Today the use of electromagnetic waves has dramatically increased in modern industrial societies. This study aimed to investigate the effect of prenatal exposure to 2.4 GHz wireless frequency on forelimb development in an NMRI mouse in vivo.

Methods: A total of 21 female mice weighing 25-30 g were included in the present study. They were randomly assigned to 3 groups, namely control (n=7), sham (n=7), and experimental (n=7). After mating, the experimental group was exposed to 2.4 GHz radio frequency at a distance of 20-30 cm from the device, 4 h/d until the delivery. The sham group was placed at a distance of 20-30 cm from the device every day without exposure to electromagnetic waves, and the control group had a pregnancy period without any stress and electromagnetic wave exposure. After giving birth, the forelimbs were isolated from the infants and examined by stereological studies and RT-PCR for the evaluation of osteocalcin and RUNX2 gene expression.

Results: Although, at first glance, there was no macroscopic teratogen effect in forelimbs in all groups, via a stereological method, we showed that bone and cartilage volume decreased in the experimental group compared to the other groups. We also found that the experimental group had lower expression of the osteocalcin and RUNX2 gene than the control and sham groups did. However, there were no significant differences between the control and sham groups in terms of bone and cartilage volume and gene expression.

Conclusion: Although teratogen effect of prenatal exposure to 2.4 GHz radio frequency on forelimbs was not demonstrated macroscopically, further studies showed negative effects on the forelimb bone, cartilage volume, and gene expression.

The exposure apparatus was a wireless router (CISCO, EA6300V1, China) that applied 2.4 GHz wireless frequency for 21 days and 4 h/d.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6885904/

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Effect of Occupational Exposure to Radar Radiation on Cancer Risk: A Systematic Review and Meta-Analysis

Variani AS, Saboori S, Shahsavari S, Saeed Yari S, Zaroushani V. Effect of Occupational Exposure to Radar Radiation on Cancer Risk: A Systematic Review and Meta-Analysis. Asian Pac J Cancer Prev. 20 (11): 3211-3219. 2019 Nov 1. DOI: 10.31557/APJCP.2019.20.11.3211.

Abstract

Objective: Microwave radiation is one of the most growing environmental workplace factors that exposes too many workers in the various workplaces. Regard to concerns about cancer incidence in these workers and lack of systematic or meta-analytic studies about this object, so, we conducted a meta-analysis to acquire an understanding of the association between cancer risk and occupational exposure to radar radiation.

Methods: A systematic search was carried out on case-control, cohort and clinical control trial studies that published in the Cochrane Library, PubMed, ISI Web of Science, Scopus and Google scholar databases that accomplished from March 2017 to March 2018 and updated on 30 September, 2018 in English and Persian articles without time limit in publication date. Keywords were selected based on PICO principle and collected from MeSH database. After removal of duplicated studied, taking into inclusion and exclusion criteria, the process of screening was carried out and data were extracted after preparation of the full text of included articles. Article collection was completed by manually searching for a reference list of eligible studies. For quality assessment of included studies, Newcastle-Ottawa scale was used.

Results: a total of 533 studies was found in the first step of literature search, only 6 were included with 53,008 sample size according to inclusion and exclusion criteria. Estimated pooled random effects size analysis showed no significant increasing effect of occupational exposure to radar radiation on mortality rate (MR=0.81, 95%CI: 0.78, 0.83) and relative risk (RR=0.87, 95%CI: 0.75, 0.99, P <0.0001) of cancer with a significant heterogeneity between the selected studies.

Conclusions: In conclusion, the results of this meta-analysis study have shown no significant increase in overall mortality ratio and cancer risk ratio from occupational exposure to the radar frequency of workers. But, these results are not conclusive. As regards to some limitation such as fewer numbers of included studies, lack of data about exposure characterizations and demographic characterizations in this meta-analysis, this result is not certain and conclusive. It is recommended to conduct future studies.

Open access paper: http://journal.waocp.org/?sid=Entrez:PubMed&id=pmid:&key=2019.20.11.3211

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Scoping Review of the Potential Health Effects of Exposure to Extremely Low-Frequency Electric and Magnetic Fields

Habash M, Gogna P, Krewski D, Habash RWY. Scoping Review of the Potential Health Effects of Exposure to Extremely Low-Frequency Electric and Magnetic Fields. Crit Rev Biomed Eng. 2019;47(4):323-347. doi: 10.1615/CritRevBiomedEng.2019030211.

Abstract

Previous studies suggest that extremely low-frequency (ELF) electric and magnetic fields (EMFs) may impact human health. However, epidemiologic studies have provided inconsistent results on the association between exposure to ELF EMFs and various health outcomes. This scoping review reports on primary investigations that were published during the ten-year period of 2007-2017 on the association between ELF EMFs and cancer, cardiovascular disease (CVD), reproductive health effects, and neurodegenerative diseases. We identified a total of 361 articles from two bibliographic databases (PubMed and EMBASE). Of these, 39 articles (19 cancer studies, two CVD studies, nine reproductive health studies, and ten neurodegenerative disease studies [with one repeated for two outcomes]) met inclusion criteria. Articles identified in this study focus on three different types of exposure: occupational (22 studies), residential (15 studies), and electric blanket (two

studies). This review suggests that ELF EMFs may be associated with neurodegenerative diseases, specifically Alzheimer's disease; however, limited evidence was found to suggest that ELF EMFs are associated with several types of cancer, CVD, and reproductive outcomes. Additional epidemiological studies in large study populations with improved exposure assessments are needed to clarify current inconclusive relationships.

https://www.ncbi.nlm.nih.gov/pubmed/31679262

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Maternal cumulative exposure to extremely low frequency electromagnetic fields, prematurity and small for gestational age: a pooled analysis of two birth cohorts

Migault L, Garlantézec R, Piel C, Marchand-Martin L, Orazio S, Cheminat M, Zaros C, Carles C, Cardis E, Ancel PY, Charles MA, de Seze R, Baldi I, Bouvier G. Maternal cumulative exposure to extremely low frequency electromagnetic fields, prematurity and small for gestational age: a pooled analysis of two birth cohorts. Occup Environ Med. 2020 Jan;77(1):22-31. doi: 10.1136/oemed-2019-105785.

Abstract

BACKGROUND: Data on the effects of extremely low frequency electromagnetic fields (ELF-EMF) on pregnancy outcomes are inconclusive.

OBJECTIVE: To study the relation between maternal cumulative exposure to ELF-EMF during pregnancy and the risk of prematurity or small for gestational age (SGA) in a pooled analysis of two French birth cohorts.

METHODS: Elfe and Epipage2 are both population-based birth cohorts initiated in 2011 and included 18 329 and 8400 births, respectively. Health data and household, mother and child characteristics were obtained from medical records and questionnaires at maternity and during follow-up. A job exposure matrix was used to assess cumulative exposure to ELF-EMF during three periods: (1) until 15 weeks of gestation, (2) until 28 weeks of gestation and (3) until 32 weeks of gestation. Analyses were restricted to single live births in mainland France and to mothers with documented jobs (N=19 894). Adjusted logistic regression models were used.

RESULTS: According to the period studied, 3.2%-4% of mothers were classified as highly exposed. Results were heterogeneous. Increased risks of prematurity were found among low exposed mothers for the three periods, and no association was observed among the most exposed (OR1=0.92 (95% CI 0.74 to 1.15); OR2=0.98 (95% CI 0.80 to 1.21); OR3=1.14 (95% CI 0.92 to 1.41)). For SGA, no association was observed with the exception of increased risk among the low exposed mothers in period 2 and the most exposed in period 3 (OR=1.25 (95% CI 1.02 to 1.53)).

CONCLUSION: Some heterogeneous associations between ELF-EMF exposure and prematurity and SGA were observed. However, due to heterogeneity (ie, their independence regarding the level of exposure), associations cannot be definitely explained by ELF-EMF exposure.

https://www.ncbi.nlm.nih.gov/pubmed/31831625

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Low frequency magnetic fields inside cars

Pääkkönen R, Korpinen L. LOW FREQUENCY MAGNETIC FIELDS INSIDE CARS. Radiat Prot Dosimetry. 2019 Nov 7. pii: ncz248. doi: 10.1093/rpd/ncz248.

Abstract

Magnetic fields were compared inside passenger seats of electric, petrol and hybrid cars. While driving about 5 km in an urban environment, values were recorded and compared between car types. The magnetic flux densities of the cars were less than 2.6 μT. The magnitudes of the magnetic fields of petrol cars and hybrid cars were about the same and slightly lower for electric cars. Based on our measurements, values were less than 3% of the guidelines given for the general population or people using pacemakers.

https://www.ncbi.nlm.nih.gov/pubmed/31702768

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Evaluation in humans of ELF-EMF exposure on chromogranin A, a marker of neuroendocrine tumors and stress

Touitou Y, Lambrozo J, Mauvieux B, Riedel M. Evaluation in humans of ELF-EMF exposure on chromogranin A, a marker of neuroendocrine tumors and stress. Chronobiol Int. 2019 Nov 4:1-8. doi: 10.1080/07420528.2019.1683857.

Abstract

Chromogranin A (CgA), which is a major protein in adrenal chromaffin cells and adrenergic neurons, is a clinically relevant endocrine and neuroendocrine tumor marker including pheochromocytomas, neuroblastomas, and related neurogenic tumors. In this study, we looked at the effect in humans of chronic daily exposure to a 50-Hz magnetic field. We examined in 15 men (38.0 ± 0.9 years) the effects of chronic daily exposure to a 50-Hz magnetic field for 1-20 yrs both at home and at work. EMDEX II dosimeters were used to record magnetic field all day long every 30 s. for 1 week. The weekly geometric mean of the individual exposures ranged from 0.1 to 2.6 μT. Blood samples were taken hourly between 20:00 h and 08:00 h. CgA patterns of exposed subjects were compared to age-matched controls. The results of exposed subjects were compared with those for 15 unexposed men who served as controls and whose individual exposure was ten times lower ranging from 0.004 to 0.092 μT. This work shows that in the control group the serum CgA levels exhibited a nighttime peak with a progressive decline of the serum concentrations and a nadir in the morning. Both the profile and the serum concentrations of CgA, a marker of neuroendocrine tumors and stress, did not appear to be impaired in the subjects chronically exposed over a long period (up to 20 yrs) to magnetic fields though a trend toward lower levels were found at the highest exposure (>0.3 μT). This does not rule out, however, that the potential deleterious risk of ELF-EMF on frail populations such as children and the elderly may be greater at low exposure and should hence be documented, at least for their residential exposure.

https://www.ncbi.nlm.nih.gov/pubmed/31682468

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Gender and Age Differences in the Suppressive Effect of a 50 Hz Electric Field on the Immobilization-Induced Increase of Plasma Glucocorticoid in Mice

Harakawa S, Hori T, Nedachi T, Suzuki H. Gender and Age Differences in the Suppressive Effect of a 50 Hz Electric Field on the Immobilization-Induced Increase of Plasma Glucocorticoid in Mice. Bioelectromagnetics. 2019 Dec 12. doi: 10.1002/bem.22238.

Abstract

We developed an experimental system to characterize the suppressive effect of extremely low-frequency (ELF) electric fields (EFs) on the stress response. We assessed differences in the EF effects by age and gender. Control, EF-alone, immobilization-alone, and co-treated groups were subjected to an EF (50 Hz, 10 kV/m). Co-treated mice were exposed to the EF for 60 min, with immobilization during the latter half. Our results indicate that the suppressive effects of ELF EFs on the stress response in immobilized mice occur regardless of gender or age. As stress plays an important role in the onset and progression of various diseases, these findings may have broad implications for understanding the efficacy of EFs in animal, and perhaps human, health

https://www.ncbi.nlm.nih.gov/pubmed/31833072

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An Extremely Low Frequency Magnetic Field and Global Cerebral Ischemia Affect Pituitary ACTH and TSH Cells in Gerbils

Rauš Balind SManojlović-Stojanoski M, Šošić-Jurjević B, Selaković V, Milošević V, Petković B. An Extremely Low Frequency Magnetic Field and Global Cerebral Ischemia Affect Pituitary ACTH and TSH Cells in Gerbils. Bioelectromagnetics. 2019 Dec 11. doi: 10.1002/bem.22237.

Abstract

The neuroendocrine system can be modulated by a magnetic field and cerebral ischemia as external and internal stressors, respectively. This study deals with the separate or combined effects of an extremely low frequency (ELF) magnetic field (50 Hz, average magnetic field of 0.5 mT) for 7 days and global cerebral ischemia for 10 min on the morpho-functional features of pituitary adrenocorticotrophic (ACTH) and thyrotrophic (TSH) cells in 3-month-old gerbils. To determine the immediate and delayed effects of the applied stressors, measurements were made on the 7th and 14th days after the onset of the experiment. The ELF magnetic field and 10-min global cerebral ischemia, separately and particularly in combination, decreased ($P < 0.05$) the volume density of ACTH cells, while only in combination were intracellular ACTH content and plasma ACTH concentration increased ($P < 0.05$) on day 7. The ELF magnetic field elevated serum TSH concentration on day 7 and intracellular TSHβ content on day 14 ($P < 0.05$). Also, 10-min global cerebral ischemia alone increased serum TSH concentration ($P < 0.05$), while in combination with the ELF magnetic field it elevated ($P < 0.05$) intracellular TSHβ content on day 14. In conclusion, an ELF magnetic field and/or 10-min global cerebral ischemia can induce immediate and delayed stimulation of ACTH and TSH synthesis and secretion.

https://www.ncbi.nlm.nih.gov/pubmed/31828821

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CT2A Cell Viability Modulated by Electromagnetic Fields at Extremely Low Frequency under No Thermal Effects

García-Minguillán O, Prous R, Ramirez-Castillejo MDC, Maestú C. CT2A Cell Viability Modulated by Electromagnetic Fields at Extremely Low Frequency under No Thermal Effects. Int J Mol Sci. 2019 Dec 24;21(1). pii: E152. doi: 10.3390/ijms21010152.

Abstract

The effects produced by electromagnetic fields (EMFs) on human beings at extremely low frequencies (ELFs) have being investigated in the past years, across in vitro studies, using different cell lines. Nevertheless, the effects produced on cells are not clarified, and the cellular mechanisms and cell-signaling processes involved are still unknown. This situation has resulted in a division among the scientific community about the adequacy of the recommended level of exposure. In this sense, we consider that it is necessary to develop long-term exposure studies and check if the recommended levels of EMFs are under thermal effects. Hence, we exposed CT2A cells to different EMFs at different ELFs at short and long times. Our results showed frequency dependence in CT2A exposed during 24 h to a small EMF of 30 μT equal to those originated by the Earth and frequency dependence after the exposure during seven days to an EMF of 100 μT at different ELFs. Particularly, our results showed a remarkable cell viability decrease of CT2A cells exposed to EMFs of 30 Hz. Nevertheless, after analyzing the thermal effects in terms of HSP90 expression, we did not find thermal damages related to the differences in cell viability, so other crucial cellular mechanism should be involved.

Open access paper: https://www.mdpi.com/1422-0067/21/1/152

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Magnetic Fields Trump Oxygen in Controlling the Death of Erythro-Leukemia Cells

Li Y, Héroux P. Magnetic fields trump oxygen in controlling the death of erythro-leukemia Cells. Applied Sciences, 6 December 2019.

Abstract

Expansions in power and telecommunications systems have created a new electromagnetic environment. Here, we compare the death rate of human cancer cells in vitro in the pre-industrial electromagnetic environment of the past (“Zero Field”) with that of an electromagnetic environment typical of contemporary human exposures (“Incubator Field”). A cell incubator provides magnetic fields comparable to those in the current human environment. Steel shields divert those same fields away from cell preparations in the “pre-industrial” assays. Large changes in oxygen levels are provided by nitrogen or atmospheric gas over the cell cultures. Human cancer cells are then separated according to three categories: necrotic, early apoptotic, or late apoptotic. The results are compiled for two variables, magnetic field and oxygen, in 16 different situations (“Transitions”) likely to occur in the human body under present living conditions. We find that magnetic fields are a more powerful determinant of cell death than oxygen, and induce death by different mechanisms. This has important implications for the reproducibility of in vitro biological experiments focusing on cell survival or metabolism, and for public health. The rate and mechanisms of cell death are critical to many chronic human ailments such as cancer, neurological diseases, and diabetes.

Open access paper: https://www.mdpi.com/2076-3417/9/24/5318

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Review. The influence of bioactive mobile telephony radiation at the level of a plant community – Possible mechanisms and indicators of the effects

Czerwiński M, Januszkiewicz L, Vian A, Lázaro.A. Review. The influence of bioactive mobile telephony radiation at the level of a plant community – Possible mechanisms and indicators of the effects.

Ecological Indicators. 108, January 2020, 105683. https://doi.org/10.1016/j.ecolind.2019.105683.

Highlights

• There are various indicators of microwave radiation impact on herbaceous vegetation.
• The best indicators are some parameters of vegetation canopy or individual plants.

• Specific plant functional groups may be indicators of long-term community processes.

• Other organisms interacting with plants, e.g. pollinators, should also be cons idered.

• The selection of indicators depends on the propagation of radiation in the canopy.

Abstract

Environmental exposure to radiofrequency electromagnetic fields (RF-EMFs) from mobile telephony has rapidly increased in the last two decades and this trend is expected to continue. The effects of this exposure at plant community level are unknown and difficult to assess in a scientifically appropriate manner. Such an assessment can be scientifically adequate if a studied plant community is completely new and control-impact radiation treatment is used.

In this review we aimed to predict ecological effects and identify indicators of the impact of bioactive RF-EMFs at the mobile telephony frequency range on plant communities. We considered the scenario where a plant community was exposed to radiation generated by a base transmitting station antenna mounted on a nearby mast. This plant community can be represented by mesic meadow, ruderal or arable weed community, or other herbaceous, moderately productive vegetation type. We concentrated primarily on radiation effects that can be recorded for a year since the exposure started. To predict them we used physical theories of radiowave propagation in vegetation and the knowledge on plants physiological responses to RF-EMF. Our indicators can be used for the detection of the impact of RF-EMFs on vegetation in a control-impact experiment.

The identified indicators can be classified into the following groups: (1) canopy parameters; (2) plant characteristics to be measured in the field or laboratory in a number of individuals that represent the populations of selected species; (3) community weighted means/medians (CWMs) of plant traits and strategies; (4) the abundance of other organisms that interact with plants and can influence their fitness or population size. The group of canopy parameters includes mean height, vertical vegetation structure and dry weight of above-ground standing phytomass. Plant characteristics requiring biometric sampling in the field are plant height, the number of fruits and seeds, as well as seed viability. The group of plant traits that are calculated as CWMs covers seed releasing height, seed dispersal mode, SLA, leaf orientation, month of germination and flowering, Ellenberg's light indicator value, and the proportion of individuals in the classes of competitors and stress tolerators according to Grime's CSR strategy scheme. The group of "non-plant" indicators includes primarily the frequency of flower visits by beetles, wasps, hoverflies, and bees that have their nests over ground. To detect ecological responses that occur for the first year since a herbaceous community has been exposed to potentially bioactive RF-EMF, the first two indicators groups should be used.

https://www.sciencedirect.com/science/article/pii/S1470160X19306764?via%3Dihub

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Long-distance navigation and magnetoreception in migratory animals

Mouritsen H. Long-distance navigation and magnetoreception in migratory animals. Nature. 2018 Jun;558(7708):50-59. doi: 10.1038/s41586-018-0176-1.

Abstract

For centuries, humans have been fascinated by how migratory animals find their way over thousands of kilometres. Here, I review the mechanisms used in animal orientation and navigation with a particular focus on long-distance migrants and magnetoreception. I contend that any long-distance navigational task consists of three phases and that no single cue or mechanism will enable animals to navigate with pinpoint accuracy over thousands of kilometres. Multiscale and multisensory cue integration in the brain is needed. I conclude by raising twenty important mechanistic questions related to long-distance animal navigation that should be solved over the next twenty years.

https://www.ncbi.nlm.nih.gov/pubmed/29875486

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Exposure Effects of Terahertz Waves on Primary Neurons and Neuron-like Cells Under Nonthermal Conditions

Tan SZ, Tan PC, Luo LQ, et al. Exposure Effects of Terahertz Waves on Primary Neurons and Neuron-like Cells Under Nonthermal Conditions. Biomed Environ Sci. 2019 Oct;32(10):739-754. doi: 10.3967/bes2019.094.

Abstract

OBJECTIVE: This study aimed to explore the potential effects of terahertz (THz) waves on primary cultured neurons from 4 rat brain regions (hippocampus, cerebral cortex, cerebellum, and brainstem) and 3 kinds of neuron-like cells (MN9D, PC12, and HT22 cells) under nonthermal conditions.

METHODS: THz waves with an output power of 50 (0.16 THz) and 10 (0.17 THz) mW with exposure times of 6 and 60 min were used in this study. Analysis of temperature change, neurite growth, cell membrane roughness, micromorphology, neurotransmitters and synaptic-related proteins (SYN and PSD95) was used to evaluate the potential effects.

RESULTS: Temperature increase caused by the THz wave was negligible. THz waves induced significant neurotransmitter changes in primary hippocampal, cerebellar, and brainstem neurons and in MN9D and PC12 cells. THz wave downregulated SYN expression in primary hippocampal neurons and downregulated PSD95 expression in primary cortical neurons.

CONCLUSION: Different types of cells responded differently after THz wave exposure, and primary hippocampal and cortical neurons and MN9D cells were relatively sensitive to the THz waves. The biological effects were positively correlated with the exposure time of the THz waves.

Open access paper: http://www.besjournal.com/en/article/doi/10.3967/bes2019.094

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Behavioral evidence for geomagnetic imprinting and transgenerational inheritance in fruit flies

Oh IT, Kwon HJ, Kim SC, Kim HJ, Lohmann KJ, Chae K. Behavioral evidence for geomagnetic imprinting and transgenerational inheritance in fruit flies. Proc Natl Acad Sci U S A. 2019 Dec 30. pii: 201914106. doi: 10.1073/pnas.1914106117.

Abstract

Certain long-distance migratory animals, such as salmon and sea turtles, are thought to imprint on the magnetic field of their natal area and to use this information to help them return as adults. Despite a growing body of indirect support for such imprinting, direct experimental evidence thereof remains elusive. Here, using the fruit fly as a magnetoreceptive model organism, we demonstrate that exposure to a specific geographic magnetic field during a critical period of early development affected responses to a matching magnetic field gradient later in life. Specifically, hungry flies that had imprinted on a specific magnetic field from 1 of 3 widely separated geographic locations responded to the imprinted field, but not other magnetic fields, by moving downward, a geotactic behavior associated with foraging. This same behavior occurred spontaneously in the progeny of the next generation: female progeny moved downward in response to the field on which their parents had imprinted, whereas male progeny did so only in the presence of these females. These results represent experimental evidence that organisms can learn and remember a magnetic field to which they were exposed during a critical period of development. Although the function of the behavior is not known, one possibility is that imprinting on the magnetic field of a natal area assists flies and their offspring in recognizing locations likely to be favorable for foraging and reproduction.

https://www.ncbi.nlm.nih.gov/pubmed/31889001

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The Significance of Primary Tumors in the NTP Study of Chronic Rat Exposure to Cell Phone Radiation]

Lin JC. The Significance of Primary Tumors in the NTP Study of Chronic Rat Exposure to Cell Phone Radiation [Health Matters]. IEEE Microwave Magazine. 20(11):18-21. Nov 2019. DOI:10.1109/MMM.2019.2935361

Abstract

Most media accounts of the U.S. National Toxicology Program's (NTP's) final report have understandably focused on the statistically significant finding of "clear evidence" that both GSM and code-division multiple access (CDMA)-modulated 900-MHz wireless RF radiation led to the development of malignant schwannoma, a rare form of tumor, in the hearts of male rats. In addition to this, unusual patterns of cardiomyopathy, i.e., damage to heart tissue, were observed in both RF-exposed male and female Sprague-Dawley rats compared with concurrent control animals, although the findings for female rats were deemed as providing only uncertain or "equivocal" evidence for schwannomas and malignant gliomas, compared to concurrent controls.

https://ieeexplore.ieee.org/document/8866792

Excerpts

"A Closer Look at the NTP Findings

“In all fairness, the primary cancer or overall cancer rates detected in any organ or tissue inside the animal body do not appear to have been purposefully overlooked or unnoticed. Indeed, the results for total primary cancer or tumor occurrences in NTP animal studies can be found in the appendices of its final reports [1]. However, although the data may not have been purposefully disregarded or ignored, the NTP excluded them from its publicized report summaries. An independent analysis of the data showed that rats exposed to GSM and CDMA RF radiation had significantly higher overall or total primary tumor rates than did the concurrent control rats [4].

In particular, the highest overall cancer (or malignant tumors) rates were found in male rats exposed to whole-body SARs of 3 W/kg from 900-MHz cell phone RF radiation (42 and 46% for GSM and CDMA, respectively), and the lowest rate was found in the concurrent control group (27%). Thus, the RF-exposed groups had significantly higher overall or total primary cancer rates than did the concurrent control rats. Moreover, the highest overall tumor rates (either a benign or malignant tumor in any organ or tissue) were observed in male rats exposed to SARs of 3-W/kg (87 and 84% for GSM and CDMA, respectively) cell phone RF radiation. As stated previously, the lowest rate was seen in the concurrent control group (63%). The RF-exposed groups had significantly higher overall tumor rates than did the concurrent control rats. Male rats in the lowest RF-exposed groups (whole-body SARs of 1.5 W/kg) had significantly higher rates of benign primary tumors (76 and 73% for GSM and CDMA, respectively) than did concurrent or sham control groups (54%).”

"IARC Assessment

The International Agency for Research on Cancer (IARC) assessed the then available scientific literature and concluded that the epidemiological studies on humans that had reported increased risks for malignant gliomas and acoustic neuromas among heavy or long-term users of cell phones were sufficiently strong to support a classification of 2B, i.e., possibly carcinogenic to humans [9]. With its classification of RF radiation as a 2B carcinogen, the IARC suggested that it also believed the available scientific evidence was incomplete and limited, especially with regard to results from animal experiments.

“The time is right for the IARC to upgrade its previous epidemiology-based classification of RF exposure to higher levels in terms of the carcinogenicity of RF radiation for humans. Recently, two relatively well-conducted RF and microwave exposure studies employing the Sprague–Dawley strain of rats—without, however, using any cancer-promoting agents (or cocarcinogens)—showed consistent results in significantly increased total primary cancer or overall tumor rates in animals exposed to RF radiation.”

It is important to note that the recent NTP and Ramazzini animal RF exposure studies presented similar findings in heart schwannomas and brain gliomas. The increased schwannomas and abnormal heart tissue development/damage to heart tissue are significant findings in RF-exposed animal research studies. In addition to this, the incidence of benign pheochromocytomas of the adrenal medulla was found to be higher in the exposed group than in the sham controls for the 2,450-MHz circular waveguide experiment [6]. Interestingly, in the recent NTP study, there was “some evidence” of carcinogenicity in the adrenal gland. The number of pheochromocytomas was significantly higher ($p < 0.05$) in male rats at 1.5 and 3 W/kg, compared with the concurrent controls. Moreover, the increase in malignant tumor-like hyperplasia in the adrenal gland of female rats was significantly higher at 6 W/kg, relative to the concurrent controls ($p < 0.05$)."

"Postscripts

... It is important to note that the recent NTP and Ramazzini animal RF exposure studies presented similar findings in heart schwannomas and brain gliomas. The increased schwannomas and abnormal heart tissue development/damage to heart tissue are significant findings in RF-exposed animal research studies....

A particular perspective to keep in mind is that, with the induction of cancer by a carcinogen, an agent is typically considered carcinogenic if it induces a significant response in a specific tissue."

[4] J. Moskowitz, "National toxicology program publishes final cell phone radiation study reports," Electromagn. Radiation Safety, Nov. 2018. [Online]. Available: https://www.saferemr.com/2018/11/NTP-final-reports31.html

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Evaluation of genotoxicity of cell phone radiation in male and female rats and mice following subchronic exposure (NTP study)

Smith-Roe SL, Wyde ME, Stout MD, Winters JW, Hobbs CA, Shepard KG, Green AS, Kissling GE, Shockley KR, Tice RR, Bucher JR, Witt KL. Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure. Environ Mol Mutagen. 2019 Oct 21. doi: 10.1002/em.22343.

Abstract

The National Toxicology Program tested two common radiofrequency radiation (RFR) modulations emitted by cellular telephones in a 2-year rodent cancer bioassay that included interim assessments of additional animals for genotoxicity endpoints.

Male and female Hsd:Sprague Dawley SD rats and B6C3F1/N mice were exposed from gestation day 5 or postnatal day 35, respectively, to code division multiple access (CDMA) or global system for mobile (GSM) modulations over 18 h/day, at 10 min intervals, in reverberation chambers at specific absorption rates (SAR) of 1.5, 3, or 6 W/kg (rats, 900 MHz) or 2.5, 5, or 10 W/kg (mice, 1900 MHz).After 19 (rats) or 14 (mice) weeks of exposure, animals were examined for evidence of RFR-associated genotoxicity using two different measures. Using the alkaline (pH > 13) comet assay, DNA damage was assessed in cells from three brain regions, liver cells, and peripheral blood leukocytes; using the micronucleus assay, chromosomal damage was assessed in immature and mature peripheral blood erythrocytes.

Results of the comet assay showed significant increases in DNA damage in the frontal cortex of male mice (both modulations), leukocytes of female mice (CDMA only), and hippocampus of male rats (CDMA only). Increases in DNA damage judged to be equivocal were observed in several other tissues of rats and mice. No significant increases in micronucleated red blood cells were observed in rats or mice. In conclusion, these results suggest that exposure to RFR is associated with an increase in DNA damage.

https://www.ncbi.nlm.nih.gov/pubmed/31633839

Excerpts

The NTP bioassay was designed to evaluate non-thermal effects of cell phone RFR exposure, which meant that body temperature could not change more than 1 °C under our exposure conditions .... Therefore, we consider it unlikely that thermal effects were a confounding factor for our genetic toxicity tests, although more

work in general is needed to clarify the thermal effects of RFR on different tissues, and the degree to which increases in body or tissue temperature affect genomic integrity.

... our results and the results of other experiments suggest that non-thermal exposure of cells or whole organisms to RFR may result in measurable genotoxic effects, despite varied and weak responses across studies overall (Brusick et al., 1998; Ruediger, 2009; Verschaeve et al., 2010). Induction of oxygen radicals or interference with DNA repair processes have been proposed as possible mechanisms by which RFR could cause DNA damage (Ruediger 2009; Yakymenko et al. 2015).

... NTP Technical Reports on the results of the 2-year cancer bioassay for exposure to RFR for rats (TR 595) and mice (TR 596) were finalized, peer reviewed, and made publicly available in 2018. The NTP concluded that results demonstrated clear evidence of carcinogenic activity of cell phone RFR (both modulations) based on incidences of malignant schwannomas of the heart in male rats. Malignant gliomas in the brain were also observed in male rats exposed to cell phone RFR and were considered to be related to exposure. Female rats exhibited malignant schwannomas of the heart and malignant gliomas, but incidences of these tumors were considered equivocal. The observation that cell phone RFR affects heart and brain tissue in Sprague Dawley rats after long-term exposure was replicated in a similar study (that used only the GSM modulation) by the Ramazzini Institute (Falcioni et al., 2018). The gliomas and schwannomas observed in rats are similar to the tumor types reported in some epidemiology studies to be associated with cell phone use. The NTP bioassay findings in mice, in which different organs were affected compared to rats, were considered equivocal....

The highest exposure of 6 W/kg in rats and 10 W/kg in mice, for a total of 9 h 10 min a day (achieved by cycling for 10 min on, 10 min off over 18 h 20 min), produced higher exposures than experienced by humans under normal cellular phone use conditions. Thus, whether the findings in the NTP animal studies (e.g. malignant gliomas in the brain and malignant schwannomas in the hearts of male rats; increased levels of DNA damage in hippocampal cells of male rats and the frontal cortex of male mice) indicate a potential for adverse health outcomes in humans remains a question. Because one of the most important questions prompted by our results concerns the mechanism(s) by which RFR might induce biological effects, follow-up studies by the NTP to investigate mechanisms of genetic damage associated with RFR exposure are underway.

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Adverse Effects of Wireless Radiation

Kostoff RN. Adverse Effects of Wireless Radiation. 2019. PDF. http://hdl.handle.net/1853/61946.

Abstract

This monograph identifies adverse effects of wireless radiation as reported in the premier biomedical literature. It shows that most of the reported laboratory experiments are not designed to elicit the more severe adverse effects reflective of the real-life operating environment in which wireless radiation is embedded. Many do not include pulsing and modulation of the carrier signal, and most do not account for synergistic effects of other toxic stimuli acting in concert with the wireless radiation. It also presents evidence that the nascent 5G mobile networking technology will affect not only the skin and eyes, as commonly believed, but will have systemic adverse effects as well. The monograph includes a substantial bibliography of papers that present these adverse effects, and shows that what has been reported is the tip of the iceberg of the full spectrum of potential adverse effects from wireless radiation.

Open access paper:
https://smartech.gatech.edu/bitstream/handle/1853/61946/ADVERSE%20EFFECTS%20OF%20WIRELESS%20RADIATION%20%283%29.pdf

Note: This 649-page monograph is not a peer-reviewed publication.

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Mobile phone induced cognitive and neurochemical consequences

Sharma A, Sharma S, Shrivastava S, Singhal PK, Shukla S. Mobile phone induced cognitive and neurochemical consequences. J Chem Neuroanat. 2019 Sep 22:101684. doi: 10.1016/j.jchemneu.2019.101684.

Highlights

• Use of mobile phone lowers acetyl cholinesterase activity of brain.
• MWR cause increase in lipid per oxidation thus alters membrane integrity.
• Microwave radiation alters the oxidative stress management.
• Effects on Hippocampus, Spatial Memory, Learning Behavior in Rats.

Abstract

With the rapid advances in technology, extensive use of mobile phones has increased the risk of health problems. This study was performed to find out the effect of mobile phone frequency on male Wistar rats. Animals were divided into two groups (n = 6 in each group). Group one was considered as control and group two (experimental group) was exposed to microwave radiation (2100 MHz) for 4 hours/day (5 days/week) for 3 months. Exposure of microwave radiation frequency showed significant alterations in cholinesterase activity, muscular strength, learning ability and anxiety. MWR exposure was also associated with significant alteration in the oxidative defense system and hippocampus degeneration. Histopathological observations clearly depicted the neural degeneration. Thus, it can be concluded that MWR significantly affects the central nervous system and may lead to many severe illnesses. This study may reveal a platform to understand its toxic effect and can further be used for amendment in current guidelines of mobile radiation.

https://www.ncbi.nlm.nih.gov/pubmed/31553920

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Cancers of the Brain and CNS: Global Patterns and Trends in Incidence

Mortazavi SMJ, Mortazavi SAR, Paknahad M. Cancers of the Brain and CNS: Global Patterns and Trends in Incidence. J Biomed Phys Eng. 2018 Mar 1;8(1):151-152.

Abstract

Miranda-Filho et al. in their recently published paper entitled "Cancers of the brain and CNS: global patterns and trends in incidence" provided a global status report of the geographic and temporal variations in the incidence of brain and CNS cancers in different countries across continents worldwide. While the authors confirm the role of genetic risk factors and ionizing radiation exposures, they claimed that no firm conclusion

could be drawn about the role of exposure to non-ionizing radiation. The paper authored by Miranda-Filho et al. not only addresses a challenging issue, it can be considered as a good contribution in the field of brain and CNS cancers. However, our correspondence addresses a basic shortcoming of this paper about the role of electromagnetic fields and cancers and provides evidence showing that exposure to radiofrequency electromagnetic fields (RF-EMFs), at least at high levels and long durations, can increases the risk of cancer.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5928307/

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Radiofrequency field exposure assessment: a pilot study on mobile phone signal strength and transmitted power levels

Brzozek C, Zeleke BM, Abramson MJ, Benke KK, Benke G. Radiofrequency electromagnetic field exposure assessment: a pilot study on mobile phone signal strength and transmitted power levels. J Expo Sci Environ Epidemiol. 2019 Oct 22. doi: 10.1038/s41370-019-0178-6.

Abstract

In many epidemiological studies mobile phone use has been used as an exposure proxy for radiofrequency electromagnetic field (RF-EMF) exposure. However, RF-EMF exposure assessment from mobile phone use is prone to measurement errors limiting epidemiological research. An often-overlooked aspect is received signal strength levels from base stations and its correlation with mobile phone transmit (Tx) power. The Qualipoc android phone is a tool that provides information on both signal strength and Tx power. The phone produces simultaneous measurements of Received Signal Strength Indicator (RSSI), Reference Signal Received Power (RSRP), Received Signal Code Power (RSCP), and Tx power on the 3G and 4G networks. Measurements taken in the greater Melbourne area found a wide range of signal strength levels. The correlations between multiple signal strength indicators and Tx power were assessed with strong negative correlations found for 3G and 4G data technologies (3G RSSI -0.93, RSCP -0.93; 4G RSSI -0.85, RSRP -0.87). Variations in Tx power over categorical levels of signal strength were quantified and showed large increases in Tx power as signal level decreased. Future epidemiological studies should control for signal strength or factors influencing signal strength to reduce RF-EMF exposure measurement error.

Conclusions

This study has demonstrated the use of the Qualipoc handheld android phone to assess the correlations between multiple signal strength indicators and Tx power on the 3G and 4G networks in the greater Melbourne area. The phones provided objective measurements of exposure rather than self-reported estimates from surveys. It found Tx power from a mobile phone device varied greatly depending on signal strength level, with exposure differing by orders of magnitude between poor and excellent signal strength levels. In order to reduce measurement error in RF-EMF exposure, data on distance the phone is held from the body and Tx power are required. As Tx power is difficult to measure and costly with the Qualipoc android device, it is recommended that future epidemiological studies control for signal strength as a proxy due to the strong correlations found between signal strength and Tx power. Factors influencing signal strength, such as distance from base station or base station concentration, line of site, vegetation, building materials, and service provider provide measures to control for signal strength.

Open access paper: https://www.nature.com/articles/s41370-019-0178-6

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Methodological limitations in experimental studies on symptoms in individuals with idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF) - review

Schmiedchen K, Driessen S, Oftedal G. Methodological limitations in experimental studies on symptom development in individuals with idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF) - a systematic review. Environ Health. 2019 Oct 22;18(1):88. doi: 10.1186/s12940-019-0519-x.

Abstract

BACKGROUND: Hypersensitivity to electromagnetic fields (EMF) is a controversial condition. While individuals with idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF) claim to experience health complaints upon EMF exposure, many experimental studies have found no convincing evidence for a physical relation. The aim of this systematic review was to evaluate methodological limitations in experimental studies on symptom development in IEI-EMF individuals that might have fostered false positive or false negative results. Furthermore, we compared the profiles of these limitations between studies with positive and negative results.

METHODS: The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guided the methodological conduct and reporting. Eligible were blinded experimental studies that exposed individuals with IEI-EMF to different EMF exposure levels and queried the development of symptoms during or after each exposure trial. Strengths and limitations in design, conduct and analysis of individual studies were assessed using a customized rating tool.

RESULTS: Twenty-eight studies met the eligibility criteria and were included in this review. In many studies, both with positive and negative results, we identified methodological limitations that might have either fostered false or masked real effects of exposure. The most common limitations were related to the selection of study participants, the counterbalancing of the exposure sequence and the effectiveness of blinding. Many studies further lacked statistical power estimates. Methodically sound studies indicated that an effect of exposure is unlikely.

CONCLUSION: Overall, the evidence points towards no effect of exposure. If physical effects exist, previous findings suggest that they must be very weak or affect only few individuals with IEI-EMF. Given the evidence that the nocebo effect or medical/mental disorders may explain the symptoms in many individuals with IEI-EMF, additional research is required to identify the various factors that may be important for developing IEI-EMF and for provoking the symptoms. We recommend the identification of subgroups and exploring IEI-EMF in the context of other idiopathic environmental intolerances. If further experimental studies are conducted, they should preferably be performed at the individual level. In particular, to increase the likelihood of detecting hypersensitive individuals, if they exist, we encourage researchers to achieve a high credibility of the results by minimizing sources of risk of bias and imprecision.

EXCERPT: At present, it is not clear whether further provocation or intervention studies would provide new insight, but if further experimental studies are conducted, they should preferably be performed at the individual level. In order to increase the likelihood of detecting hypersensitive individuals, if they exist, we encourage researchers to achieve a high credibility of the results by minimizing of sources of risk of bias and imprecision. In any such study, efforts must be made to identify and include any individuals whose symptoms are caused by physical effects of the EMF exposure.

Open access paper: https://ehjournal.biomedcentral.com/articles/10.1186/s12940-019-0519-x

MY NOTE: Some scientists have argued that the provocation studies which this review paper evaluated employ an inappropriate methodology to test individuals with electromagnetic hypersensitivity (EHS, or IEI-EMF). Provocation studies assume that symptoms appear immediately after an exposure to EMF ignoring the fact that in many instances there is a time lag between an EMF exposure and experience of symptoms. Thus, I concur with the authors' suggestion that further provocation studies are likely a waste of time. I would argue we need new paradigms to study EHS.

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Measurement and mapping of the electromagnetic radiation in the urban environment

Liu J, Wei M, Li H, Wang X, Wang X, Shi S. Measurement and mapping of the electromagnetic radiation in the urban environment. Electromagn Biol Med. 2019 Oct 31:1-6. doi: 10.1080/15368378.2019.1685540.

Abstract

People are increasingly exposed to electromagnetic radiation with the rapid development of technologies such as broadcasting and mobile communication system. There is a concern that long-term exposure at low levels may be associated with various non-specific physical symptoms and ecological effects on animals and plants. It is extremely important to measure and analyze the electromagnetic radiation levels in order to protect people from the possible effects of electromagnetic radiation. A large-scale assessment of the effects of electromagnetic radiation on health or on ecology requires the ambient electromagnetic radiation levels over areas too vast to cover with conventional measurement methods. In this article, detailed information about the measurement tools and measurement method are given. The electromagnetic radiation exposure levels were measured on the main streets in the dense urban areas of Beijing, the capital of China. We apply ordinary kriging as an interpolation technique to assess the electromagnetic radiation exposure in large outdoor areas based on car-mounted measurements along the surrounding roads. The electromagnetic radiation exposure levels for larger areas can be investigated visually on the electromagnetic pollution map, which can assist decision makers by identifying the hotspots.

https://www.ncbi.nlm.nih.gov/pubmed/31668093

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Chromosome damage in human cells induced by UMTS mobile telephony radiation

Panagopoulos DJ. Chromosome damage in human cells induced by UMTS mobile telephony radiation. Gen Physiol Biophys. 2019 Sep 13. doi: 10.4149/gpb_2019032.

Abstract

Environmental exposure to modern microwave telecommunication electromagnetic fields (EMFs) has increased to unprecedented levels with consequent health complaints and concerns. Many studies have already reported genotoxic effects on a variety of organisms and cell/tissue types. Human peripheral blood lymphocytes from six healthy donors were stimulated for mitosis and exposed to microwave EMF of Universal Mobile Telecommunications System (UMTS) or third generation (3G) mobile telephony (MT) EMF/radiation emitted by a commercially available mobile phone handset. Lymphocytes exposed during the G2 phase of the cell division cycle and observed at metaphase, exhibited chromatid-type aberrations (gaps and breaks) at highly significant percentages - up to 275% - compared to the control (sham-exposed) samples. Each subject

exhibited a different sensitivity to the microwave exposure. Moreover, the percentages of aberrations in the control samples among subjects were different due to genetic and environmental factors. The MT EMF exposure induced mainly achromatic lesions (gaps), and secondarily terminal deletions (breaks) in a smaller degree. In conclusion, the present study shows that microwave 3G MT EMF/radiation - within the current exposure limits - has significant genotoxic action on human cells, and human exposure to this EMF/radiation should be kept at levels as low as possible.

https://www.ncbi.nlm.nih.gov/pubmed/31516130

Excerpts

Exposures were performed by a UMTS (3G) commercially available mobile phone handset in order to test the effects of real-life exposures experienced daily by billions of MT users around the world. UMTS employs the "Wideband Code Division Multiple Access" (W-CDMA) code to offer greater spectral efficiency and bandwidth to mobile network operators. All modern digital MT signals, combine both high (RF) and low (ELF) frequencies....

... Representative average power density (from five representative instant measurements excluding background) in the RF band ± SD was 92 ± 27 μW/cm2. The carrier frequency was variable ~ 1920–1960 MHz during the exposures. Representative average ELF-E and ELF-B (from five representative instant measurements excluding background) ± SD at 100 Hz was 12 ± 4.2 V/m, and 0.9 ± 0.4 mG, respectively. Corresponding average ELF-E and ELF-B (from five instant measurements excluding background) ± SD at 1500 Hz was 8 ± 4.6 V/m, and 0.06 ± 0.02 mG, respectively. All measurements were carried out separately from the exposures in order to have the measuring devices at exactly the same position with the samples during the exposures. The above measured EMF/radiation intensity values are representative for UMTS mobile phone EMFs during "talk" mode, and are well within the current exposure limits (ICNIRP 1998, 2010)....

The disruption of cell electrochemical balance by manmade (polarized) EMFs through irregular gating of voltage-gated ion channels on cell membranes is described by the "ion forced-oscillation mechanism" (Panagopoulos et al. 2000, 2002, 2015b). In turn, it is explained how the disruption of intracellular ionic concentrations may lead to DNA damage by intracellular release of free radicals or hydrolytic enzymes like DNases (Barzilai and Yamamoto 2004; Phillips et al. 2009; Panagopoulos 2011; Pall 2013). This is in line with the attribution of the DNA and chromosome damage to oxidative stress by El-Abd and Eltoweissy (2012). According to the ion forced-oscillation mechanism, the bioactivity of a polarized EMF is proportional to its intensity and inversely proportional to its frequency, meaning that the ELF pulsing and modulation of the MT EMFs seem to be responsible for their intense bioactivity and not the carrier (RF) frequency which is several orders of magnitude higher than ELF. This is supported by significant experimental evidence (Panagopoulos 2019). Thus, reports that MT EMF-bioactivity depends on carrier frequency (Markova et al. 2005) seem unlikely according to this mechanism and the corresponding experimental evidence.

The present study – in line with previous studies of my group – indicates that people should necessarily reduce exposures to MT EMFs as much as possible by making prudent use of this technology and reduce drastically the number and duration of calls, make use of wired headsets (especially air-tube headsets) or the loudspeaker during calls and keep the device at the greatest possible distance from the body, not carry the mobile phones on their bodies while they are turned on, keep them at the greatest possible distance during the day, and switch them off during sleep. An avoidance strategy is the key for protection against the tremendously increased levels of man-made EMF exposures rather than metal shielding which is accused for internal desynchronization This is a severe medical syndrome in which the circadian rhythms of an individual (activity, temperature sleep/waking cycles, body secretions, etc.) start deviating from their normal 24 h-periodicity. Long-

term persistence of this phenomenon is connected to a variety of health problems such as depression, sleep disorders, impulsivity, mania, metabolic syndrome, cardiovascular disease, and increased cancer risk (Panagopoulos and Chrousos 2019). Finally, the responsible public health authorities should take into account the results of the present study as well as the results of hundreds of other peer-reviewed published studies (Panagopoulos 2019) and establish much stringer exposure limits than the existing ones.

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Effect of electromagnetic field exposure on the transcription of repetitive DNA elements in human cells

Del Re B, Bersani F, Giorgi G. Effect of electromagnetic field exposure on the transcription of repetitive DNA elements in human cells. Electromagn Biol Med. 2019 Sep 21:1-9. doi: 10.1080/15368378.2019.1669634.

Abstract

Repetitive DNA (RE-DNA) was long thought to be silent and inert; only recent research has shown that it can be transcribed and that transcription alteration can be induced by environmental stress conditions, causing human pathological effects. The aim of this study was to determine whether exposure to radiofrequency electromagnetic fields (RF-EMF) could affect the transcription of RE-DNA. To this purpose, three different human cell lines (HeLa, BE(2)C and SH-SY5Y) were exposed to 900 MHz GSM-modulated RF-EMF at specific absorption rate of 1 W/kg or to sham. After exposure, mRNA levels of RE-DNA were evaluated through quantitative real-time PCR. The following RE-DNA types were investigated: Long Interspersed nucleotide Element 1, DNA alpha satellite and Human Endogenous Retroviruses-like sequences. When comparing cells exposed to RF-EMF versus control samples, different results were found for the three cell lines evaluated, indicating that RF-EMF exposure can significantly affect RE-DNA transcription and that the effects strongly depend on the cellular context and the tissue type. Further studies are needed to elucidate which molecular mechanisms could be involved.

https://www.ncbi.nlm.nih.gov/pubmed/31542968

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Investigation of the neuroprotective effects of thymoquinone on rat spinal cord exposed to 900 MHz electromagnetic field

Yahyazadeh A, Altunkaynak BZ. Investigation of the neuroprotective effects of thymoquinone on rat spinal cord exposed to 900 MHz electromagnetic field. J Chem Neuroanat. 2019 Oct;100:101657. doi: 10.1016/j.jchemneu.2019.101657.

Abstract

Exposure to electromagnetic field in long-term use of cell phones has increased concerns about serious health problems. Our aim was to survey the possible effects of electromagnetic field radiation (60 min/day for 28 days) on the spinal cords of 12 weeks old rats. Further, we investigated whether the administration of thymoquinone (10 mg/kg/day) would protect the spinal cord tissue against the adverse effects of electromagnetic field or not. Twenty-four adult male Wistar albino rats were assigned randomly into four groups: control, electromagnetic field, thymoquinone and electromagnetic field + thymoquinone. The cervical spinal cords of all rats was evaluated using the stereological, biochemical and histological methods. The number of motor neurons were reduced in the electromagnetic field group compared to the control group

($p < 0.05$). Superoxide dismutase level was higher in the electromagnetic field group compared to the control group ($p < 0.05$). In the electromagnetic field + thymoquinone group, we found an increase in the number of motor neurons and decrease in superoxide dismutase activity compared to the electromagnetic field group ($p < 0.05$). Our histological findings also exhibit the remarkable architectural alterations. We speculated that electromagnetic field radiation induced the morphological and biochemical damage to the spinal cord tissue of rats. Administration of antioxidant, thymoquinone, also ameliorated such complications caused by electromagnetic field.

https://www.ncbi.nlm.nih.gov/pubmed/31228532

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Effect of Cell Phone Radiation on Gelatinolytic Activity of Matrix Metalloproteinase-2 and -9 of Mouse Pre-Antral Follicles during In Vitro Culture

Azimipour F, Zavareh S, Lashkarbolouki T. The Effect of Radiation Emitted by Cell Phone on The Gelatinolytic Activity of Matrix Metalloproteinase-2 and -9 of Mouse Pre-Antral Follicles during In Vitro Culture. Cell J. 2020 Apr;22(1):1-8. doi: 10.22074/cellj.2020.6548. Epub 2019 Sep 8.

Abstract

Objective: The unfavorable effects of electromagnetic radiation (EMR) emitted by the cell phone on reproduction health are controversial. Metalloproteinases play a vital role in ovarian follicle development. This study was designed to investigate the effects of exposure to the cell phone on the gelatinolytic activity of in vitro cultured mouse pre-antral follicle.

Materials and Methods: In this experimental study, pre-antral follicles were isolated from ovaries of immature mice (n=16) and cultured with or without exposure to the cell phone in talking mode for 60 minutes. The gelatinolytic activity was evaluated through the zymography method, as well as the gene expression of matrix metalloproteinases (MMPs) namely MMP-2 and -9 and tissue inhibitors of metalloproteinases (TIMPs) namely, TIMP-1 and -2 by the real-time polymerase chain reaction (PCR) method. Also, in parallel, the development of pre-antral follicles was assessed.

Results: The maturation parameters of the cell phone-exposed pre-antral follicles were significantly lower compared with the control group ($P<0.05$). The gelatinolytic activity was significantly decreased in the cell phone-exposed preantral follicles compared with the control group ($P<0.05$). The relative mRNA expression of the MMP-2 gene was significantly ($P<0.05$) increased in the cell phone-exposed pre-antral follicles whereas the expression rate of the MMP-9 gene was considerably ($P<0.05$) reduced when compared with the control group. Conversely, the relative expression of the TIMP-1 was markedly ($P<0.05$) increased in the cell phone-exposed pre-antral follicles while the expression of the TIMP-2 was ($P<0.05$) significantly diminished in comparison with the control group.

Conclusion: Exposure to the cell phone alters the growth and maturation rate of murine ovarian follicle through the changing in the expression of the MMP-2 and -9 genes, as well as the gelatinolytic activity.

https://www.ncbi.nlm.nih.gov/pubmed/31606960

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Melatonin Modulates NMDA-Receptor 2B/Calpain-1/Caspase-12 Pathways in Rat Brain After Long Time Exposure to GSM Radiation

Seymen CM, Ilgaz C, Erdogan D, Elmas C, Yar Saglam AS, Elmazoglu Z, Sirav Aral B, Take Kaplanoglu G. Melatonin Modulates NMDA-Receptor 2B/Calpain-1/Caspase-12 Pathways in Rat Brain After Long Time Exposure to GSM Radiation. Turk Neurosurg. 2019 Jul 11. doi: 10.5137/1019-5149.JTN.26492-19.2.

Abstract

AIM: In this study we aimed to investigate the potential protective effects of melatonin on the chronic radiation emitted by third generation mobile phones on the brain.

MATERIAL AND METHODS: 24 male Wistar albino rats were divided into four equal groups. Throughout a 90-day experiment, no application was performed on the control group. The second group was exposed to 2100 MHz radiation for 30 minutes. Subcutaneous melatonin was injected into the third group. Subcutaneous melatonin injection was applied 40 minutes before radiation and then the fourth group was exposed to radiation for 30 minutes. At the end of the experiment, brain (cerebrum and cerebellum) tissues were taken from the subjects. Histochemical, immunohistochemical, ultrastructural and Western blot analyses were applied. In addition to brain weight, Purkinje cells' number, immunohistochemical H Score analyses and the results of the Western blot were examined statistically.

RESULTS: As a result, with the application of radiation, neuronal edema, relatively-decreased numbers of neurons on hippocampal CA1 and CA3 regions, displacement of the Purkinje neurons and dark neurons findings were observed as a result of histochemical stainings. Radiation also activated the NMDA-receptor 2B/Calpain-1/Caspase-12 pathway, NMDA-receptor 2B and Calpain-1 with the findings being supported by Western blot analyses. Pre-increased protein synthesis before apoptosis was identified by electron microscopy.

CONCLUSION: Taken together, mobile phone radiation caused certain (ultra) structural changes on the brain and activated the NMDA-receptor 2B/Calpain-1/Caspase-12 pathway; in addition, melatonin was effective, but insufficient to demonstrate any protective effects.

https://www.ncbi.nlm.nih.gov/pubmed/31608966

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Uncertainty Analysis of Mobile Phone Use and Its Effect on Cognitive Function: The Application of Monte Carlo Simulation in a Cohort of Australian Primary School Children

Brzozek C, Benke KK, Zeleke BM, Croft RJ, Dalecki A, Dimitriadis C, Kaufman J, Sim MR, Abramson MJ, Benke G. Uncertainty Analysis of Mobile Phone Use and Its Effect on Cognitive Function: The Application of Monte Carlo Simulation in a Cohort of Australian Primary School Children. Int J Environ Res Public Health. 2019 Jul 8;16(13). pii: E2428. doi: 10.3390/ijerph16132428.

Abstract

Previous epidemiological studies on health effects of radiation exposure from mobile phones have produced inconsistent results. This may be due to experimental difficulties and various sources of uncertainty, such as

statistical variability, measurement errors, and model uncertainty. An analytical technique known as the Monte Carlo simulation provides an additional approach to analysis by addressing uncertainty in model inputs using error probability distributions, rather than point-source data. The aim of this investigation was to demonstrate using Monte Carlo simulation of data from the ExPOSURE (Examination of Psychological Outcomes in Students using Radiofrequency dEvices) study to quantify uncertainty in the output of the model. Data were collected twice, approximately one year apart (between 2011 and 2013) for 412 primary school participants in Australia. Monte Carlo simulation was used to estimate output uncertainty in the model due to uncertainties in the call exposure data. Multiple linear regression models evaluated associations between mobile phone calls with cognitive function and found weak evidence of an association. Similar to previous longitudinal analysis, associations were found for the Go/No Go and Groton maze learning tasks, and a Stroop time ratio. However, with the introduction of uncertainty analysis, the results were closer to the null hypothesis.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6651811/

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Radiofrequency electromagnetic fields, mobile phones, and health effects: where are we now?

Miligi L. Radiofrequency electromagnetic fields, mobile phones, and health effects: where are we now? [Article in Italian]. Epidemiol Prev. 2019 Sep-Dec;43(5-6):374-379. doi: 10.19191/EP19.5-6.P374.107.

Abstract

This paper aims to present useful elements for framing the issue of exposure to radio frequencies (RFs), in particular those related to telecommunications, and the possible effects on health also in the light of the rapid evolution of technologies (the advent of 5G). New developments in the field oblige us to reflect on the possible implications in terms of public health. Here, we have preferred to take stock and not to demand a systematic review. The development of telecommunications is creating great interest in all sectors for the possibility of new applications, but is also increasing concern for the effects on health not yet fully known, to the point that there is a growing mobilization against the introduction of 5G both at national and at international level. Epidemiological studies and metanalyses on the relationship between cancer and RFs, particularly those on mobile phones, still identify areas of uncertainty that need to be investigated, and studies on non-cancer effects are growing in number, suggesting the possibility of new risks. The relative scenarios that will open with the 5G trial are likely to change the overall exposure level of the population as a result of major changes in the network architecture. Therefore, it is important to adopt a strongly precautionary approach. Given the strong concerns of the population, the competent institutions should implement information and awareness programmes through adequate risk communication.

https://www.ncbi.nlm.nih.gov/pubmed/31659885

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Why we do not agree with the reassuring conclusions of the report on radiofrequencies and cancer of the Italian National Institute of Health

Di Ciaula A, Terracini B. Why we do not agree with the reassuring conclusions of the report on radiofrequencies and cancer of the Italian National Institute of Health. [Article in Italian], Epidemiol Prev. 2019 Sep-Dec;43(5-6):314-316. doi: 10.19191/EP19.5-6.P314.097.

No abstract.

https://www.ncbi.nlm.nih.gov/pubmed/31659875

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Comparative Investigations on the Inhibition of Mobile Phone Radiation by Multiple Compartment Cavity Resonance Devices

Dartsch PC, König FM.Comparative Investigations on the Inhibition of Mobile Phone Radiation by Multiple Compartment Cavity Resonance Devices. Japan Journal of Medicine. 2019: 2:3.

Abstract

Mobile phone modulation technologies like LTE, UMTS and GSM are now fully established. Among these, mobile phones have been considered to emit only a radiation with low intensities when they are actively working and are placed near to the head. However, the safety aspects are not cleared evaluated. To address this topic, we have already investigated the cellular effects of DECT base radiation and its compensation by multiple compartment cavity resonance devices (RD). Prompted by this background, this study compares the efficacy of a second-generation RD with an optimized design in comparison to the first-generation RD used in previous studies. Connective tissue fibroblasts (cell line L-929) were exposed to the radiation of an actively transmitting commercially available mobile phone with 1.25 W/m2 at the level of the cells with and without the two different RD directed crosswise towards the cell layer during mobile phone irradiation. Unexposed cells in a similar incubator served as corresponding controls. The resulting cell vitality was checked by measurement of the enzymatic activity of mitochondrial dehydrogenases by the color change of the sodium salt 2,3-bis[2-methoxy-4-nitro-5-sulfo-pheny]-2H-tetrazolium-5-carboxyanilide (XTT). The results clearly demonstrate that exposure to mobile phone radiation caused a significantly reduced cell vitality by more than 50 % for non-thermal radiation with an intensity of 1.25 W/m2 at the level of the cells. The decreased cell vitality after mobile phone radiation exposure could be largely compensated by use of two crossed RD directed towards the cells. However, the newly designed RD construction was even more effective (reduction of cell vitality by 13.01 ± 1.86 %; mean value ± standard deviation) than the standard RD (reduction of cell vitality by 20.17 ± 2.16 %; mean value ± standard deviation) which has been already used successfully to compensate digitally enhanced cordless telecommunication (DECT) phone base station radiation.

Open access paper: https://japanjournalofmedicine.com/comparative-investigations-on-the-inhibition-of-mobile-phone-radiation-by-multiple-compartment-cavity-resonance-devices/

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Confronting Risk of Bias in RF Bioeffects Research. Comments on Two Papers by Vijayalaxmi and Prihoda

Foster KR, Simkó M, Verschaeve L. Confronting Risk of Bias in RF Bioeffects Research. Comments on Two Papers by Vijayalaxmi and Prihoda. Radiat Res. 2019 Aug;192(4):363-366. doi: 10.1667/RR15478.1.

No abstract

https://www.ncbi.nlm.nih.gov/pubmed/31393822

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Review: The influence of bioactive mobile telephony radiation at the level of a plant community – Possible mechanisms and indicators of the effects

Czerwiński M, Januszkiewicz L, Vian, Lázaro A. Review. The influence of bioactive mobile telephony radiation at the level of a plant community – Possible mechanisms and indicators of the effects. Ecological Indicators. Volume 108, January 2020, 105683. https://doi.org/10.1016/j.ecolind.2019.105683

Highlights

- There are various indicators of microwave radiation impact on herbaceous vegetation.
- The best indicators are some parameters of vegetation canopy or individual plants.
- Specific plant functional groups may be indicators of long-term community processes.
- Other organisms interacting with plants, e.g. pollinators, should also be considered.
- The selection of indicators depends on the propagation of radiation in the canopy.

Abstract

Environmental exposure to radiofrequency electromagnetic fields (RF-EMFs) from mobile telephony has rapidly increased in the last two decades and this trend is expected to continue. The effects of this exposure at plant community level are unknown and difficult to assess in a scientifically appropriate manner. Such an assessment can be scientifically adequate if a studied plant community is completely new and control-impact radiation treatment is used.

In this review we aimed to predict ecological effects and identify indicators of the impact of bioactive RF-EMFs at the mobile telephony frequency range on plant communities. We considered the scenario where a plant community was exposed to radiation generated by a base transmitting station antenna mounted on a nearby mast. This plant community can be represented by mesic meadow, ruderal or arable weed community, or other herbaceous, moderately productive vegetation type. We concentrated primarily on radiation effects that can be recorded for a year since the exposure started. To predict them we used physical theories of radiowave propagation in vegetation and the knowledge on plants physiological responses to RF-EMF. Our indicators can be used for the detection of the impact of RF-EMFs on vegetation in a control-impact experiment.

The identified indicators can be classified into the following groups: (1) canopy parameters; (2) plant characteristics to be measured in the field or laboratory in a number of individuals that represent the populations of selected species; (3) community weighted means/medians (CWMs) of plant traits and strategies; (4) the abundance of other organisms that interact with plants and can influence their fitness or population size. The group of canopy parameters includes mean height, vertical vegetation structure and dry weight of above-ground standing phytomass. Plant characteristics requiring biometric sampling in the field are plant height, the number of fruits and seeds, as well as seed viability. The group of plant traits that are calculated as CWMs covers seed releasing height, seed dispersal mode, SLA, leaf orientation, month of germination and flowering, Ellenberg's light indicator value, and the proportion of individuals in the classes of competitors and stress tolerators according to Grime's CSR strategy scheme. The group of "non-plant" indicators includes primarily the frequency of flower visits by beetles, wasps, hoverflies, and bees that have their nests over ground. To detect ecological responses that occur for the first year since a herbaceous community has been exposed to potentially bioactive RF-EMF, the first two indicators groups should be used.

https://www.sciencedirect.com/science/article/pii/S1470160X19306764

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Global gene expression analysis of Escherichia coli K-12 DH5α after exposure to 2.4 GHz wireless fidelity radiation

Said-Salman IH, Jebaii FA, Yusef HH, Moustafa ME. Global gene expression analysis of Escherichia coli K-12 DH5α after exposure to 2.4 GHz wireless fidelity radiation. Sci Rep. 2019 Oct 8;9(1):14425. doi: 10.1038/s41598-019-51046-7.

Abstract

This study investigated the non-thermal effects of Wi-Fi radiofrequency radiation of 2.4 GHz on global gene expression in Escherichia coli K-12 DH5α. High-throughput RNA-sequencing of 2.4 GHz exposed and non-exposed bacteria revealed that 101 genes were differentially expressed (DEGs) at $P \leq 0.05$. The up-regulated genes were 52 while the down-regulated ones were 49. QRT-PCR analysis of pgaD, fliC, cheY, malP, malZ, motB, alsC, alsK, appB and appX confirmed the RNA-seq results. About 7% of DEGs are involved in cellular component organization, 6% in response to stress stimulus, 6% in biological regulation, 6% in localization, 5% in locomotion and 3% in cell adhesion. Database for annotation, visualization and integrated discovery (DAVID) functional clustering revealed that DEGs with high enrichment score included genes for localization of cell, locomotion, chemotaxis, response to external stimulus and cell adhesion. Kyoto encyclopedia of genes and genomes (KEGG) pathways analysis showed that the pathways for flagellar assembly, chemotaxis and two-component system were affected. Go enrichment analysis indicated that the up-regulated DEGs are involved in metabolic pathways, transposition, response to stimuli, motility, chemotaxis and cell adhesion. The down-regulated DEGs are associated with metabolic pathways and localization of ions and organic molecules. Therefore, the exposure of E. coli DH5α to Wi-Fi radiofrequency radiation for 5 hours influenced several bacterial cellular and metabolic processes.

https://www.ncbi.nlm.nih.gov/pubmed/31595026

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Ocular Effects of Exposure to 40, 75, and 95 GHz Millimeter Waves

Kojima M, Suzuki Y, Sasaki K,Taki M, Wake K, Watanabe S, Mizuno M, Tasaki T, Sasaki H. Ocular Effects of Exposure to 40, 75, and 95 GHz Millimeter Waves. Journal of infrared, millimeter and terahertz waves. 39(9):912-925. DOI: 10.1007/s10762-018-0497-z

Abstract

The objective of this study was to develop a model of ocular damage induced by 40, 75, and 95 GHz continuous millimeter waves (MMW), thereby allowing assessment of the clinical course of ocular damage resulting from exposure to thermal damage-inducing MMW. This study also examined the dependence of ocular damage on incident power density. Pigmented rabbit eyes were exposed to 40, 75, and 95 GHz MMW from a spot-focus-type lens antenna. Slight ocular damage was observed 10 min after MMW exposure, including reduced cornea thickness and reduced transparency. Diffuse fluorescein staining around the pupillary area indicated corneal epithelial injury. Slit-lamp examination 1 day after MMW exposure revealed a round area of opacity, accompanied by fluorescence staining, in the central pupillary zone. Corneal edema, indicative of corneal stromal damage, peaked 1 day after MMW exposure, with thickness gradually subsiding to normal. Three days after exposure, ocular conditions had almost normalized, though corneal thickness was slightly greater than that before exposure. The 50% probability of ocular damage (DD50) was in the order 40 > 95 ≈ 75 GHz at the same incident power densities.

Conclusion

We created rabbit models of ocular disorder by exposure to 40, 75, and 95 GHz MMW. In assessing the relationship between the degree of ocular disorder and incident power density of these three frequencies, we found that ocular damage induced by exposure to 40, 75, and 95 GHz was essentially the same, with no characteristic specific to each frequency. We also found that corneal surface temperature during exposure was increased in the order 40 < 95 < 75 GHz, but there was no relationship between degree of ocular damage and eye surface temperature. In addition, we performed probit analyses by using experimental data and estimated probabilities for incidence of ocular damage depending on the power density. DD_{50}, defined as dose level to cause ocular damage with 50% probability, was in the order 40 GHz (206 mW/cm^2) > 95 GHz (146 mW/cm^2) ≈ 75 GHz (143 mW/cm^2). At the same incident power density, the degree of ocular damage was greater in the eyes exposed for 30 min than for 6 min. These findings suggested that damage to the corneal epithelium was not induced by corneal dryness alone, but by exposure of dried corneas to MMW-induced heat to above body temperature.

Open access paper: https://link.springer.com/article/10.1007%2Fs10762-018-0497-z

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Millimeter-Wave Heating in In Vitro Studies: Effect of Convection in Continuous and Pulse-Modulated Regimes

Orlacchio R, Zhadobov M, Alekseev SI, Nikolayev D, Sauleau R, Le Page Y, Le Dréan Y. Millimeter-Wave Heating in In Vitro Studies: Effect of Convection in Continuous and Pulse-Modulated Regimes. Bioelectromagnetics. Published online October 3, 2019. https://doi.org/10.1002/bem.22223

Abstract

Shallow penetration of millimeter waves (MMW) and non-uniform illumination in in vitro experiments result in a non-uniform distribution of the specific absorption rate (SAR). These SAR gradients trigger convective currents in liquids affecting transient and steady-state temperature distributions. We analyzed the effect of convection on temperature dynamics during MMW exposure in continuous-wave (CW) and pulsed-wave (PW) amplitude-modulated regimes using micro-thermocouples. Temperature rise kinetics are characterized by the occurrence of a temperature peak that shifts to shorter times as the SAR of the MMW exposure increases and precedes initiation of convection in bulk. Furthermore, we demonstrate that the liquid volume impacts convection. Increasing the volume results in earlier triggering of convection and in a greater cooling rate after the end of the exposure. In PW regimes, convection strongly depends on the pulse duration that affects the heat pulse amplitude and cooling rate. The latter results in a change of the average temperature in PW regime.

Excerpt

In conclusion, our results suggest that in planning in vitro studies in the MMW band, convection is one of the parameters that has to be carefully taken into account. It may affect cellular response through indirect mechanisms, such as the local change of the concentration of oxygen or nutrients transported by the culture medium. Deeper investigation of convection mechanisms requires numerical analysis of the multi-physics problem, which constitutes one of the perspectives of a future study.

https://onlinelibrary.wiley.com/doi/abs/10.1002/bem.22223

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Scoping Review of the Potential Health Effects of Exposure to Extremely Low-Frequency Electric and Magnetic Fields

Habash M, Gogna P, Krewski D, Habash RWY. Scoping Review of the Potential Health Effects of Exposure to Extremely Low-Frequency Electric and Magnetic Fields. Crit Rev Biomed Eng. 2019;47(4):323-347. doi: 10.1615/CritRevBiomedEng.2019030211.

Abstract

Previous studies suggest that extremely low-frequency (ELF) electric and magnetic fields (EMFs) may impact human health. However, epidemiologic studies have provided inconsistent results on the association between exposure to ELF EMFs and various health outcomes. This scoping review reports on primary investigations that were published during the ten-year period of 2007-2017 on the association between ELF EMFs and cancer, cardiovascular disease (CVD), reproductive health effects, and neurodegenerative diseases. We identified a total of 361 articles from two bibliographic databases (PubMed and EMBASE). Of these, 39 articles (19 cancer studies, two CVD studies, nine reproductive health studies, and ten neurodegenerative disease studies [with one repeated for two outcomes]) met inclusion criteria. Articles identified in this study focus on three different types of exposure: occupational (22 studies), residential (15 studies), and electric blanket (two studies). This review suggests that ELF EMFs may be associated with neurodegenerative diseases, specifically Alzheimer's disease; however, limited evidence was found to suggest that ELF EMFs are associated with several types of cancer, CVD, and reproductive outcomes. Additional epidemiological studies in large study populations with improved exposure assessments are needed to clarify current inconclusive relationships.

https://www.ncbi.nlm.nih.gov/pubmed/31679262

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Melatonin Levels and Low-Frequency Magnetic Fields in Humans and Rats: New Insights

Bouché NF, McConway K. Melatonin levels and low-frequency magnetic fields in humans and rats: New insights from a Bayesian logistic regression. Bioelectromagnetics. 2019 Sep 29. doi: 10.1002/bem.22218.

Abstract

The present analysis revisits the impact of extremely low-frequency magnetic fields (ELF-MF) on melatonin (MLT) levels in human and rat subjects using both a parametric and non-parametric approach. In this analysis, we use 62 studies from review articles. The parametric approach consists of a Bayesian logistic regression (LR) analysis and the non-parametric approach consists of a Support Vector analysis, both of which are robust against spurious/false results. Both approaches reveal a unique well-ordered pattern, and show that human and rat studies are consistent with each other once the MF strength is restricted to cover the same range (with $B \lesssim 50\ \mu T$). In addition, the data reveal that chronic exposure (longer than ~22 days) to ELF-MF appears to decrease MLT levels only when the MF strength is below a threshold of i.e., when the man-made ELF-MF intensity is below that of the static geomagnetic field. Studies reporting an association between ELF-MF and changes to MLT levels and the opposite (no association with ELF-MF) can be reconciled under a single framework.

https://www.ncbi.nlm.nih.gov/pubmed/31564068

Conclusions

From our analysis of 62 studies on the possible variations of MLT levels in humans and rats from Jahandideh et al. [2010], Touitou and Selmaoui [2012], and Halgamuge [2013], we examined the possible relationship between a dichotomous-dependent variable (corresponding to studies showing an effect or no effect on MLT excretion pattern) and independent variables such as exposure duration and magnetic field strength using a Bayesian approach and a simple LR model. We find that:

- MF exposure duration is the most significant parameter in causing changes in the MLT levels both in human (Fig. 2) and rat (Fig. 4) studies, as others have reported [e.g., Selmaoui and Touitou, 1995; Kurokawa et al., 2003; Savitz, 2003; Jahandideh et al., 2010; Vanderstraeten et al., 2012];
- human and rat studies are entirely consistent with one another, but only after matching the MF strengths to similar ranges, i.e., $B \lesssim 50$ μT;
- there seems to be no dose-dependence between any change in the MLT levels with MF strengths ranging from 0.5 to 100μT as others have reported [e.g., Kato et al., 1993; Reiter, 1993; Pfluger and Minder, 1996; Halgamuge, 2013]; and
- the impact of MF on the MLT levels does, however, depend on the ELF-MF strength, in the regime where ELF-MFs are weaker than (Fig. 5). Such a window effect was already discussed in Löscher et al. [1998].

In light of these results, we suggest performing additional research on rats with ELF-MF with intensities in the range from 20 nT to 20 μT, while controlling the additional factors listed earlier in the section Limitations, because epidemiological studies have indicated that adverse effects on human health become noticeable at ~0.4 μT. But so far, very few rat studies involved ELF-MF with intensities below 5 μT. This range 20 nT to a few μT covers the regime experienced by humans in man-made and natural environments. Indeed, the natural variations of the geomagnetic field range from 20 nT to a few hundreds of nT [Hitchman et al., 1998].

As MF strengths > 50 μT are not found in nature, studies on rats with MF strengths > 50 μT, or mT levels, might reveal a different (likely acute effect) than the duration-dependent effect discussed here, where perhaps one of the other factors discussed earlier has become dominant.

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DNA damage from long-term occupational exposure to extremely low frequency electromagnetic fields among power plant workers

Bagheri Hosseinabadi M, Khanjani N, Mirzaii M, Norouzi P, Atashi A. DNA damage from long-term occupational exposure to extremely low frequency electromagnetic fields among power plant workers.Mutat Res. 2019 Oct;846:403079. doi: 10.1016/j.mrgentox.2019.07.007.

Abstract

Extremely low frequency electromagnetic fields (ELF-EMFs) are not known as definite occupational carcinogens, but some studies have reported the genotoxic effects of these fields on cell lines. The present study aimed to evaluate the effects of long-term occupational exposure to these fields on DNA damage. In this cross-sectional study, blood samples were taken from 102 thermal power plant workers as the exposure group and 136 subjects as the unexposed group. DNA damage was evaluated using alkaline comet assay and flow cytometry. Exposure to ELF-EMFs was measured based on spot measurements and the IEEE Std C95.3.1 standard. The indices of comet assay, tail DNA percent, tail factor (%), and damage index were significantly higher in the exposed group compared to the unexposed group. Increased exposure to magnetic fields

enhanced comet assay indices, except tail length; while exposure to electric fields had no significant effect on such indices. The percentage of cells at early apoptosis and late apoptosis phases caused by exposure to magnetic fields, respectively, decreased and increased significantly. Long-term occupational exposure to ELF-EMFs can probably cause genotoxic effects.

https://www.ncbi.nlm.nih.gov/pubmed/31585627

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Effect of low frequency magnetic field on efficiency of chromosome break repair

Burgos-Molina AM, Mercado-Sáenz S, Sendra-Portero F, Ruiz-Gómez MJ. Effect of low frequency magnetic field on efficiency of chromosome break repair. Electromagn Biol Med. 2019 Oct 28:1-8. doi: 10.1080/15368378.2019.1685541.

Abstract

DNA repair is essential to maintain genome integrity. There is scientific evidence that exposure to magnetic fields (MF) can produce alterations in DNA repair without clear conclusions. This work aims to study the cellular response to and repair of a very deleterious type of DNA damage, the DNA double strand break (DSB), in S. cerevisiae, under MF exposure. In S. cerevisiae cells, pairs of DSB were induced enzymatically by HO endonuclease by plating the cells on Galactose-containing media. The repair processes took place under exposure to a 50Hz, 2.45mT sinusoidal MF during 21 days. MF was generated by a pair of Helmholtz coils. MF induced 1.29- and 1.5-fold increase in the number of colonies grown at day 21 of exposure in relation to untreated controls for Pho91 and Rmd5 strain, respectively. In relation to the kinetics of DSB repair during MF exposure, a higher increase (55.56-fold) in DNA reparation was observed at day 15 for Rmd5 strain in relation to the slight increment (1.18-fold) found for Pho91 strain. The results suggest that long-term MF exposure could increase the DNA repair activity and there may be a relationship between the position of the DSB and the distance to the centromere.

https://www.ncbi.nlm.nih.gov/pubmed/31657656

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Long-Term Monitoring of Extremely Low Frequency Magnetic Fields in Electric Vehicles

Yang L, Lu M, Lin J, Li C, Zhang C, Lai Z, Wu T. Long-Term Monitoring of Extremely Low Frequency Magnetic Fields in Electric Vehicles. Int J Environ Res Public Health. 2019 Oct 7;16(19). pii: E3765. doi: 10.3390/ijerph16193765.

Abstract

Extremely low frequency (ELF) magnetic field (MF) exposure in electric vehicles (EVs) has raised public concern for human health. There have been many studies evaluating magnetic field values in these vehicles. However, there has been no report on the temporal variation of the magnetic field in the cabin . This is the first study on the long-term monitoring of actual MFs in EVs. In the study, we measured the magnetic flux density (B) in three shared vehicles over a period of two years. The measurements were performed at the front and rear seats during acceleration and constant-speed driving modes. We found that the B amplitudes and the

spectral components could be modified by replacing the components and the hubs, while regular checks or maintenance did not influence the B values in the vehicle. This observation highlights the necessity of regularly monitoring ELF MF in EVs, especially after major repairs or accidents, to protect car users from potentially excessive ELF MF exposure. These results should be considered in updates of the measurement standards. The ELF MF effect should also be taken into consideration in relevant epidemiological studies.

Open access paper: https://www.mdpi.com/1660-4601/16/19/3765

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Electric Field Exposure Assessments and a Novel Control Method for Buildings Installed Nearby High-Voltage Lines

Shemshadi A, Maleki AK. Electric Field Exposure Assessments and a Novel Control Method for Buildings Installed Nearby High-Voltage Lines. Indian J Occup Environ Med. 2019 May-Aug;23(2):63-67. doi: 10.4103/ijoem.IJOEM_215_18.

Abstract

This essay presents a review of new methods for electric field value assessment in high-voltage areas. For buildings that are placed near high-voltage transmission line corridor, two main scenarios are modeled using finite element method. A new approach to reduce electric field value is also simulated and the results are discussed in detail. The results are compared to related standards values. In some cases the improvement rate exceeds 65%.

https://www.ncbi.nlm.nih.gov/pubmed/31619877

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Increased aggression and reduced aversive learning in honey bees exposed to extremely low frequency electromagnetic fields

Shepherd S, Hollands G, Godley VC, Sharkh SM, Jackson CW, Newland PL. Increased aggression and reduced aversive learning in honey bees exposed to extremely low frequency electromagnetic fields. PLoS One. 2019 Oct 10;14(10):e0223614. doi: 10.1371/journal.pone.0223614. eCollection 2019.

Abstract

Honey bees, Apis mellifera, are a globally significant pollinator species and are currently in decline, with losses attributed to an array of interacting environmental stressors. Extremely low frequency electromagnetic fields (ELF EMFs) are a lesser-known abiotic environmental factor that are emitted from a variety of anthropogenic sources, including power lines, and have recently been shown to have a significant impact on the cognitive abilities and behaviour of honey bees. Here we have investigated the effects of field-realistic levels of ELF EMFs on aversive learning and aggression levels, which are critical factors for bees to maintain colony strength. Bees were exposed for 17 h to 100 μT or 1000 μT ELF EMFs, or a sham control. A sting extension response (SER) assay was conducted to determine the effects of ELF EMFs on aversive learning, while an intruder assay was conducted to determine the effects of ELF EMFs on aggression levels. Exposure to both 100 μT and 1000 μT ELF EMF reduced aversive learning performance by over 20%. Exposure to 100 μT ELF EMFs also increased aggression scores by 60%, in response to intruder bees from foreign hives. These results indicate that short-term exposure to ELF EMFs, at levels that could be encountered in bee hives placed under power lines, reduced aversive learning and increased aggression levels. These behavioural changes could

have wider ecological implications in terms of the ability of bees to interact with, and respond appropriately to, threats and negative environmental stimuli.

Open access paper: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0223614

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Self-organizing maps classification with application to the low-frequency magnetic field emitted by portable computers

Brodic D, Draganov IR. Self-organizing maps classification with application to the low-frequency magnetic field emitted by portable computers. 2017 3rd International Conference on Applied and Theoretical Computing and Communication Technology (iCATccT). 21-23 Dec. 2017. DOI: 10.1109/ICATCCT.2017.8389155

Abstract

This study presents an application of the Self-Organizing-Map method used for the classification of the extremely low-frequency magnetic field emission in the close neighborhood of the portable computers. The experiment is conducted on two different groups of portable computers: (i) laptop and (ii) tablet computers. After measuring their extremely low-frequency magnetic field emission, the Self-Organizing-Map is used for the classification of these results, which authorized the typical emission levels. Some of them are dangerous, because they are far above the valid safety standards' limit. At the end, a discussion is performed on the importance of using the classification as a possible solution for safely use of the portable computers. In this way, it is used to define and reduce the risk of the magnetic field emission negative effects to the portable computer users.

Excerpts

The measurement experiment includes the ELF magnetic field measurement of 18 different portable computers. 9 out of 18 are laptop computers, while the rest of 9 portable computers are tablet computers ....

If we observe Fig. 5, it is quite clear that there is no laptop computer, which is completely safe for the use. Also, we can notice high peaks of the ELF emission at some positions at the surface of the top or bottom areas. These positions are typically linked with the places where are processor, cooler or graphic cards are below inside the laptop computer. These peaks are noticeable in the laptops 7 and 9. On the contrary, the laptops 3,4,6, and 8 are the safest of all tested laptops if we compare them to the other laptop computers at the top measuring positions.

Furthermore, if we divide the ELF emission at the top and bottom positions of the laptop computers, then we can notice that higher magnetic field emission is mainly connected to the bottom representing a battery position. However, a similar situation repeats with high level peaks as at the top of the laptop computers. The high peaks are noticeable in the laptops 1, 2, 3,4 and 7. On the contrary, the laptops 8 and 9 have the smallest level of the measured ELF magnetic field emission.

Then, if we observe Fig. 6, it is worth noting that Tablet 2 is completely safe for the use. Also, in the contrast to the laptop computers, the tablet computers are not characterized by the high-level ELF magnetic field peaks. It is quite reasonable, because they do not have active coolers and processors of such high processing power like laptop computers. Furthermore, the least safe tablet computers are tablets 1, 3 and 5.

Furthermore, if we divide the ELF emission at the top and bottom positions of the tablet computers, then we can notice that mainly higher magnetic field emission is at the top than at the bottom areas of the tablet

computers. From this fact, we can conclude that the top protective cover glass (Gorilla glass 3 or 4) can reduce the level of the ELF

https://ieeexplore.ieee.org/document/8389155

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Genotoxic effects of intermediate frequency magnetic fields on blood leukocytes in vitro

Brech A, Kubinyi G, Németh Z, Bakos J, Fiocchi S, Thuróczy G. Genotoxic effects of intermediate frequency magnetic fields on blood leukocytes in vitro.
Mutat Res. 2019 Sep;845:403060. doi: 10.1016/j.mrgentox.2019.05.016.

Abstract

The widespread presence of electromagnetic sources in daily life has initiated several studies on the effects of radiofrequency and power frequency fields. Only few investigations on the genotoxic effects of exposure to intermediate frequency magnetic fields (IF-MF) have been done so far. Therefore, the aim of this study was to evaluate possible genotoxic effects of exposure to 123.90 kHz and 250.80 kHz IF-MF on canine and human blood. Blood was exposed to IF-MF at 630 A/m (0.79 mT) and 80 A/m (0.10 m T) with exposure durations of 1-5 h (hourly), 20 and 24 h. Cylindrically divided Petri dish system was developed for in vitro exposures where different induced current could be achieved in the samples at the same magnetic flux density level. For the assessment of genotoxicity the alkaline comet assay was applied. We detected a statistically significant increase in DNA damage only following 20 h exposure to IF-MF.

https://www.ncbi.nlm.nih.gov/pubmed/31561904

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Effects of 171 MHz Low-Intensity Electromagnetic Field on Glucocorticoid and Mineral Corticoid Activity of the Adrenal Glands of Rats

Perov S, Rubtsova N, Balzano Q. Effects of 171 MHz Low-Intensity Electromagnetic Field on Glucocorticoid and Mineral Corticoid Activity of the Adrenal Glands of Rats. Bioelectromagnetics. 2019 Oct 22. doi: 10.1002/bem.22226.

Abstract

A sub-acute electromagnetic field (EMF) biological effect study was carried out on rats exposed in the Transverse ElectroMagnetic exposure chamber at 171 MHz Continuous Wave (CW). The experiments involved three exposure levels (15, 25, and 35 V/m) for 15 days with triplicate parallel sham-exposed controls in each series. All exposure conditions were simulated for the evaluation of the electromagnetic energy distribution and specific absorption rate (SAR) in the rat phantoms. Studies have shown a biphasic biological response depending on time and absorbed electromagnetic energy. Under low SAR, approximately 0.006 W/kg, EMF exposure leads to the stimulation of adrenal gland activity. This process is accompanied by an initial increase of daily excretion of corticosterone and Na+ , which is seen as a higher Na+ /K+ ratio, followed by a decrease of these parameters over time. It is possible that EMF exposure causes a stress response in animals, which is seen as an increased adrenal activity.

https://www.ncbi.nlm.nih.gov/pubmed/31642089

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5G technology: Why should we expect a shift from RF-induced brain cancers to skin cancers?

Mehdizadeh AR, Mortazavi SMJ. Editorial. 5G technology: Why should we expect a shift from RF-induced brain cancers to skin cancers? J Biomed Phys Eng. Published online first.

Open access paper: http://www.jbpe.ir/Journal_OJS/JBPE/index.php/jbpe/article/viewFile/1225/558

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5G Wireless Communication and Health Effects-A Pragmatic Review Based on Available Studies Regarding 6 to 100 GHz

Simkó M, Mattsson MO. 5G Wireless Communication and Health Effects-A Pragmatic Review Based on Available Studies Regarding 6 to 100 GHz. Int J Environ Res Public Health. 2019 Sep 13;16(18). pii: E3406. doi: 10.3390/ijerph16183406.

Abstract

The introduction of the fifth generation (5G) of wireless communication will increase the number of high-frequency-powered base stations and other devices. The question is if such higher frequencies (in this review, 6-100 GHz, millimeter waves, MMW) can have a health impact. This review analyzed 94 relevant publications performing in vivo or in vitro investigations. Each study was characterized for: study type (in vivo, in vitro), biological material (species, cell type, etc.), biological endpoint, exposure (frequency, exposure duration, power density), results, and certain quality criteria. Eighty percent of the in vivo studies showed responses to exposure, while 58% of the in vitro studies demonstrated effects. The responses affected all biological endpoints studied. There was no consistent relationship between power density, exposure duration, or frequency, and exposure effects. The available studies do not provide adequate and sufficient information for a meaningful safety assessment, or for the question about non-thermal effects. There is a need for research regarding local heat developments on small surfaces, e.g., skin or the eye, and on any environmental impact. Our quality analysis shows that for future studies to be useful for safety assessment, design and implementation need to be significantly improved.

Funding: This research was funded by Deutsche Telekom Technik GmbH, Bonn, Germany, PO number 4806344812.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

Open access paper: https://www.mdpi.com/1660-4601/16/18/3406

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The Contribution of In Vivo Mammalian Studies to the Knowledge of Adverse Effects of Radiofrequency Radiation on Human Health

Vornoli A, Falcioni L, Mandrioli D, Bua L, Belpoggi F. The Contribution of In Vivo Mammalian Studies to the Knowledge of Adverse Effects of Radiofrequency Radiation on Human Health. Int J Environ Res Public Health. 2019 Sep 12;16(18). pii: E3379. doi: 10.3390/ijerph16183379.

Abstract

The proliferation of cellular antennas and other radiofrequency radiation (RFR) generating devices of the last decades has led to more and more concerns about the potential health effects from RFR exposure. Since the 2011 classification as a possible carcinogen by the International Agency for Research on Cancer (IARC), more experimental studies have been published that support a causal association between RFR exposure and health hazards. As regard cancer risk, two long-term experimental studies have been recently published by the US National Toxicology Program (NTP) and the Italian Ramazzini Institute (RI). Despite important experimental differences, both studies found statistically significant increases in the development of the same type of very rare glial malignant tumors. In addition to carcinogenicity, reproductive organs might be particularly exposed, as well as sensitive to RFR. In this work, we reviewed the currently available evidence from in vivo studies on carcinogenicity and reproductive toxicity studies in order to summarize the contribution of experimental research to the prevention of the adverse effects of RFR on human health.

Conclusions

In conclusion, according to NTP, there is now clear evidence that RFR causes cancer in experimental animals. RFR re-evaluation has also been listed as a priority by IARC [87]. There is also stronger evidence that RFR exposure is responsible for causing alteration of various sperm parameters, thus, affecting male fertility. Although a clear quantification of the carcinogenic and reproductive risk is still lacking, these animal findings suggest that a precautionary approach should be promoted by regulatory and health agencies, especially for children and pregnant women. Caution should also be considered in the development and spread of the upcoming 5G technology, particularly in light of the proposed higher frequencies and intensities of the signal. Long-term animal studies are urgently necessary to verify the possible health effects of 5G technology.

Open access paper: https://www.mdpi.com/1660-4601/16/18/3379

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Building science and radiofrequency radiation: What makes smart and healthy buildings

Clegg FM, Sears M, Friesen M, Scarato T, Metzinger R, Russell CL, Stadtner A, Miller AB. Building science and radiofrequency radiation: What makes smart and healthy buildings. Building & Environment. Published online August 6, 2019, 106324. https://doi.org/10.1016/j.buildenv.2019.106324Get rights and content

Highlights

• Wireless systems increase radiofrequency radiation (RFR) in buildings.
• Scientific evidence identifies adverse effects from RFR below regulatory limits.
• Globally, some governments and public health agencies are reducing RFR exposures.
• Low RFR best practices include wired technology instead of Wi-Fi, and corded phones.
• Safer, sustainable strategies and solutions for “smart” buildings are feasible.

Abstract

Radiofrequency radiation (RFR), used for wireless communications and “smart” building technologies, including the “Internet of Things,” is increasing rapidly. As both RFR exposures and scientific evidence of harmful effects increase apace, it is timely to heed calls to include low RFR levels as a performance indicator for the health, safety and well-being of occupants and the environment.

Adverse biochemical and biological effects at commonly experienced RFR levels indicate that exposure guidelines for the U.S., Canada and other countries, are inadequate to protect public health and the environment.

Some industry liability insurance providers do not offer coverage against adverse health effects from radiation emitted by wireless technologies, and insurance authorities deem potential liability as “high.” Internationally, governments have enacted laws, and medical and public health authorities have issued recommendations, to reduce and limit exposure to RFR.

There is urgent need to implement strategies for no- or low-RFR emitting technologies, and shielding, in building design and retrofitting. These strategies include installing wired (not wireless) Internet networks, corded rather than cordless phones, and cable or wired connections in building systems (e.g., mechanical, lighting, security). Building science can profit from decades of work to institute performance parameters, operationalizing prudent guidelines and best practices. The goal is to achieve RFR exposures that are ALARA, “As Low As Reasonably Achievable.”

We also challenge the business case of wireless systems, because wired or cabled connections are faster, more reliable and secure, emit substantially less RFR, and consume less energy in a sector with rapidly escalating green-house gas emissions.

Open access paper: https://www.sciencedirect.com/science/article/pii/S0360132319305347?via%3Dihub

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Influence of radiofrequency electromagnetic fields on brain activity, sleep and cognitive performance of older women

Danker-Hopfe H, Dorn H, Eggert T, Sauter C. [Influence of radiofrequency electromagnetic fields on brain activity, sleep and cognitive performance of older women.] Radiofrequency Electromagnetic Field (RF-EMF) Effects on Brain Activity During Sleep and Waking in Healthy Elderly Women Project 3614S30012. Federal Office for Radiation Protection (BfS). 2019, Departmental Research Reports on Nuclear Safety and Radiation Protection (BfS-RESFOR) 143/19: 1-226

Excerpts from Summary

The aim of the present randomized, double-blind cross-over study was to investigate acute effects of radiofrequency electromagnetic fields (RF-EMF) emitted by GSM900 mobile phones and TETRA (BOS) handheld devices on the central nervous system (CNS). Possible effects on the sleeping brain as well as on the waking brain in resting state and under cognitive demand were studied....

In the present study three different exposure signals were applied: 1) Sham exposure with a partial body SAR value of 0 W/kg (averaged over 10 g of tissue), 2) GSM 900 exposure with a partial body SAR value of 2.0 W/kg (averaged over 10 g of tissue) and 3) TETRA exposure a partial body SAR value of 6.0 W/kg (averaged over 10 g of tissue)….

Overall, 30 women with a mean age of 67.8 ± 5.7 years (range: 60-80 years) participated in the present study. At study nights subjects were exposed at the left side of the head for 30 min prior to sleep and afterwards for the duration of the whole night (7.5 hours). Sleep architecture, sleep spindle parameters and power spectra of the sleep EEG were analysed. Daytime assessments comprised the level of tonic alertness as measured by the pupillographic sleepiness test (PST), the alpha-attenuation test (AAT) and the resting state waking EEG with eyes closed. Phasic alertness was tested by several evoked potentials (readiness potential, contingent negative variation, slow potential arising from a visual monitoring task, and auditory evoked potentials: N1, P2, and P3) with and without behavioural measures like reaction times and number of correct responses. Additionally effects on selective attention, divided attention, vigilance and working memory were investigated. Prior to testing subjects were exposed for 30 min followed by tests with parallel EEG registration for a duration of around 2.5 hours. To avoid time of day effects, all tests were performed in the afternoon starting at approximately 03:00 p.m….

In the elderly women exposure effects on brain activity during sleep showed more statistically significant differences in the macrostructure of sleep under RF exposure than in younger men. These effects point to a sleep-consolidating effect of RF exposure. Analysis of the power spectra values revealed that GSM exposure mainly resulted in a statistically significant lower EEG power in higher frequency bands at frontal electrode positions in the sleep stages N2, N3 and NREM. On the other hand, TETRA exposure mainly affected the deep delta frequency band, with statistically significant increased EEG power in sleep stage N1 at frontal electrode positions and in sleep stage N2 and NREM also at posterior electrodes. These results can also be interpreted to reflect a sleep-consolidating effect of RF exposure. The spindle analysis revealed no important exposure-dependent variations in the investigated sleep spindle parameters. In summary, none of the observed effects can be interpreted in terms of a disturbed sleep under exposure.

While the PST and the AAT did not reveal any evidence for an RF exposure effect on the tonic level of central nervous alertness, power spectra of the waking EEG was increased in the alpha frequency range following TETRA exposure. These slight physiological variations, however, are typically not reflected in parameters of phasic alertness (exception: Contingent Negative Variation and P300 where results indicate a more efficient information processing under GSM exposure). With some exceptions [increased reaction time (mean + median) under GSM exposure in the first part of the vigilance task as well as increased reaction time (median) under GSM and TETRA exposure in the selective attention task] no systematic exposure related differences were observed for the three attention components: vigilance, selective and divided attention. There were also no systematic effects on working memory.

A pre-post exposure comparison of mood and symptoms revealed only slight variation in relation to exposure. However, with one exception, the study night questionnaire outcome parameters, which were affected by exposure, were exclusively attributable to subjective sleep perception and can be interpreted as "better sleep" under RF exposure. These subjective assessments correspond to the observations for the objectively measured sleep parameters. Results of thermal perception suggest that the subjects were neither influenced nor unblinded due to a possible heating from the antenna.

Overall the data indicate that brain activity as measured by power spectra of the wake and of the sleep EEG may differ between exposure conditions. This is in line with several other study results in this specific field of

research. The slight physiological changes, however, are typically not reflected by behavioural measures and symptoms. Moreover, in particular the sleep data shows that the effects seen in elderly women differ significantly from those of young men. Whether these differences are age- and / or gender-specific can only be answered when the data of a study in elderly men (60 to 80 years) is analyzed. So far results refer to the group level. Analyses at the individual level, which can be performed based on multiple assessments per exposure condition and subject, are still pending.

Open access paper (in German): https://doris.bfs.de/jspui/bitstream/urn:nbn:de:0221-2019013117414/3/BfS_2019_3614S30012.pdf

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Incidence trends of adult malignant brain tumors in Finland, 1990-2016

Natukka T, Raitanen J, Haapasalo H, Auvinen A. Incidence trends of adult malignant brain tumors in Finland, 1990-2016. Acta Oncol. 2019 Jul;58(7):990-996. doi: 10.1080/0284186X.2019.1603396.

Abstract

Background: Several studies have reported increased incidence trends of malignant gliomas in the late 1900s with a plateau in the 2000s, but also some recent increases have been reported. The purpose of our study was to analyze incidence trends of malignant gliomas in Finland by morphology and tumor location.

Material and methods: Data on 4730 malignant glioma patients were obtained from case notifications to the nationwide, population-based Finnish Cancer Registry (FCR), and less detailed data on 3590 patients up to 2016. Age-standardized incidence rates (ASR) and average annual percent changes (APCs) in the incidence rates were calculated by histological subtype and tumor location.

Results: The incidence rate of gliomas was 7.7/100,000 in 1990-2006 and 7.3 in 2007-2016. The incidence of all gliomas combined was stable during both study periods, with no departure from linearity. In an analysis by age group, increasing incidence was found only for ages 80 years and older (1990-2006). During both study periods, incidence rates were increasing in glioblastoma and decreasing in unspecified brain tumors. In 1990-2006, rates were also increasing for anaplastic oligodendroglioma, oligoastrocytoma and unspecified malignant glioma, while decreasing for astrocytoma. As for tumor location, incidence in 1990-2006 was increasing for frontal lobe and brainstem tumors, as well as those with an unspecified location, but decreasing for the parietal lobes, cerebrum and ventricles.

Conclusions: No increasing incidence trend was observed for malignant gliomas overall. An increasing incidence trend of malignant gliomas was found in the oldest age group during 1990-2006.

https://www.ncbi.nlm.nih.gov/pubmed/30985227

Excerpts

A difference in incidence trends between histological types during 1990–2006 was evident (likelihood ratio test $p<.001$). The incidence trend of glioblastoma was slightly increasing (APC: +0.8%; 95% CI: −0.0, +1.7 for 1990–2006 and +1.9%; 95% CI: +0.2, +3.5 for 2007–2016; Tables 2 and 3. A decreasing ASR was found for unspecified tumors of the brain (APC: −4.5%; 95% CI: −6.0, −2.9 for 1990–2006 and −6.0%; 95% CI: −8.6, −3.3 for 2007–2016), whereas incidence of unspecified malignant glioma increased by +6.7% per year (95%

CI: +2.6, +11.0)) in 1990–2006 and at a nearly identical rate in 2007–2016. Incidence of oligoastrocytoma increased in 1990–2006 (APC: +6.6%; 95% CI: +3.8, +9.5), but not any more during the later period. During the earlier study period, significant increase in ASRs was also observed for anaplastic oligodendroglioma (APC: +6.0%; 95% CI: +2.3, +9.8), while incidence trend of astrocytoma showed a decrease of −2.8% per year (95% CI: −4.4, −1.1). Incidence of anaplastic astrocytoma increased in 2007–2016 (APC: +7.3%; 95% CI: +2.2, +12.7). In addition, imputing specific histologic types (in similar proportion to those with known cell type) to unspecified tumors had no substantial effect on the incidence trends in 1990–2006 (Supplementary Table 1).

We also found a difference in incidence trends between anatomic locations during 1990–2006 (likelihood ratio test $p<.001$). Incidence trends were increasing for the frontal lobe (APC: +1.7%; 95% CI: +0.6, +2.8), brainstem (APC: +5.8%; 95% CI: +1.7, +10.0) and unspecified locations (APC: +2.3%; 95% CI: +0.5, +4.1) (Table 4). Trends were decreasing for the parietal lobes (APC: −2.4%; 95% CI: −4.0, −0.9), cerebrum (APC: −3.5%; 95% CI: −6.2, −0.7) and ventricles (APC: −6.0%; 95% CI: −10.4, −1.4).

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Evaluation of radiofrequency and extremely low-frequency field levels at children's playground sites in Greece from 2013 to 2018

Maria Christopoulou M, Karabetsos E. Evaluation of radiofrequency and extremely low-frequency field levels at children's playground sites in greece from 2013 to 2018. Bioelectromagnetics. Published online September 20, 2019. https://doi.org/10.1002/bem.22220

Abstract

From 2013 to 2018, in-situ measurements of radiofrequency (RF) electromagnetic fields (EMF) and extremely low-frequency (ELF) electric and magnetic fields in 317 existing and under-construction children's playground facilities, in 16 municipalities all over Greece, were carried out by the Greek Atomic Energy Commission (EEAE). These measurements were conducted following legislative framework established in 2009, which requires that compliance with the established exposure limits for EMFs should be verified in playground areas. The results are presented by the value of the electric field (E) and exposure ratio (Λ) for the RF EMF, as well as the value of the electric field (E) and magnetic flux density (B) for the ELF electric and magnetic fields. Statistical analysis tools were applied on measurement data and conclusions have been made, taking into consideration: (i) environment type (urban/suburban), and (ii) vicinity to any transmitting installations. Measurement results correspond to the typical EMF background levels for each environment type. Concerning the environment type, RF EMF, and ELF electric/magnetic field measurements reveal no differentiation between urban and suburban environments.

Conclusion

In conclusion, the aim of this work was to analyze in-situ measurements of RF EMF and ELF electric and magnetic fields in 317 existing and under-construction playground facilities, conducted from 2013 to 2018. Concerning the environment type, RF EMF measurements reveal no differentiation between urban and suburban environments. Higher *E*-field values, e.g., 1.66 V/m for urban environment, are due to the proximity of the playground facilities to base stations. Concerning ELF measurements, median values for magnetic flux density did not differ within environment types and were kept at 0.14 μT. Selected high-measurement values in

suburban environments may be due to a larger number of low- and medium-voltage power distribution network facilities located near the playground sites. Based on both measurement datasets, RF and ELF field levels were found even lower than typical background levels in urban/suburban environments. This study is in line with the international literature's findings, confirming the children's exposure levels in urban and suburban environments. Although spot measurements provide overestimation of RF exposure levels compared to personal dosimeters' data [Gallastegi et al., 2018], EEAE intends to correlate this study's findings with personal dosimeters' data and schedule national epidemiological investigations, in order to provide a complete description of the exposure patterns.

https://onlinelibrary.wiley.com/doi/pdf/10.1002/bem.22220

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Radiofrequency radiation from nearby mobile phone base stations-a case comparison of one low and one high exposure apartment

Koppel T, Ahonen M, Carlberg M, Hedendahl LK, Hardell L. Radiofrequency radiation from nearby mobile phone base stations-a case comparison of one low and one high exposure apartment. Oncology Letters. Published online Sep 20, 2019. https://doi.org/10.3892/ol.2019.10899

Abstract

Radiofrequency (RF) radiation in the frequency range of 30-300 GHz has, since 2011, been classified as a 'possible' human carcinogen by Group 2B, International Agency for Research on Cancer (IARC) at WHO. This was based on a number of human epidemiology studies on increased risk for glioma and acoustic neuroma. Based on further human epidemiology studies and animal studies, the evidence on RF radiation carcinogenesis has increased since 2011. In previous measurement studies, it has been indicated that high environmental RF radiation levels are present in certain areas of Stockholm Sweden, including in one apartment. Field spatial distribution measurements were performed in the previously measured apartment in Stockholm, which exhibited high RF radiation from nearby base stations. Based on the RF broadband analyzer spot measurements, the maximum indoor E-field topped at 3 V m-1 in the bedroom at the 7th floor. The maximum outdoor exposure level of 6 V m-1 was encountered at the 8th floor balcony, located at the same elevation and only 6.16 m away from the base station antennas. For comparison, a measurement was made in a low exposure apartment in Stockholm. Here, the maximum indoor field 0.52 V m-1 was measured at the corner window, with direct line of sight to the neighboring house with mobile phone base station antennas. The maximum outdoor field of 0.75 V m-1 was measured at the balcony facing the same next-door building with mobile phone base station antennas. The minimum field of 0.10 V m-1 was registered on the apartment area closest to the center of the building, demonstrating the shielding effects of the indoor walls. Good mobile phone reception was achieved in both apartments. Therefore, installation of base stations to risky places cannot be justified using the good reception requirement argument.

Open access paper: https://www.spandidos-publications.com/10.3892/ol.2019.10899

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Radiation measurements in office environment with Wi-Fi, 3G and 4G users

Koutsi E, Deligiannis S, Sarantopoulos I, Zarbouti D, Athanasiadou G, Tsoulos G. Radiation measurements in

office environment with Wi-Fi, 3G and 4G users. 2019 8th International Conference on Modern Circuits and Systems Technologies (MOCAST). 13-15 May 2019. DOI: 10.1109/MOCAST.2019.8741720

Abstract

The unprecedented explosion of wireless communications with billions of devices across several wireless and cellular systems, has increased concerns about the human exposure to electromagnetic waves. In this context, this work focuses in office operational environments and the most widely used wireless systems therein, i.e. Wi-Fi and 3G/4G networks, in order to evaluate the radiation levels with 4–5 people working in the room. The results show that even with one Wi-Fi user the radiation level can be higher than the reference level for the whole band, while the corresponding scenario for 3G/4G would be with three users. Also, with three or more users, the 4G levels are ∼10% higher than the second higher Wi-Fi.

Conclusions

In this work a measurement campaign was carried out with the frequency selective NARDA SRM-3000 inside a medium sized office room. The goal of the campaign was to investigate the impact of Wi-Fi, 3G and 4G users on the E-field footprint when they maximize their activity, i.e. downloading/uploading data files from/to the web. As a reference scenario, wideband measurements were performed outside office hours when no users were present.

The results show that even one Wi-Fi downloading user drives the E-field value above the reference scenario (of no WiFi router users or cell phone users), while three 3G or 4G users are needed to overtake it. After two users, the 4G contribution dominates the E-field footprint inside the office. Specifically, compared to 3G, 4G almost doubles the E-field values which are ~10% higher compared to Wi-Fi.

It must be mentioned though that in all cases the measured E-field values were much lower (~66 times) than the existing non-ionizing radiation for public exposure safety values [8].

https://ieeexplore.ieee.org/document/8741720

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Early-Life Exposure to Pulsed LTE (4G) Radiofrequency Fields Causes Persistent Changes in Activity and Behavior in C57BL/6 J Mice

Broom KA, Findlay R, Addison DS, Goiceanu C, Sienkiewicz Z. Early-Life Exposure to Pulsed LTE Radiofrequency Fields Causes Persistent Changes in Activity and Behavior in C57BL/6 J Mice. Bioelectromagnetics. 2019 Sep 15. doi: 10.1002/bem.22217.

Abstract

Despite much research, gaps remain in knowledge about the potential health effects of exposure to radiofrequency (RF) fields. This study investigated the effects of early-life exposure to pulsed long term evolution (LTE) 1,846 MHz downlink signals on innate mouse behavior. Animals were exposed for 30 min/day, 5 days/week at a whole-body average specific energy absorption rate (SAR) of 0.5 or 1 W/kg from late pregnancy (gestation day 13.5) to weaning (postnatal day 21). A behavioral tracking system measured

locomotor, drinking, and feeding behavior in the home cage from 12 to 28 weeks of age. The exposure caused significant effects on both appetitive behaviors and activity of offspring that depended on the SAR. Compared with sham-exposed controls, exposure at 0.5 W/kg significantly decreased drinking frequency ($P \leq 0.000$) and significantly decreased distance moved ($P \leq 0.001$). In contrast, exposure at 1 W/kg significantly increased drinking frequency ($P \leq 0.001$) and significantly increased moving duration ($P \leq 0.005$). In the absence of other plausible explanations, it is concluded that repeated exposure to low-level RF fields in early life may have a persistent and long-term effect on adult behavior.

https://www.ncbi.nlm.nih.gov/pubmed/31522469

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Effects of mobile phone radiation on certain hematological parameters

Christopher B, Sheena MY, Uddin Khandaker M, Bradley DA, Chew MT, Jojo PJ. Effects of mobile phone radiation on certain hematological parameters. Radiation Physics and Chemistry. Published online September 14, 2019. 108443. https://doi.org/10.1016/j.radphyschem.2019.108443.

Highlights

• Mobile phone radiation affects blood hemoglobin level, white blood cell and platelets count and erythrocytes sedimentation rate.
• Effects of mobile phone radiation on hematological factors studied in a controlled condition in the laboratory.
• A matched case control approach was adopted for the investigation.
• Long time and over exposure to mobile phone radiation may affect the individual health.

Abstract

Exorbitant chronic exposure to any sort of radiation is hazardous to human health. Besides ionizing radiation, exposures to electromagnetic radiation mainly from the use of mobile phones have become a matter of great health concern, especially its extortionate use even by children. At the same time there are several myths related to the ill effects including carcinogenicity of the prolonged exposure continuously. The objective of this investigation was to find the effect on certain vital hematological parameters namely hemoglobin level, white blood cell (WBC) count, platelet count and erythrocytes sedimentation rate (ESR) level due to the prolonged exposure to mobile radiations through in vitro examination of human blood samples. Matched case control methodology was adopted for the study. Blood samples were collected by clinicians from 27 voluntary subjects for investigation. From each, one sample was kept un-exposed while the other three samples were exposed to mobile microwave radiations for 60 min continuously in identical and controlled conditions. A 4G hand phone of a very popular brand having transmission frequency range from 2.3 to 2.4 GHz including uplink and downlink was used. Hematological analyses were carried out on fresh samples immediately after collection. For comparison of the levels of hematological parameters, blood exposed to 1 h of phone radiation and control were analysed. Experimental results show that there is a significant change on the hematological components. The exposed blood samples were found to have decrease in platelet count only. Hemoglobin level, ESR rate and the WBC counts were found to be increased. While these observations are performed in a controlled laboratory conditions, the tremendous growth in number of mobile phone users, the effects could be many more folds especially in work places and cities even through passive exposure.

https://www.sciencedirect.com/science/article/abs/pii/S0969806X19305481

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Chromosome damage in human cells induced by UMTS (3G) mobile telephony radiation

Panagopoulos DJ. Chromosome damage in human cells induced by UMTS mobile telephony radiation. Gen Physiol Biophys. 2019 Sep 13. doi: 10.4149/gpb_2019032.

Abstract

Environmental exposure to modern microwave telecommunication electromagnetic fields (EMFs) has increased to unprecedented levels with consequent health complaints and concerns. Many studies have already reported genotoxic effects on a variety of organisms and cell/tissue types. Human peripheral blood lymphocytes from six healthy donors were stimulated for mitosis and exposed to microwave EMF of Universal Mobile Telecommunications System (UMTS) or third generation (3G) mobile telephony (MT) EMF/radiation emitted by a commercially available mobile phone handset. Lymphocytes exposed during the G2 phase of the cell division cycle and observed at metaphase, exhibited chromatid-type aberrations (gaps and breaks) at highly significant percentages - up to 275% - compared to the control (sham-exposed) samples. Each subject exhibited a different sensitivity to the microwave exposure. Moreover, the percentages of aberrations in the control samples among subjects were different due to genetic and environmental factors. The MT EMF exposure induced mainly achromatic lesions (gaps), and secondarily terminal deletions (breaks) in a smaller degree. In conclusion, the present study shows that microwave 3G MT EMF/radiation - within the current exposure limits - has significant genotoxic action on human cells, and human exposure to this EMF/radiation should be kept at levels as low as possible.

https://www.ncbi.nlm.nih.gov/pubmed/31516130

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Should parents allow their children to use smart phones and tablets? The issue of cognitive performance

Mortazavi SAR, Haghani M, Zarei S, Rastegarian N, Alighanbari N, Haghparast M, Darvish L. Should parents allow their children to use smart phones and tablets? The issue of cognitive performance. J Biomed Phys Eng. https://doi.org/10.22086/jbpe.v0i0.535, Published online first.

Abstract

Mobile phones, mobile phone base stations, cordless phones and power lines are among the main sources of our daily exposures to radiofrequency electromagnetic fields (RF-EMF). Today, a large proportion of children aged eight and under has used smart phones and tablets for media activities such as playing online games, watching videos or using different applications. Over the past several years, our society has witnessed a rapid growth both in the percent of children who regularly use smart phones and tablets and the time spent using these devices. Expanded access of children to these mobile devices and the games that make mobile phones attractive to young users are believed to be the key factors that increased the time spent by children for using mobile devices. In IR Iran, students are not allowed to use mobile phones in schools. On the other hand, although students do not have access to Wi-Fi in schools, as Wi-Fi provides efficient access to the Internet on the campus, Wi-Fi routers are widely used. The rapid growth of mobile phone use has raised global public concerns especially for children. Focusing on the issue of cognitive performance, this paper is aimed at answering the following question; Should parents let their children use smart phones and tablets?

Conclusions

Nowadays in many countries, there are warnings about children mobile phone use [53]. Radiofrequency electromagnetic radiation is a Class 2B (possible). It is widely believed that children are more susceptible to radiation at least in some regions of the electromagnetic spectrum [54]. It has been reported that chil-dren absorb more radiofrequency radiation than adults [53]. Moreover, some individuals are hypersensitive to RF-EMFs [55] and this hypersensitivity may cause more problems in children. As long-term effects of the children's exposures to RF EMF emitted from mobile phones and other wireless technologies are not fully understood, overexposure to phones and other wireless technologies should be avoided to protect their cognitive performance. In this light, setting time limits for cell phone use by children is highly recommended. Moreover, in each country authorities should adopt radia-tion standards which protect children's health and well-being.

Open access paper: http://www.jbpe.ir/Journal_OJS/JBPE/index.php/jbpe/article/download/535/306

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Children exposure to femtocell in indoor environments estimated by sparse low-rank tensor approximations

Chiaramello E, Parazzini M, Fiocchi S, Bonato M, Ravazzani P, Wiart J. Children exposure to femtocell in indoor environments estimated by sparse low-rank tensor approximations. Annals of Telecommunications. 74(1-2):113-121. February 2019.

Abstract

The exposure of an 8-year-old child to a femtocell operating at 2600 MHz, both (child and source) freely located in random positions in an indoor environment, was assessed. In order to develop surrogate models of the exposure, stochastic dosimetry based on sparse low-rank tensor approximation method (sparse LRA) was used. The surrogate models were used for fastly estimating the specific absorption rate (SAR) in all the possible positions of femtocell and child. Results showed that, for all the possible positions in the room, the exposure values were significantly below the International Commission of Non-Ionizing Radiation Protection (ICNIRP) guidelines for general public and that the probability of reaching SAR values higher than 1% of the ICNIRP guidelines value was lower than 0.006. The variation of the distance between femtocell and child influenced greatly the exposure, resulting in quartile coefficient of dispersion values always higher than 48%.

https://link.springer.com/article/10.1007%2Fs12243-018-0681-0

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Effect of electromagnetic field exposure on the transcription of repetitive DNA elements in human cells

Del Re B, Bersani F, Giorgi G. Effect of electromagnetic field exposure on the transcription of repetitive DNA elements in human cells. Electromagn Biol Med. 2019 Sep 21:1-9. doi: 10.1080/15368378.2019.1669634.

Abstract

Repetitive DNA (RE-DNA) was long thought to be silent and inert; only recent research has shown that it can be transcribed and that transcription alteration can be induced by environmental stress conditions, causing human pathological effects. The aim of this study was to determine whether exposure to radiofrequency electromagnetic fields (RF-EMF) could affect the transcription of RE-DNA. To this purpose, three different human cell lines (HeLa, BE(2)C and SH-SY5Y) were exposed to 900 MHz GSM-modulated RF-EMF at specific

absorption rate of 1 W/kg or to sham. After exposure, mRNA levels of RE-DNA were evaluated through quantitative real-time PCR. The following RE-DNA types were investigated: Long Interspersed nucleotide Element 1, DNA alpha satellite and Human Endogenous Retroviruses-like sequences. When comparing cells exposed to RF-EMF versus control samples, different results were found for the three cell lines evaluated, indicating that RF-EMF exposure can significantly affect RE-DNA transcription and that the effects strongly depend on the cellular context and the tissue type. Further studies are needed to elucidate which molecular mechanisms could be involve

https://www.ncbi.nlm.nih.gov/pubmed/31542968

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Long-term exposure to 4G smartphone radiofrequency electromagnetic radiation diminished male reproductive potential by directly disrupting Spock3-MMP2-BTB axis in the testes of adult rats

Yu G, Tang Z, Chen H, Chen Z, Wang L, Cao H, Wang G, Xing J, Shen H, Cheng Q, Li D, Wang G, Xiang Y, Guan Y, Zhu Y, Liu Z, Bai Z. Long-term exposure to 4G smartphone radiofrequency electromagnetic radiation diminished male reproductive potential by directly disrupting Spock3-MMP2-BTB axis in the testes of adult rats. Sci Total Environ. 2019 Aug 31;698:133860. doi: 10.1016/j.scitotenv.2019.133860.

Abstract

The correlation between long-term exposure to SRF-EMR and the decline in male fertility is gradually receiving increasing attention from the medical society. While male reproductive organs are often exposed to SRF-EMR, little is currently known about the direct effects of long-term SRF-EMR exposure on the testes and its involvement in the suppression of male reproductive potential. The present study was designed to investigate this issue by using 4G SRF-EMR in rats. A unique exposure model using a 4G smartphone achieved localized exposure to the scrotum of the rats for 6 h each day (the smartphone was kept on active talk mode and received an external call for 1 min over 10 min intervals). Results showed that SRF-EMR exposure for 150 days decreased sperm quality and pup weight, accompanied by testicular injury. However, these adverse effects were not evident in rats exposed to SRF-EMR for 50 days or 100 days. Sequencing analysis and western blotting suggested Spock3 overexpression in the testes of rats exposed to SRF-EMR for 150 days. Inhibition of Spock3 overexpression improved sperm quality decline and alleviated testicular injury and BTB disorder in the exposed rats. Additionally, SRF-EMR exposure suppressed MMP2 activity, while increasing the activity of the MMP14-Spock3 complexes and decreasing MMP14-MMP2 complexes; these results were reversed by Spock3 inhibition. Thus, long-term exposure to 4G SRF-EMR diminished male fertility by directly disrupting the Spock3-MMP2-BTB axis in the testes of adult rats. To our knowledge, this is the first study to show direct toxicity of SRF-EMR on the testes emerging after long-term exposure.

https://www.ncbi.nlm.nih.gov/pubmed/31514029

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Review: The influence of bioactive mobile telephony radiation at the level of a plant community – Possible mechanisms and indicators of the effects

Czerwiński M, Januszkiewicz L, Vian A, Lázarod A. Review: The influence of bioactive mobile telephony

radiation at the level of a plant community – Possible mechanisms and indicators of the effects. Ecological Indicators. 108, Jan 2020. 105683. https://doi.org/10.1016/j.ecolind.2019.105683.

Highlights

• There are various indicators of microwave radiation impact on herbaceous vegetation.
• The best indicators are some parameters of vegetation canopy or individual plants.
• Specific plant functional groups may be indicators of long-term community processes.
• Other organisms interacting with plants, e.g. pollinators, should also be considered.
• The selection of indicators depends on the propagation of radiation in the canopy.

Abstract

Environmental exposure to radiofrequency electromagnetic fields (RF-EMFs) from mobile telephony has rapidly increased in the last two decades and this trend is expected to continue. The effects of this exposure at plant community level are unknown and difficult to assess in a scientifically appropriate manner. Such an assessment can be scientifically adequate if a studied plant community is completely new and control-impact radiation treatment is used.

In this review we aimed to predict ecological effects and identify indicators of the impact of bioactive RF-EMFs at the mobile telephony frequency range on plant communities. We considered the scenario where a plant community was exposed to radiation generated by a base transmitting station antenna mounted on a nearby mast. This plant community can be represented by mesic meadow, ruderal or arable weed community, or other herbaceous, moderately productive vegetation type. We concentrated primarily on radiation effects that can be recorded for a year since the exposure started. To predict them we used physical theories of radiowave propagation in vegetation and the knowledge on plants physiological responses to RF-EMF. Our indicators can be used for the detection of the impact of RF-EMFs on vegetation in a control-impact experiment.

The identified indicators can be classified into the following groups: (1) canopy parameters; (2) plant characteristics to be measured in the field or laboratory in a number of individuals that represent the populations of selected species; (3) community weighted means/medians (CWMs) of plant traits and strategies; (4) the abundance of other organisms that interact with plants and can influence their fitness or population size. The group of canopy parameters includes mean height, vertical vegetation structure and dry weight of above-ground standing phytomass. Plant characteristics requiring biometric sampling in the field are plant height, the number of fruits and seeds, as well as seed viability. The group of plant traits that are calculated as CWMs covers seed releasing height, seed dispersal mode, SLA, leaf orientation, month of germination and flowering, Ellenberg's light indicator value, and the proportion of individuals in the classes of competitors and stress tolerators according to Grime's CSR strategy scheme. The group of "non-plant" indicators includes primarily the frequency of flower visits by beetles, wasps, hoverflies, and bees that have their nests over ground. To detect ecological responses that occur for the first year since a herbaceous community has been exposed to potentially bioactive RF-EMF, the first two indicators groups should be used.

https://www.sciencedirect.com/science/article/pii/S1470160X19306764

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Health effects associated with exposure to low-frequency electromagnetic fields

French Agency for Food, Environmental and Occupational Health & Safety (ANSES). Health effects associated with exposure to low-frequency electromagnetic fields. info.
2019, ANSES OPNION Request No 2013-SA-0038: 1-14.

https://www.anses.fr/en/system/files/AP2013SA0038EN.pdf

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Electromagnetic Fields Exposure from Power Lines and Human Fertility

Esmailzadeh S, Agajani Delavar M, Gholamian SA, Ahmadi A, Hosseinpour Haydari F, Pourali M. Electromagnetic Fields Exposure from Power Lines and Human Fertility. Iran J Public Health. 2019 May;48(5):986-987.

Open access letter: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6717401/

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Effect of Static Magnetic Field of Electric Vehicles on Driving Performance and on Neuro-Psychological Cognitive Functions

He Y, Sun W, Leung PS, Chow YT. Effect of Static Magnetic Field of Electric Vehicles on Driving Performance and on Neuro-Psychological Cognitive Functions.
Int J Environ Res Public Health. 2019 Sep 12;16(18). pii: E3382. doi: 10.3390/ijerph16183382.

Abstract

Human neuropsychological reactions and brain activities when driving electric vehicles (EVs) are considered as an issue for traffic and public safety purposes; this paper examined the effect of the static magnetic field (SMF) derived from EVs. A lane change task was adopted to evaluate the driving performance; and the driving reaction time test and the reaction time test were adopted to evaluate the variation of the neuro-psychological cognitive functions. Both the sham and the real exposure conditions were performed with a 350 μT localized SMF in this study; 17 student subjects were enrolled in this single-blind experiment. Electroencephalographs (EEGs) of the subjects were adopted and recorded during the experiment as an indicator of the brain activity for the variations of the driving performance and of the cognitive functions. Results of this study have indicated that the impact of the given SMF on both the human driving performance and the cognitive functions are not considerable; and that there is a correlation between beta sub-band of the EEGs and the human reaction time in the analysis.

Open access paper: https://www.mdpi.com/1660-4601/16/18/3382

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Geomagnetic disturbances driven by solar activity enhance total and cardiovascular mortality risk in 263 U.S. cities

Zilli Vieira CL, Alvares D, Blomberg A, Schwartz J, Coull B, Huang S, Koutrakis P. Geomagnetic disturbances driven by solar activity enhance total and cardiovascular mortality risk in 263 U.S. cities. Environmental Health. 18(83). Sep 11, 2019.

Abstract

Background Short-term geomagnetic disturbances (GMD) driven by the quasi-periodic 11-year cycle of solar activity have been linked to a broad range of adverse health effects, including cardiovascular diseases (CVD) and total deaths. We conducted a large epidemiological study in 263 U.S. cities to assess the effects of GMD on daily deaths of total, CVD, myocardial infarction (MI), and stroke.

Methods We employed a two-step meta-analysis approach, in which we estimated city-specific and season-stratified mortality risk associated with a GMD parameter (Kp index) in 263 U.S. cities. In addition, sensitivity analysis was performed to assess whether effect modification of particulate matter (PM2.5) in the prior day changed Kp index effects on daily deaths after adjusting for confounders.

Results We found significant association between daily GMD and total, CVD, and MI deaths. The effects were even stronger when we adjusted the models for 24-h PM2.5 for different seasons. For example, in the winter and fall one standard deviation of z-score Kp index increase was associated with a 0.13 and 0.31% increase in total deaths, respectively (Winter: $p = 0.01$, 95% CI: 0.02 to 0.24; Fall: $p = 0.00001$; 95% CI: 0.23 to 0.4), without adjusting for PM2.5. The effects of GMD on total deaths were also observed in spring and summer in the models without PM2.5 ($p = 0.00001$). When the models were adjusted for PM2.5 the total deaths increased 0.47% in winter ($p = 0.00001$, 95% CI: 0.3 to 0.65) and by 0.23% in fall ($p = 0.001$, 95% CI: 0.09 to 0.37). The effects of GMD were also significant associated with MI deaths and CVD. No positive significant association were found between Kp and stroke. The GMD effects on deaths were higher than for 24 h-PM2.5 alone, especially in spring and fall.

Conclusion Our results suggest that GMD is associated with total, CVD and MI deaths in 263 U. S cities. Increased mortality in the general population during GMD should be further investigated to determine whether those human physiological dynamics driven by variations in solar activity can be related to daily clinical cardiovascular observations.

Open access paper: https://ehjournal.biomedcentral.com/articles/10.1186/s12940-019-0516-0

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Risks to Health and Well-Being From Radio-Frequency Radiation Emitted by Cell Phones and Other Wireless Devices

Miller AB, Sears ME, Morgan LL, Davis DL, Hardell L, Oremus M and Soskolne CL (2019) Risks to health and well-being from radio-frequency radiation emitted by cell phones and other wireless devices. Front. Public Health 7:223. doi: 10.3389/fpubh.2019.00223.

Abstract

Radiation exposure has long been a concern for the public, policy makers, and health researchers. Beginning with radar during World War II, human exposure to radio-frequency radiation1 (RFR) technologies has grown substantially over time. In 2011, the International Agency for Research on Cancer (IARC) reviewed the published literature and categorized RFR as a “possible” (Group 2B) human carcinogen. A broad range of adverse human health effects associated with RFR have been reported since the IARC review. In addition, three large-scale carcinogenicity studies in rodents exposed to levels of RFR that mimic lifetime human exposures have shown significantly increased rates of Schwannomas and malignant gliomas, as well as chromosomal DNA damage. Of particular concern are the effects of RFR exposure on the developing brain in children. Compared with an adult male, a cell phone held against the head of a child exposes deeper brain structures to greater radiation doses per unit volume, and the young, thin skull's bone marrow absorbs a

roughly 10-fold higher local dose. Experimental and observational studies also suggest that men who keep cell phones in their trouser pockets have significantly lower sperm counts and significantly impaired sperm motility and morphology, including mitochondrial DNA damage. Based on the accumulated evidence, we recommend that IARC re-evaluate its 2011 classification of the human carcinogenicity of RFR, and that WHO complete a systematic review of multiple other health effects such as sperm damage. In the interim, current knowledge provides justification for governments, public health authorities, and physicians/allied health professionals to warn the population that having a cell phone next to the body is harmful, and to support measures to reduce all exposures to RFR.

Open access paper: https://www.frontiersin.org/articles/10.3389/fpubh.2019.00223/full

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Radiofrequency electromagnetic radiation-induced behavioral changes and their possible basis

Narayanan SN, Jetti R, Kesari KK, Kumar RS, Nayak SB, Bhat PG. Radiofrequency electromagnetic radiation-induced behavioral changes and their possible basis. Environ Sci Pollut Res Int. 2019 Aug 28. doi: 10.1007/s11356-019-06278-5.

Abstract

The primary objective of mobile phone technology is to achieve communication with any person at any place and time. In the modern era, it is impossible to ignore the usefulness of mobile phone technology in cases of emergency as many lives have been saved. However, the biological effects they may have on humans and other animals have been largely ignored and not been evaluated comprehensively. One of the reasons for this is the speedy uncontrollable growth of this technology which has surpassed our researching ability. Initiated with the first generation, the mobile telephony currently reaches to its fifth generation without being screened extensively for any biological effects that they may have on humans or on other animals. Mounting evidences suggest possible non-thermal biological effects of radiofrequency electromagnetic radiation (RF-EMR) on brain and behavior. Behavioral studies have particularly concentrated on the effects of RF-EMR on learning, memory, anxiety, and locomotion. The literature analysis on behavioral effects of RF-EMR demonstrates complex picture with conflicting observations. Nonetheless, numerous reports suggest a possible behavioral effect of RF-EMR. The scientific findings about this issue are presented in the current review. The possible neural and molecular mechanisms for the behavioral effects have been proposed in the light of available evidences from the literature.

https://www.ncbi.nlm.nih.gov/pubmed/31463749

Conclusions

Mobile phone safety recommendations depend mainly on ‘sinusoidal wave’ emitted from the cell phone when it is idle. At idle mode, the RF-EMR exposure is negligible, hence, it might not be that detrimental at this level. However, chronic exposure to the ‘carrier signal’ emitted when phone is in ‘ON’ mode (when the phone is ringing/call receiving mode) would be responsible for biological effects. Exposure to RF-EMR induces an imbalance in the oxidant/antioxidant defense system in the brain indicating that the internal environment of each brain cell was getting disturbed by the insult from RFEMR. This therefore does not favor the nerve cells to function appropriately. Whenever the threshold is reached, the cell either stops functioning, functions abnormally, or dies. We call it structural change or morphological change. Most of the time, what happens at the cellular level is indicated at the behavioral level. It is highly difficult to join up biochemical change,

morphological change, and then behavior. An imbalance in the biochemical homeostasis would itself alter the behavior which might not be structurally represented and vice versa. This is due to the mechanisms, which prevent or resist the insult from external stressors. Currently, we are not sure about this fact as there are no solid evidences which pin point or demonstrate this innate preventive/restrain mechanisms present in neurons under RF-EMR exposure. Further study in this regard will reveal much clearer picture of body's (especially brain) innate mechanisms which would withstand the potential threat caused by RF-EMR.

It is evident from earlier discussions that a possible behavioral effect does exist following RF-EMRexposure in rodents. However, caution should be taken while extrapolating these findings into humans. It is worth noting that an adult uses mobile phone approximately 4 to 5 h per day and this may be even more in teenagers. However, reports that analyze the behavioral, psychological, and health variables following RFEMR exposure in sensitive population like young adults are scanty. Furthermore, it would be interesting to study the effect of RF-EMR exposure in early developmental stage and see what the effects of such exposures are on the critical and sensitive periods of development using animal models. Although the current review focused principally on RFEMR-induced effects on cognition, anxiety, and locomotion, RF-EMR have been attributed to induce other behavioral effects in rodents as well as in humans. After witnessing the uncontrollable growth of this technology, everyone believes that it is high time to evaluate the health risks of continuous and chronic RF-EMR exposure effects on humans and for which further studies are warranted.

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Effect of radiofrequency radiation on reproductive health

Singh R, Nath R,Mathur AK,Sharma RS. Effect of radiofrequency radiation on reproductive health. Indian J Med Res. 2018 Dec; 148(Suppl 1): S92–S99. doi: 10.4103/ijmr.IJMR_1056_18.

Abstract

The development of cellular phone system has greatly increased the extent and magnitude of radiofrequency radiation (RFR) exposure. The RFR emitted from mobile phone and mobile phone base stations exerts thermal and non-thermal effects. The short-term and long-term exposure to RFR may have adverse effect on humans as well as animals. Most laboratory studies have indicated a direct link between exposure to RFR and adverse biological effects. Several in vitro studies have reported that RFR induces various types of cancer and DNA or chromosomal damage. On the other hand, some animal studies have not reported adverse effects of this radiation. The present review summarizes information available on the possible effects of RFR on the reproductive health.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6469375/

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Health effects of radiofrequency electromagnetic fields (RF EMF)

Bortkiewicz A. Editorial: Health effects of radiofrequency electromagnetic fields (RF EMF). Industrial Health. 2019;57(4):403-405. doi: 10.2486/indhealth.57_400.

No abstract.

Conclusion: The problem of health effects of RF EMF has not been definitely resolved, but due to the results of previous research on possible health effects of RF EMF, it seems necessary to use precautionary principles and ALARA (As Low as Reasonably Achievable) principles, when the new sources of electromagnetic emissions will be planned and installed.

Open access paper: https://www.jstage.jst.go.jp/article/indhealth/57/4/57_57_400/_pdf/-char/en

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Environmental Factors and the Risk of Brain Tumours in Young People: A Systematic Review

Zumel-Marne A, Castano-Vinyals G, Kundi M, Alguacil J, Cardis E. Environmental Factors and the Risk of Brain Tumours in Young People: A Systematic Review. Neuroepidemiology. 2019 Jun 5:1-21. doi: 10.1159/000500601.

Abstract

BACKGROUND: Brain tumours (BT) are one of the most frequent tumour types in young people, although little is known about their risk factors.

OBJECTIVE: The objective of the current work was to review and summarize the scientific literature concerning exposure to environmental factors and BT risk in young people (<25 years old).

METHODS: PUBMED, Embase, Cochrane Library, Scopus, IME-Biomedina (bibliographic database of Consejo Superior de Investigaciones Científicas) and Web of science databases were searched. A score to assess the quality of the methodological information was created.

RESULTS: Some possible associations between BT risk in young people were reported for cadmium, consumption of well water, presence of nitrate or nitrate-nitrogen in tap water, mother's passive smoking, air pollution, parental handling of pesticides at home and/or professional pesticide treatment within houses, living on a farm and/or with farm animals, some parental occupations and high amount of meat consumption.

CONCLUSIONS: Although many of the studies reviewed suggest associations between the environmental exposures and BT in children and young adults, at present no reliable conclusion can be drawn as most results are based on small number of cases and exposure assessment is limited. Large-scale studies with better exposure assessment are needed to shed light on these possible associations, especially on exposure to heavy metals, tab water consumption, pesticides and parental smoking.

Excerpt: Non-Ionizing Radiation

Three articles [19, 42, 47] studied the association between extremely low frequency (ELF) exposure during pregnancy and BT risk.

Regarding the exposure to electrically heated waterbeds during pregnancy, 2 articles found non-significantly reduced risks (1 for astrocytomas and the other for BT in general) based on small samples sizes [19, 47]. No significant association was found for PNET either [19]. Regarding exposure to ELF from electrical blankets during pregnancy, 3 articles found non-statistically significantly increased risk [19, 42, 47].

Two studies focused on childhood ELF exposure [39, 47] and BT risk. One [39] found a non-significantly

reduced risk for electric blanket and waterbed use based on very small numbers of cases (n = 6 and 1, respectively). In the other study, the ORs were close to one.

Two studies [48, 49] focused on radiofrequency (RF) exposures in childhood and BT were found. In the large multinational study [48], a non-significantly increased risk was found, with no evidence for an exposure response relationship between mobile phones use (which emits some ELF but mainly RF) and risk of BT. Use of mobile phones was low in this population, with an average duration of use of 2.7 years and lifetime cumulative time of use of only 35 h. Another study [49], which estimated average of exposure to RF from mobile phone base stations, found a non-statistically significant risk for exposure above the median, though the authors acknowledge several methodological limitations.

Three studies focused on the exposure to magnetic fields (MF) [50-52] from high-current power lines, electric heating sources or electric appliances at home during childhood. One [50] found a significantly increased risk for ≥0.4μT of MF in the children's bedroom (OR 10.9 [1.05–113] based on 3 cases and 1 control). Two [51, 52] studies found a non-statistically significant increased risk for exposure at home to high MF compared to low ones.

Open access paper: https://www.karger.com/Article/FullText/500601

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Funding Source, Quality of Publications and Outcome in Genetic Damage in Mammalian Cells Exposed to Non-Ionizing Radiofrequency Fields

Vijayalaxmi, Prihoda TJ. Funding source, quality of publications and outcome in genetic damage in mammalian cells exposed to non-ionizing radiofrequency fields.Radiat Res. 2019 Aug 7. doi: 10.1667/RR15364.1.

Abstract

There has been ongoing debate and discussion concerning whether the funding source influenced the outcome of research on human health effects from exposure to radiofrequency fields (RF, electromagnetic waves that carry energy as they propagate in air and dense media). In a study of 225 publications, in which we sought to determine a possible association between the funding source(s), quality and outcome in a total of 2,160 genetic damage assessment tests of mammalian cells exposed to RF energy, we made several observations. One finding was that a great majority of researchers had acknowledged government agencies as the funding source (53%, 120 of 225 publications), while a small number of scientists mentioned mobile phone industry as the financial source (9%, 20 of 225 publications). Numerous investigators did not mention the funding source (26%, 58 of 225 publications). Secondly, industry-funded investigations were of better quality and utilized quality control measures, i.e., blind evaluation, adequate description of dosimetry, positive controls and/or sham-exposed controls, compared to those funded by the government. Another observation was that in industry-funded studies, the d values (effect size or standardized mean difference between the cells exposed to RF energy and sham-exposed controls) were consistently lower than in government-funded studies. In addition, compared to government-funded studies, a higher percentage of industry-funded studies reported no difference in genetic damage between RF- and sham-exposed cells (80% for industry-funded studies versus 49% for government-funded studies). Finally, we observed that industry-funded studies were less likely to report an increase in genetic damage in cells exposed to RF energy (10%) compared to government-funded studies (23%). In view of the large difference between the percentage of publications funded by government and industry (53% or 122 of 225 publications for government, compared to 9% or 29 of 225 publications for

industry), caution should be used when debating and discussing the above observations. Overall, it is important to include the quality control measures in the investigations, and also mention the funding source in published studies.

https://www.ncbi.nlm.nih.gov/pubmed/31390310

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Health effects of radiofrequency electromagnetic energy

Elwood M, Wood AW. Health effects of radiofrequency electromagnetic energy. N Z Med J. 2019 Aug 30;132(1501):64-72.

Abstract

The issues of real or suspected health effects of radiofrequency fields, produced by cellphones, their base stations and many other devices, are complex and controversial. We believe that the most balanced and valid assessments of these issues are given by the extensive reports produced by reputable, multidisciplinary, expert groups. These use the principles of a comprehensive review to assess all available published literature and form their conclusions by consideration of the strength of the evidence from the available studies. This paper provides links to several of these reports, and shows how others can be accessed. These reports are large and complex, but freely available on websites. We summarise the most recent New Zealand report, which itself refers to and summarises many other reports. The scientific literature on these issues is enormous, particularly in animal and laboratory studies. There are some comprehensive reviews of these, demonstrating that the quality of the studies is very variable, and that, for example, results claiming to show increased genetic damage or other biological effects are much more common in studies of low quality, whereas higher-quality studies predominantly show no significant effects. Thus, while there are many reports which in isolation suggest health effects, there is no consistent evidence supporting important health effects caused by low intensities of radiofrequencies similar to those experienced by the general population. There are certainly many unanswered questions, and new studies need to be assessed carefully and replicated where possible. Thus, expert groups in several countries including New Zealand need to continue to regularly review new studies.

https://www.ncbi.nlm.nih.gov/pubmed/31465329

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Adverse effects of Wi-Fi radiation on male reproductive system: A systematic review

Jaffar FHF, Osman K, Ismail NH, Chin KY, Ibrahim SF. Adverse Effects of Wi-Fi Radiation on Male Reproductive System: A Systematic Review. Tohoku J Exp Med. 2019;248(3): 169-179. doi: 10.1620/tjem.248.169.

Abstract

Extensive use of Wi-Fi has contributed to radiofrequency electromagnetic radiation (RF-EMR) pollution in environment. Various studies have been conducted to evaluate the effect of RF-EMR emitted by Wi-Fi transmitter on male reproduction health. However, there are conflicting findings between studies. Thus, this review aims to elucidate the possible effects of 2.45 GHz Wi-Fi exposure on both animal and human male reproductive system. A computerized database search performed through MEDLINE via Ovid and PUBMED

with the following set of keywords: 'Wi-Fi or WiFi or wireless fidelity or Wi-Fi router or WiFi router or electromagnetic or radiofrequency radiation' AND 'sperm or spermatozoa or spermatogenesis or semen or seminal plasma or testes or testis or testosterone or male reproduction' had returned 526 articles. Only 17 studies conformed to pre-set inclusion criterion. Additional records identified through Google Scholar and reviewed article further revealed six eligible articles. A total of 23 articles were used for data extraction, including 15 studies on rats, three studies on mice, and five studies on human health. Sperm count, motility and DNA integrity were the most affected parameters when exposed to RF-EMR emitted by Wi-Fi transmitter. Unfortunately, sperm viability and morphology were inconclusive. Structural and/or physiological analyses of the testes showed degenerative changes, reduced testosterone level, increased apoptotic cells, and DNA damage. These effects were mainly due to the elevation of testicular temperature and oxidative stress activity. In conclusion, exposure towards 2.45 GHz RF-EMR emitted by Wi-Fi transmitter is hazardous on the male reproductive system.

Open access paper: https://www.jstage.jst.go.jp/article/tjem/248/3/248_169/_article

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Some Notes on the Verification of the Exposure Limits in 5G Systems

Migliore MD. Some Notes on the Verification of the Exposure Limits in 5G Systems.2019 IEEE International Symposium on Measurements & Networking (M&N). 8-10 July 2019. DOI: 10.1109/IWMN.2019.880504

Abstract

The aim of this contribution is to discuss some problems regarding the measurement of the Electromagnetic Field Exposure (EFE) n 5G communication systems. The discussion clarifies how the use of the spatial resource to increase the network capacity introduces new causes of uncertainties in the estimation of the field intensity compared to previous generation of cellular networks. Simple examples regarding Massive MIMO communication systems are discussed.

Conclusions

The use of highly reconfigurable antennas represent a newchallenge for the measurement of the electromagnetic exposureof population.The simple simulations discussed in this conference contribution shows that new measurement protocols that takeexplicitly into account the reconfigurable nature of the fieldmust be considered for 5G. The simulations also suggest apossible approach, that consists in ’forcing’ the reconfigurable antenna to synthesize a maximum toward the direction of the measurement position, for example considering a system that is seen as ’receiver’ by the cellular system, while theestimation of the amplitude of the field in the close proximityof the antenna could be carried out using approaches based on near-field measurements.

https://ieeexplore.ieee.org/document/8805045

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Validation of Potential Effects on Human Health of in Vivo Experimental Models Studied in Rats Exposed to Sub-Thermal Radiofrequency. Possible Health Risks Due to the Interaction of Electromagnetic Pollution and Environmental Particles

Salas-Sánchez AA, López-Furelos A, Rodríguez-González JA, Ares-Pena FJ, López-Martín ME. Validation of

potential effects on human health of in vivo experimental models studied in rats exposed to sub-thermal radiofrequency. Possible health risks due to the interaction of electromagnetic pollution and environmental particles. IEEE Access. 7: 79186 - 79198. 17 June 2019. DOI: 10.1109/ACCESS.2019.2923581

Abstract

Studies are based on the exposure of Sprague-Dawley rats (250 male and 250 female rats) to electromagnetic fields (EMF) at different frequencies in standing and travelling wave chambers. Values of specific absorption rate (SAR) for all of these experiments were obtained from commercially available FDTD-based simulation software based on numerical phantom animals. An experimental radiation system was developed with a standing-wave cavity which keeps electromagnetic parameters constant while facilitating stress-free exposure of animals to non-thermal radiation. This makes it possible to directly measure the power absorbed by the animal and determine whole-body mean SAR according to weight. All studies using this setup were performed with global system for mobile communication (GSM) radiation at 900 MHz. The simple picrotoxin model made allow to identify morphological signs of neurotoxicity in rat brain tissue. Experiments involving travelling waves were done in a commercial Gigahertz Transverse ElectroMagnetic (GTEM) chamber connected to one or two vector signal generators (to carry single or multiple EMF exposure frequencies). In the diathermy model, rat thyroid and thymus exposed to 2.45 GHz radiation showed visible morphological and immune effects. Cellular stress in the cerebral cortex, the cerebellum or both seems to be more associated with the type of signal than with additive effects of combined frequencies. Finally, some hypothesis related with the future models about the ElectroMagnetic (EM) pollution are established. In an urban environmental that combines the electromagnetic and chemical pollution of environmental particles, cortical excitability, inflammatory response, and cell injury can be modified.

Conclusdions

The experimental models of controlled exposure of animals to radiofrequency allow us to know in the short term the mechanisms and risks that can affect human health. The modulation of EEG rhythms in epileptics, the modification of the immune response and the increase in cellular stress are biological effects that could be caused in humans by radio frequency interaction. In an urban environmental that combines the electromagnetic and chemical pollution of environmental particles cortical excitability, inflammatory response and cell injury can be modified.

https://ieeexplore.ieee.org/document/8737903

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Risk to pollinators from anthropogenic electro-magnetic radiation (EMR): Evidence and knowledge gaps

Vanbergen AJ, Potts SG, Vian A, Malkemper EP, Young J, Tscheulin T. Risk to pollinators from anthropogenic electro-magnetic radiation (EMR): Evidence and knowledge gaps. Sci Total Environ. 2019 Aug 7;695:133833. doi: 10.1016/j.scitotenv.2019.133833.

Abstract

Worldwide urbanisation and use of mobile and wireless technologies (5G, Internet of Things) is leading to the proliferation of anthropogenic electromagnetic radiation (EMR) and campaigning voices continue to call for the risk to human health and wildlife to be recognised. Pollinators provide many benefits to nature and humankind,

but face multiple anthropogenic threats. Here, we assess whether artificial light at night (ALAN) and anthropogenic radiofrequency electromagnetic radiation (AREMR), such as used in wireless technologies (4G, 5G) or emitted from power lines, represent an additional and growing threat to pollinators. A lack of high quality scientific studies means that knowledge of the risk to pollinators from anthropogenic EMR is either inconclusive, unresolved, or only partly established. A handful of studies provide evidence that ALAN can alter pollinator communities, pollination and fruit set. Laboratory experiments provide some, albeit variable, evidence that the honey bee Apis mellifera and other invertebrates can detect EMR, potentially using it for orientation or navigation, but they do not provide evidence that AREMR affects insect behaviour in ecosystems. Scientifically robust evidence of AREMR impacts on abundance or diversity of pollinators (or other invertebrates) are limited to a single study reporting positive and negative effects depending on the pollinator group and geographical location. Therefore, whether anthropogenic EMR (ALAN or AREMR) poses a significant threat to insect pollinators and the benefits they provide to ecosystems and humanity remains to be established.

https://www.ncbi.nlm.nih.gov/pubmed/31419678

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Changes in pyramidal and granular neuron numbers in rat hippocampus 7 days after exposure to continuous 900-MHz EMF during early and mid-adolescence

Keleş Aİ, Nyengaard JR, Odacı E. Changes in pyramidal and granular neuron numbers in the rat hippocampus 7 days after exposure to a continuous 900-MHz electromagnetic field during early and mid-adolescence. J Chem Neuroanat. 2019 Aug 26:101681. doi: 10.1016/j.jchemneu.2019.101681.

Abstract

The aim of this study was to investigate qualitative and quantitative changes in pyramidal and granule neurons in the male rat hippocampus after exposure to a continuous 900-megahertz (MHz) electromagnetic field (EMF) for 25 days during early and mid-adolescence. Three-week-old (21 day) healthy Sprague Dawley male rats were divided equally into control (CON), pseudo-exposed (PEX) and EMF groups. EMF rats were exposed to a 900-MHz EMF in an EMF-application cage, while the PEX rats were placed in the same cage without being exposed to EMF. No procedure was performed in CON. EMF was applied for 1 h/day, every day for 25 days. Following the 900-MHz EMF and pseudo-exposed applications, behavioral tests were performed for seven days. Then, all animals were euthanized and their brains were removed. Following histological tissue procedures, sections were taken from tissues and stained with toluidine blue. The optical fractionation technique was performed to estimate the pyramidal neuron numbers in the CA1, CA2-3 and hilus regions of the hippocampus and granule neuron numbers in the dentate gyrus region. Our findings indicated that the number of pyramidal and granule neurons in the hippocampus of the EMF group was statistically higher than PEX. Furthermore, the histopathological results showed that the cytoplasm of pyramidal (in the hilus, CA1, CA2 and CA3 region) and granular (in the dentate gyrus region) cells at the hippocampus were disrupted, as evident by intensive staining around cytoplasm and some artifacts were detected in the EMF group. In addition, statistical comparisons of the mean body weights and brain weights of the study groups revealed no significant differences. There was no statistically significant difference between the PEX and EMF groups in terms of temperature ($p > 0.05$) or humidity ($p > 0.05$) in the cages. In conclusion, higher numbers of both pyramidal and granule neurons were found in the male rat hippocampus after continuous 900-MHz EMF treatment.

https://www.ncbi.nlm.nih.gov/pubmed/31464580

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Trafficking of synaptic vesicles is changed at the hypothalamus by exposure to an 835 MHz radiofrequency electromagnetic field

Kim JH, Huh YH, Kim HR. Trafficking of synaptic vesicles is changed at the hypothalamus by exposure to an 835 MHz radiofrequency electromagnetic field. Gen Physiol Biophys. 2019 Aug 14. doi: 10.4149/gpb_2019020.

Abstract

With the rapidly increasing use of mobile phones and their close-contact usage to the brain, there are some concerns about the possible neuronal effects induced by exposure to excessive electromagnetic radiation. Exposure to a radiofrequency electromagnetic field (RF-EMF) of 835 MHz (4.0 W/kg specific absorption rate (SAR) 5 h/day for 12 weeks) may affect hypothalamic presynaptic neurons in C57BL/6 mice. The number and size of the synaptic vesicles (SVs) in the hypothalamic presynaptic terminals were significantly decreased after RF-EMF exposure. Further, the density (SVs numbers/μm) of docking and fusing SVs in the active zones of the presynaptic terminal membrane was significantly decreased in hypothalamic neurons. The expression levels of synapsin I/II and synaptotagmin 1, two regulators of SV trafficking in neurons, were also significantly decreased in the hypothalamus. In parallel, the expression of calcium channel was significantly decreased. These changes in SVs in the active zones may directly decrease the release of neurotransmitters in hypothalamic presynaptic terminals. Therefore, we further studied the possible changes in hypothalamic function by testing the core body temperature and body weight and performed the buried pellet test. The trafficking of SVs was changed by RF-EMF; however, we could not find any significant phenotypical changes in our experimental condition.

https://www.ncbi.nlm.nih.gov/pubmed/31411574

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Extremely low frequency electromagnetic fields and cancer: How source of funding affects results

Carpenter DO. Extremely low frequency electromagnetic fields and cancer: How source of funding affects results. Environ Res. 2019 Aug 24;178:108688. doi: 10.1016/j.envres.2019.108688.

Abstract

While there has been evidence indicating that excessive exposure to magnetic fields from 50 to 60 Hz electricity increases risk of cancer, many argue that the evidence is inconsistent and inconclusive. This is particularly the case regarding magnetic field exposure and childhood leukemia. A major goal of this study is to examine how source of funding influences the reported results and conclusions. Several meta-analyses dating from about 2000 all report significant associations between exposure and risk of leukemia. By examining subsequent reports on childhood leukemia it is clear that almost all government or independent studies find either a statistically significant association between magnetic field exposure and childhood leukemia, or an elevated risk of at least OR = 1.5, while almost all industry supported studies fail to find any significant or even suggestive association. A secondary goal of this report is to examine the level of evidence for exposure and

elevated risk of various adult cancers. Based on pooled or meta-analyses as well as subsequent peer-reviewed studies there is strong evidence that excessive exposure to magnetic fields increases risk of adult leukemia, male and female breast cancer and brain cancer. There is less convincing but suggestive evidence for elevations in several other cancer types. There is less clear evidence for bias based on source of funding in the adult cancer studies. There is also some evidence that both paternal and maternal prenatal exposure to magnetic fields results in an increased risk of leukemia and brain cancer in offspring. When one allows for bias reflected in source of funding, the evidence that magnetic fields increase risk of cancer is neither inconsistent nor inconclusive. Furthermore adults are also at risk, not just children, and there is strong evidence for cancers in addition to leukemia, particularly brain and breast cancer.

https://www.ncbi.nlm.nih.gov/pubmed/31476684

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Exposure to static and extremely-low frequency electromagnetic fields and cellular free radicals

Lai H. Exposure to static and extremely-low frequency electromagnetic fields and cellular free radicals. Electromagnetic Biology Medicine. Aug 26, 2019. https://doi.org/10.1080/15368378.2019.1656645.

Abstract

This paper summarizes studies on changes in cellular free radical activities from exposure to static and extremely-low frequency (ELF) electromagnetic fields (EMF), particularly magnetic fields. Changes in free radical activities, including levels of cellular reactive oxygen (ROS)/nitrogen (RNS) species and endogenous antioxidant enzymes and compounds that maintain physiological free radical concentrations in cells, is one of the most consistent effects of EMF exposure. These changes have been reported to affect many physiological functions such as DNA damage; immune response; inflammatory response; cell proliferation and differentiation; wound healing; neural electrical activities; and behavior. An important consideration is the effects of EMF-induced changes in free radicals on cell proliferation and differentiation. These cellular processes could affect cancer development and proper growth and development in organisms. On the other hand, they could cause selective killing of cancer cells, for instance, via the generation of the highly cytotoxic hydroxyl free radical by the Fenton Reaction. This provides a possibility of using these electromagnetic fields as a non-invasive and low side-effect cancer therapy. Static- and ELF-EMF probably play important roles in the evolution of living organisms. They are cues used in many critical survival functions, such as foraging, migration, and reproduction. Living organisms can detect and respond immediately to low environmental levels of these fields. Free radical processes are involved in some of these mechanisms. At this time, there is no credible hypothesis or mechanism that can adequately explain all the observed effects of static- and ELF-EMF on free radical processes. We are actually at the impasse that there are more questions than answers.

Concluding remarks

1. Change in cellular free radical activity is one of the most consistent effects of static- and ELF-EMF on living organisms.
2. The mechanisms by which static- and ELF-EMF affect cellular free radical processes is not well understood. The “radical pair” hypothesis is a likely candidate, particularly the involvement of cryptochromes. It allows immediate detection and response to changes in static- and ELF-EMF in the environment, which likely play important roles in the evolution of living organisms.
3. Oxidative responses to static- and ELF-EMF are probably dependent on the characteristic of the field and exposure (such as frequency, modulation, and duration) and the exposed object (such as cell type, and states of biological activities),

4. However, chronic exposure that leads to the excessive and persistent presence of free radicals can cause oxidative stress and should be avoided.
5. Effects of static- and ELF-EMF on free radicals probably have beneficial health effects particularly relating to cell proliferation, differentiation, cell death, and cell cycle. These are effects that could influence cancer development and treatment, growth and development, regeneration, and healing.
6. In future research, it is imperative to identify the field parameters that can selectively cause beneficial or detrimental health effects.

https://www.tandfonline.com/doi/full/10.1080/15368378.2019.1656645

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Parental occupational exposure to low-frequency magnetic fields and risk of leukemia in offspring: Findings from Childhood Leukemia International Consortium

Talibov M, Olsson A, Bailey H, Erdmann F, Metayer C, Magnani C, Petridou E, Auvinen A, Spector L, Clavel J, Roman E, Dockerty J, Nikkilä A, Lohi O, Kang A, Psaltopoulou T, Miligi L, Vila J, Cardis E, Schüz J. Parental occupational exposure to low-frequency magnetic fields and risk of leukaemia in the offspring: findings from the Childhood Leukaemia International Consortium (CLIC). Occup Environ Med. 2019 Jul 29. pii: oemed-2019-105706. doi: 10.1136/oemed-2019-105706.

Abstract

OBJECTIVES: Previously published studies on parental occupational exposure to extremely low-frequency magnetic fields (ELF-MF) and risk of acute lymphoblastic leukaemia (ALL) and acute myeloid leukaemia (AML) in their offspring were inconsistent. We therefore evaluated this question within the Childhood Leukemia International Consortium.

METHODS: We pooled 11 case-control studies including 9723 childhood leukaemia cases and 17 099 controls. Parental occupational ELF-MF exposure was estimated by linking jobs to an ELF-MF job-exposure matrix (JEM). Logistic regression models were used to estimate ORs and 95% CIs in pooled analyses and meta-analyses.

RESULTS: ORs from pooled analyses for paternal ELF-MF exposure >0.2 microtesla (μT) at conception were 1.04 (95% CI 0.95 to 1.13) for ALL and 1.06 (95% CI 0.87 to 1.29) for AML, compared with ≤0.2 μT. Corresponding ORs for maternal ELF-MF exposure during pregnancy were 1.00 (95% CI 0.89 to 1.12) for ALL and 0.85 (95% CI 0.61 to 1.16) for AML. No trends of increasing ORs with increasing exposure level were evident. Furthermore, no associations were observed in the meta-analyses.

CONCLUSIONS: In this large international dataset applying a comprehensive quantitative JEM, we did not find any associations between parental occupational ELF-MF exposure and childhood leukaemia.

"The major limitation of this study was potential exposure misclassification, which can arise in any study with retrospec - tive exposure assessment. Exposure misclassification could occur because the ELF-MF JEM, like most JEMs, assigns the mean exposure level to all persons in the same occupation, while expo - sure heterogeneity within the occupation may be substantial. It does not specify jobs by industrial groups, and exposure intensity might vary in the same occupation by industrial group.... Exposure misclassification was likely to be non-differential in our study because the JEM was applied in the same way to all parents and independently of case–control status of the child. Bias from non-differential exposure misclassification is

generally towards the null for dichotomous exposures.30 For polytomous exposures, non-differential misclassification can bias ORs away from the null only for intermediate exposure categories, but ORs for the highest category will be towards the null.31 Therefore, ORs for dichotomous ELF-MF exposures and for high categories of polytomous exposures would be underestimated if non-differential exposure misclassification was present in this study. Selection bias may also be a concern in this study ...."

Open access paper: https://oem.bmj.com/content/early/2019/07/29/oemed-2019-105706.long

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Effects of exposure to extremely low frequency electromagnetic fields on hippocampal long-term potentiation in hippocampal CA1 region

Zheng Y, Cheng J, Dong L, Ma X, Kong Q. Effects of exposure to extremely low frequency electromagnetic fields on hippocampal long-term potentiation in hippocampal CA1 region. Biochem Biophys Res Commun. 2019 Jul 31. pii: S0006-291X(19)31439-1. doi: 10.1016/j.bbrc.2019.07.085.

Abstract

Exposure to environmental electromagnetic fields, especially to the extremely low-frequency (ELF < 300 Hz) electromagnetic fields (EMFs) might produce modulation effects on neuronal activity. Long-term changes in synaptic plasticity such as long-term potentiation (LTP) involved in learning and memory may have contributions to a number of neurological diseases. However, the modulation effects of ELF-EMFs on LTP are not yet fully understood. In our present study, we aimed to evaluate the effects of exposure to ELF-EMFs on LTP in hippocampal CA1 region in rats. Hippocampal slices were exposed to magnetic fields generated by sXcELF system with different frequencies (15, 50, and 100 Hz [Hz]), intensities (0.5, 1, and 2 mT [mT]), and duration (10 s [s], 20 s, 40 s, 60 s, and 5 min), then the baseline signal recordings for 20 min and the evoked field excitatory postsynaptic potentials (fEPSPs) were recorded. We found that the LTP amplitudes decreased after magnetic field exposure, and the LTP amplitudes decreased in proportion to exposure doses and durations, suggesting ELF-EMFs may have dose and duration-dependent inhibition effects. Among multiple exposure duration and doses combinations, upon 5 min magnetic field exposure, 15 Hz/2 mT maximally inhibited LTP. Under 15 Hz/2 mT ELF-EMFs, LTP amplitude decreases in proportion to the length of exposure durations within 5 min time frame. Our findings illustrated the potential effects of ELF-EMFs on synaptic plasticity and will lead to better understanding of the influence on learning and memory.

https://www.ncbi.nlm.nih.gov/pubmed/31376941

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Extremely low frequency magnetic field induces human neuronal differentiation through NMDA receptor activation

Özgün A, Marote A, Behie LA, Salgado A, Garipcan B. Extremely low frequency magnetic field induces human neuronal differentiation through NMDA receptor activation. J Neural Transm (Vienna). 2019 Jul 17. doi: 10.1007/s00702-019-02045-5.

Abstract

Magnetic fields with different frequency and intensity parameters exhibit a wide range of effects on different

biological models. Extremely low frequency magnetic field (ELF MF) exposure is known to augment or even initiate neuronal differentiation in several in vitro and in vivo models. This effect holds potential for clinical translation into treatment of neurodegenerative conditions such as autism, Parkinson's disease and dementia by promoting neurogenesis, non-invasively. However, the lack of information on underlying mechanisms hinders further investigation into this phenomenon. Here, we examine involvement of glutamatergic Ca2+ channel, N-methyl-D-aspartate (NMDA) receptors in the process of human neuronal differentiation under ELF MF exposure. We show that human neural progenitor cells (hNPCs) differentiate more efficiently under ELF MF exposure in vitro, as demonstrated by the abundance of neuronal markers. Furthermore, they exhibit higher intracellular Ca2+ levels as evidenced by c-fos expression and more elongated mature neurites. We were able to neutralize these effects by blocking NMDA receptors with memantine. As a result, we hypothesize that the effects of ELF MF exposure on neuronal differentiation originate from the effects on NMDA receptors, which sequentially triggers Ca2+-dependent cascades that lead to differentiation. Our findings identify NMDA receptors as a new key player in this field that will aid further research in the pursuit of effect mechanisms of ELF MFs.

https://www.ncbi.nlm.nih.gov/pubmed/31317262

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Exposure to 50 Hz magnetic field at 100 μT exert no DNA damage in cardiomyocytes.

Wang Y, Liu X, Zhang Y, Wan B, Zhang J, He W, Hu D, Yang Y, Lai J, He M, Chen C. Exposure to 50 Hz magnetic field at 100 μT exert no DNA damage in cardiomyocytes. Biol Open. 2019 Jul 30. pii: bio.041293. doi: 10.1242/bio.041293.

Abstract

The effects of exposure to magnetic fields (MFs) at city electric frequencies (50-60 Hz) on carcinogenicity are still in debate. Besides, whether exposure to MFs affects the heart is also a debated issue. This study aimed to determine whether exposure to extremely low frequency magnetic fields (ELF-MFs) induced DNA damage in cardiomyocytes both in vitro and in vivo. Human ventricular cardiomyocytes were exposed to 50 Hz ELF-MF at 100 μT for 1 hr continuously or 75 min intermittently. The effects of the treatments were evaluated by DNA damage, redox status changes, and relative signal molecular expression. Moreover, ten male Sprague-Dawley rats were exposed to a 50 Hz MF at 100 μT for 7 days, while another 10 rats were sham exposed. The protein levels of p53 and Hsp70 in heart tissue were analyzed by western blot. The results showed that exposure to ELF-MF did not induce DNA damage, cell cycle distribution change, or increased ROS level. No significant differences were detected in p53 and Hsp70 expression level between the ELF-MF and sham-exposure groups both in vitro and in vivo. All these data indicated that MFs at power-frequency may not cause DNA damage in cardiomyocyte.

Open access paper: https://bio.biologists.org/content/early/2019/07/22/bio.041293.long

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Comparison of polymerization and structural behavior of microtubules in rat brain and sperm affected by the extremely low-frequency electromagnetic field.

Gholami D, Riazi G, Fathi R, Sharafi M, Shahverdi A. Comparison of polymerization and structural behavior of microtubules in rat brain and sperm affected by the extremely low-frequency electromagnetic field. BMC Mol

Cell Biol. 2019 Aug 29;20(1):41. doi: 10.1186/s12860-019-0224-1.

Abstract

BACKGROUND: Microtubule proteins are able to produce electromagnetic fields and have an important role in memory formation, and learning. Therefore, microtubules have the potential to be affected by exogenous electromagnetic fields. This study aimed to examine the comparison of microtubule polymerization and its structural behavior in brain and sperm affected by 50 Hz extremely low-frequency electromagnetic field (ELEF).

RESULTS: Twenties adult male rats were randomly and equally divided into control and experimental groups, to evaluate the effect of 50 Hz ELEF on the sperm and brain functions. Plus-maze, serum testosterone and corticosterone, and sperm evaluation were performed. Next, the semen and brain samples were obtained, and they were divided into four experimental groups for investigation of microtubule polymerization. There was no significant difference in testosterone and, corticosterone levels, anxiety behaviors, and sperm morphology between control and ELEF-exposure groups. The sperm viability, total and progressive motility were significantly higher in the ELEF-exposed group than that of the control group. The microtubule polymerization in sperm ELEF was significantly higher than in other groups. The secondary and tertiary structures of tubulins were significantly affected in the brain, and sperm ELEF groups.

CONCLUSION: It seems that the polymerization of microtubules and conformational changes of tubulin dimers are improved by ELEF application.

https://www.ncbi.nlm.nih.gov/pubmed/31464580

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Characterization of levels of extremely low frequency magnetic fields emitted from portable hand-held fans

Choi S, Kim S, Bae S, Kim W, Park JH, Chung E, Park J, Park DU. Characterization of Levels of Extremely Low Frequency Magnetic Fields Emitted From Portable Hand-Held Fans. Bioelectromagnetics. 2019 Aug 2. doi: 10.1002/bem.22210.

Abstract

This study aims to assess the levels of extremely low frequency magnetic fields (ELF-MF) emitted from portable hand-held fans (HHFs) and their principal frequency and to identify factors influencing these levels. We collected a total of eleven models of HHF and monitored the ELF-MF as a function of fan speed and distance from the fan. EMDEX II was used to monitor the ELF-MF. An SMP2 EMF-meter equipped with a P400 field probe was used to determine the levels of ELF-MF and the frequency spectrum. Ten of the fans, excluding only one bladeless-fan model, emitted a high level of ELF-MF near the source of the HHF direct-current motor. The maximum measured level of ELF-MF ranged from 14.07 to 218.7 μT. All measurements of the ELF-MF taken within 10 cm from the HHFs showed values higher than 1.0 μT. ELF-MF levels were found to decrease markedly with distance, regardless of the HHF product. The level of ELF-MF rose noticeably with increased fan speed. The speed of and distance from the HHF significantly influenced the level of ELF-MF. All principal frequencies ranged from 1 to 300 Hz, which falls in the typical range of ELF. © 2019 Bioelectromagnetics Society.

https://www.ncbi.nlm.nih.gov/pubmed/31373404

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Computational simulations of the penetration of 0.30 THz radiation into the human ear

Vilagosh Z, Lajevardipour A, Wood A. Computational simulations of the penetration of 0.30 THz radiation into the human ear. Biomed Opt Express. 2019 Feb 28;10(3):1462-1468. doi: 10.1364/BOE.10.001462.

Abstract

There is an increasing interest in industrial and security applications and the establishment of wireless communication operating at frequencies of up to 0.30 THz. Soft tissue has a high coefficient of absorption at 0.30 THz and this limits effective penetration of the energy to a depth of 0.2 to 0.4 mm. The capacity of 0.30 THz radiation to access the deeper parts of the ear by diffusing through the ear canal and exposing the tympanic membrane (ear drum) to the radiation has not been studied. Simulations show that, with excitation parallel to the ear canal, the average power flux density within the central tympanic membrane region is 97% of the incident excitation. The structures of the outer ear are highly protective; less than 0.4% of the power flux density is directed at 45° from the parallel reached the same region. Given the sensitivity of the tympanic membrane to mechanical change, in-vivo assessment of the penetration of 0.3 THz into the ear canal is warranted to assess the suitability of the present radiation safety limits and to inform 0.3 THz emitting device deign.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6420278/

Note: 0.3THz is 300 GHz.

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Effect of low frequency electromagnetic field on the behavior and bioenergetics of the ragworm

Jakubowska M, Urban-Malinga B, Otremba Z, Andrulewicz E. Effect of low frequency electromagnetic field on the behavior and bioenergetics of the polychaete Hediste diversicolor. Marine Environ Res. 2019 Aug 3;150:104766. doi: 10.1016/j.marenvres.2019.104766.

Abstract

The aim of the present study was to determine the effect of an electromagnetic field (EMF) of value typically recorded in the vicinity of submarine cables (50 Hz, 1 mT) on the behavior and bioenergetics of the polychaete Hediste diversicolor. No avoidance or attraction behavior to EMF was shown, but the burrowing activity of H. diversicolor was enhanced in EMF treatment, indicating a stimulating effect on bioturbation potential. The polychaete maintained a positive energy balance and high amount (85% of assimilated energy) of energy available for individual production (scope for growth) after exposure to EMF. Food consumption and respiration rates were not affected but ammonia excretion rate was significantly reduced in EMF-exposed animals compared to the control conditions (geomagnetic field). The mechanisms behind this effect remain, however, unclear. This is the first study demonstrating the effects of environmentally realistic EMF value on the behavior and physiology of marine invertebrates, thus there is a need for more research.

https://www.ncbi.nlm.nih.gov/pubmed/31404727

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Headache, tinnitus and hearing loss in the international Cohort Study of Mobile Phone Use and Health (COSMOS) in Sweden and Finland

Auvinen A, Feychting M, Ahlbom A, Hillert L, Elliott P, Schüz J, Kromhout H, Toledano MB, Johansen C, Poulsen AH, Vermeulen R, Heinävaara S, Kojo K, Tettamanti G, COSMOS Study Group. Headache, tinnitus and hearing loss in the international Cohort Study of Mobile Phone Use and Health (COSMOS) in Sweden and Finland. Int J Epidemiol. 2019 Jul 13. pii: dyz127. doi: 10.1093/ije/dyz127.

Abstract

BACKGROUND: Mobile phone use and exposure to radiofrequency electromagnetic fields (RF-EMF) from it have been associated with symptoms in some studies, but the studies have shortcomings and their findings are inconsistent. We conducted a prospective cohort study to assess the association between amount of mobile phone use at baseline and frequency of headache, tinnitus or hearing loss at 4-year follow-up.

METHODS: The participants had mobile phone subscriptions with major mobile phone network operators in Sweden (n = 21 049) and Finland (n = 3120), gave consent for obtaining their mobile phone call data from operator records at baseline, and filled in both baseline and follow-up questionnaires on symptoms, potential confounders and further characteristics of their mobile phone use.

RESULTS: The participants with the highest decile of recorded call-time (average call-time >276 min per week) at baseline showed a weak, suggestive increased frequency of weekly headaches at 4-year follow-up (adjusted odds ratio 1.13, 95% confidence interval 0.95-1.34). There was no obvious gradient of weekly headache with increasing call-time (P trend 0.06). The association of headache with call-time was stronger for the Universal Mobile Telecommunications System (UMTS) network than older Global System for Mobile Telecommunications (GSM) technology, despite the latter involving higher exposure to RF-EMF. Tinnitus and hearing loss showed no association with call-time.

CONCLUSIONS: People using mobile phones most extensively for making or receiving calls at baseline reported weekly headaches slightly more frequently at follow-up than other users, but this finding largely disappeared after adjustment for confounders and was not related to call-time in GSM with higher RF-EMF exposure. Tinnitus and hearing loss were not associated with amount of call-time.

https://www.ncbi.nlm.nih.gov/pubmed/31302690

In conclusion, we found a small increase in weekly headache at 4-year follow-up among those in the highest decile of amount of call-time but free of weekly headache at baseline, but it largely disappeared after adjustment for confounders. There was no clear gradient in occurrence of weekly headache with amount of call-time. Any association between call-time and weekly headaches was limited to call-time in the third-generation UMTS network and was not found for the older GSM system characterized by higher RF-EMF exposure levels. This suggests that other factors related to the amount of mobile phone use (e.g. lifestyle, when and how the phone is used) may explain the weak association, rather than an effect of RF-EMF. We observed no association in our prospective study with occurrence of tinnitus or hearing loss.

My note: An alternative explanation is that UMTS is more biologically active than GSM even though the power density is lower. Also, it's no surprise that the association between the exposure and the health outcome

largely disappears after adjustment for confounders because some of the confounders were on the causal pathway.

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A survey on electromagnetic risk assessment and evaluation mechanism for future wireless communication systems

Jamshed MA, Heliot F, Brown T. A survey on electromagnetic risk assessment and evaluation mechanism for future wireless communication systems. IEEE Journal of Electromagnetics, RF and Microwaves in Medicine and Biology. May 20, 2019. DOI: 10.1109/JERM.2019.2917766

Abstract

The accurate measurement of electromagnetic exposure and its application is expected to become more and more important in future wireless communication systems, given the explosion in both the number of wireless devices and equipments radiating electromagnetic-fields(EMF)and the growing concerns in the general public linked to it. Indeed, the next generation of wireless systems aims at providing a higher data rate,better quality of service(QoS), and lower latency to users by increasing the number of access points,i.e.densification, which in turn will increase EMF exposure. Similarly, the multiplication of future connected devices,e.g. internet of things(IoT)devices, will also contribute to an increase in EMF exposure. This paper provides a detailed survey relating to the potential health hazards linked with EMF exposure and the different metrics that are currently used for evaluating,limiting and mitigating the effects of this type of exposure on the general public. This paper also reviews the possible impacts of new wireless technologies on EMF exposure and proposes some novel research directions for updating the EMF exposure evaluation framework and addressing these impacts in future wireless communication systems. For instance, the impact of mmWave or massive-MIMO/beamforming on EMF exposure has yet to be fully understood and included in the exposure evaluation framework.

Conclusions

A thorough survey on exposure risk assessment, evaluation, limitation and mitigation for current and future wireless devices and equipments has been provided in this paper. From the human health point of view, it seems that the possibility of brain tumor is still the main cause of concerns related to the extensive use of wireless devices, even though the effects of EMF exposure is now being investigated in new parts of the body (e.g. eyes). Meanwhile, with the advent of 5G, more efforts are now been made to understand the thermal and non-thermal effects of mmWave exposure on the human body. When it comes to the evaluation of EMF exposure, we have presented the most common evaluation frameworks and metrics that are utilized in wireless communications to measure the exposure. We have also explained how new more generic metrics have been defined by combining existing metrics to better reflect the exposure of large geographical areas and have argued that a generic metric for measuring the individual exposure would also be of interest. We have also reviewed the existing exposure guidelines and have explained how they can be updated for better reflecting the true nature of EMF exposure, i.e. by better taking into account the duration of exposure. Finally, we have provided some views on how key 5G enabling technologies such as densification, massive MIMO and mmWave will impact the EMF exposure in the near future; for instance, the dense deployment of small cells and IoT devices is very likely to increase the overall ambient exposure. We also believe that there could be some technical opportunities in 5G to increase the exposure awareness of wireless system users and to let them decide if they want to reduce it at the cost of, for instance, a lower QoS.

https://ieeexplore.ieee.org/document/8718293

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Statistical approach for human electromagnetic exposure assessment in future wireless ATTO-cell networks

Shikhantsov S, Thielens A, Vermeeren G, Demeester P, Martens L, Torfs G, Joseph W. Statistical approach for human electromagnetic exposure assessment in future wireless ATTO-cell networks. Radiat Prot Dosimetry. 2019 May 1;183(3):326-331. doi: 10.1093/rpd/ncy120.

Abstract

In this article, we study human electromagnetic exposure to the radiation of an ultra dense network of nodes integrated in a floor denoted as ATTO-cell floor, or ATTO-floor. ATTO-cells are a prospective 5G wireless networking technology, in which humans are exposed by several interfering sources. To numerically estimate this exposure we propose a statistical approach based on a set of finite difference time domain simulations. It accounts for variations of antenna phases and makes use of a large number of exposure evaluations, based on a relatively low number of required simulations. The exposure was expressed in peak-spatial 10-g SAR average (psSAR10g). The results show an average exposure level of ~4.9 mW/kg and reaching 7.6 mW/kg in 5% of cases. The maximum psSAR10g value found in the studied numerical setup equals around 21.2 mW/kg. Influence of the simulated ATTO-floor size on the resulting exposure was examined. All obtained exposure levels are far below 4 W/kg ICNIRP basic restriction for general public in limbs (and 20 W/kg basic restriction for occupational exposure), which makes ATTO-floor a potential low-exposure 5 G candidate.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6543880/

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Monitoring electromagnetic radiation emissions in buildings and developing strategies for improved indoor environmental quality.

Weldu YW, Mannan M, Al-Ghamdi SG. Monitoring electromagnetic radiation emissions in buildings and developing strategies for improved indoor environmental quality.

Health Phys. 2019 Jul 5. doi: 10.1097/HP.0000000000001112.

Abstract

Electronic devices have become ubiquitous in daily life, but they emit electromagnetic radiation, which may have negative health impacts at excessive levels. Little is known regarding the impact of radiation emissions on building occupants or strategies for reducing its intensity. This study applied a novel approach using system analysis to quantify radiation exposure in building spaces, examine building material responses to radiation propagation, and investigate risks to human health in the country of Qatar. Radiation intensity levels varied based on the location and type of building space. Different types of construction materials showed varied responses to electromagnetic field wave propagation. Drywall exhibited the best blocking effect, whereas glass and lumber walls exhibited poor blocking effects. The field strengths quantified in this study are less than the corresponding reference values specified by some jurisdictions, but they are still significantly higher than the safety levels defined in many other countries, which could result in significant health risks. The key strategies

for improving indoor environmental quality include the use of shielding materials, spatial design, reduction of exposure time, increased exposure distance, and complete avoidance of exposure in sensitive areas.

https://www.ncbi.nlm.nih.gov/pubmed/31283546

Conclusions

Emission intensity levels varied significantly based on locations and types of building spaces. Office building spaces exhibited relatively low electromagnetic emission intensity, and hospital building spaces exhibited relatively high power density values. The high electromagnetic emission intensities measured in surveyed green residential buildings highlight the importance of novel strategies for reducing radiation propagation. EMF intensity is greater at locations near radiation sources. Different types of building construction respond variably to EMF wave propagation. Certain materials, such as drywall, ceramic-faced lumber, tile-faced drywall, and plain or masonry-faced concrete, effectively shield EMF propagation, whereas glass and plain lumber have poor shielding effects. Drywall exhibited the best shielding effect among all compared building materials. Additionally, the magnitudes of the transmission coefficients for magnetic fields were higher than the corresponding power densities for all building wall materials. Infants, children, senior citizens, and patients all have relatively weak immune systems that are susceptible to radiation exposure. Therefore, it is important to design sensitive spaces using drywall and ceramic- or masonry-faced concrete walls.

... The exposure intensities measured in this study exceeded the safety limits defined by Switzerland, raising Table 4. significant concerns regarding adverse health effects.

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Mobile phone antenna-matching study with different finger positions on an inhomogeneous human model

Jeladze V, Nozadze T, Petoev-Darsavelidze I, Partsvania B. Mobile phone antenna-matching study with different finger positions on an inhomogeneous human model. Electromagn Biol Med. 2019 Jul 13:1-10. doi: 10.1080/15368378.2019.1641722.

Abstract

The human head and hand being in the near-field zone of a mobile phone antenna can drastically influence the antenna matching with free space. The goal of the presented research is to study this phenomenon on an inhomogeneous human model for different relative positions and distances of hand and fingers when using a mobile phone. The only safety criteria commonly used to estimate RF exposure impact on humans is the specific absorption rate (SAR). Its limits are determined by the Federal Communication Commission (FCC) in the USA and the International Commission on Non-Ionizing Radiation Protection (ICNIRP) in Europe. The maximal values of SAR for a mobile handset are determined for each model by the manufacturer. In this paper, it is shown that the peak values provided by the manufacturers and their understanding may need refinement. It is almost impossible to consider all parameters, such as the dependence of SAR on antenna communication matching, with a variety of shapes and forms and other details during physical measurements or numerical estimation. The premise for such assumptions is based on the analysis of S11 dependency on the exposure scenario and the fact that the Automatic Gain Control (AGC) increases power when the signal strength at the base station drops.

https://www.ncbi.nlm.nih.gov/pubmed/31303069

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Electrohypersensitivity (EHS) is an Environmentally-Induced Disability that Requires Immediate Attention

Havas M. Electrohypersensitivity (EHS) is an Environmentally-Induced Disability that Requires Immediate Attention. Review Article. J Sci Discov. 3(1):jsd18020; DOI:10.24262/jsd.3.1.18020. 2019.

Abstract

A growing number of countries are beginning to acknowledge that electrohypersensitivity (EHS) exists and a few countries have classified it as a disability or a functional impairment attributable to the environment. Epidemiological studies and in vivo experiments show that exposure to non-ionizing radiation (NIR) from extremely low to microwave frequency electromagnetic fields (EMF) at exposure intensities far below the maximum limits in international guidelines increases anxiety, depression, and physiological stress and impairs cognitive functions that include concentration, memory and learning. Furthermore, exposure to NIR contributes to neurodegenerative diseases including dementia, Alzheimer's disease, amyotrophic lateral sclerosis, multiple sclerosis, Parkinson's disease, attention deficit hyperactivity disorder and autism spectrum disorder. Exposure of the fetus to NIR (mobile phone) affects the neonatal heart and can lead to emotional and behavioral problems in human offspring. Similar exposures in laboratory studies report impaired cognitive performance, neuronal losses and pathological changes in the brain of rat offspring. The scientific and medical communities have repeatedly sent out urgent warnings, in the form of appeals, declarations and testimonies, that exposure to NIR needs to be reduced from a public health perspective. These warnings have been largely ignored. With continued development of wireless technology and the imminent roll out of new and densified technologies (e.g., 5G technology, satellite constellations, repeaters, wearables, Internet of Things), society will pay an enormous price for disregarding these warnings. It is long overdue for those responsible for public health, the health of children and health policy to take these warnings seriously and to provide a refuge for those afflicted by EHS. EHS is real, it is exacerbated by exposure to NIR, it is increasing among the population and when severe it becomes a disability. Action is long overdue to minimize exposure to NIR and to provide a safe environment that all can enjoy.

Open access paper: http://www.e-discoverypublication.com/wp-content/uploads/2019/03/JSD18020-final.pdf

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Ecological momentary assessment study of exposure to RF EMF and non-specific physical symptoms with self-declared electrosensitives

Bolte JFB, Clahsen S, Vercruijsse W, Houtveen JH, Schipper CMA, van Kamp I, Bogers R. Ecological momentary assessment study of exposure to radiofrequency electromagnetic fields and non-specific physical symptoms with self-declared electrosensitives. Environ Int. 2019 Jul 6;131:104948. doi: 10.1016/j.envint.2019.104948.

Highlights
• No correlation of electromagnetic fields (EMF) and health effects at group level
• Significant within person correlation EMF and non specific physical symptoms
• Time above a level of exposure and rate of change show correlations; TWA doesn't.

Abstract

The main objective of the study is to determine if non-specific physical symptoms (NSPS) in people with self-declared sensitivity to radiofrequency electromagnetic fields (RF EMF) can be explained (across subjects) by

exposure to RF EMF. Furthermore, we pioneered whether analysis at the individual level or at the group level may lead to different conclusions. By our knowledge, this is the first longitudinal study exploring the data at the individual level. A group of 57 participants was equipped with a measurement set for five consecutive days. The measurement set consisted of a body worn exposimeter measuring the radiofrequency electromagnetic field in twelve frequency bands used for communication, a GPS logger, and an electronic diary giving cues at random intervals within a two to three hour interval. At every cue, a questionnaire on the most important health complaint and nine NSPS had to be filled out. We analysed the (time-lagged) associations between RF-EMF exposure in the included frequency bands and the total number of NSPS and self-rated severity of the most important health complaint. The manifestation of NSPS was studied during two different time lags - 0-1 h, and 1-4 h - after exposure and for different exposure metrics of RF EMF. The exposure was characterised by exposure metrics describing the central tendency and the intermittency of the signal, i.e. the time-weighted average exposure, the time above an exposure level or the rate of change metric. At group level, there was no statistically significant and relevant (fixed effect) association between the measured personal exposure to RF EMF and NSPS. At individual level, after correction for multiple testing and confounding, we found significant within-person associations between WiFi (the self-declared most important source) exposure metrics and the total NSPS score and severity of the most important complaint in one participant. However, it cannot be ruled out that this association is explained by residual confounding due to imperfect control for location or activities. Therefore, the outcomes have to be regarded very prudently. The significant associations were found for the short and the long time lag, but not always concurrently, so both provide complementary information. We also conclude that analyses at the individual level can lead to different findings when compared to an analysis at group level.

https://www.ncbi.nlm.nih.gov/pubmed/31288182

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Transcranial Electrical and Magnetic Stimulation for Addiction Medicine: Consensus paper on state of the science

Ekhtiari H, Tavakoli H, Addolorato G, Baeken C, Bonci A, et al. Transcranial Electrical and Magnetic Stimulation (tES and TMS) for Addiction Medicine: A consensus paper on the present state of the science and the road ahead. Neurosci Biobehav Rev. 2019 Jul 1. pii: S0149-7634(19)30307-0. doi: 10.1016/j.neubiorev.2019.06.007.

Abstract

There is growing interest in non-invasive brain stimulation (NIBS) as a novel treatment option for substance-use disorders (SUDs). Recent momentum stems from a foundation of preclinical neuroscience demonstrating links between neural circuits and drug consuming behavior, as well as recent FDA-approval of NIBS treatments for mental health disorders that share overlapping pathology with SUDs. As with any emerging field, enthusiasm must be tempered by reason; lessons learned from the past should be prudently applied to future therapies. Here, an international ensemble of experts provides an overview of the state of transcranial-electrical (tES) and transcranial-magnetic (TMS) stimulation applied in SUDs. This consensus paper provides a systematic literature review on published data - emphasizing the heterogeneity of methods and outcome measures while suggesting strategies to help bridge knowledge gaps. The goal of this effort is to provide the community with guidelines for best practices in tES/TMS SUD research. We hope this will accelerate the speed at which the community translates basic neuroscience into advanced neuromodulation tools for clinical practice in addiction medicine.

https://www.ncbi.nlm.nih.gov/pubmed/31271802

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Impact of exposure of diabetic rats to 900 MHz electromagnetic radiation emitted from mobile phone antenna on hepatic oxidative stress

Ismaiil LA, Joumaa WH, Moustafa ME. The impact of exposure of diabetic rats to 900 MHz electromagnetic radiation emitted from mobile phone antenna on hepatic oxidative stress. Electromagn Biol Med. 2019 Jul 13:1-10. doi: 10.1080/15368378.2019.1641722.

Abstract

The excessive exposure of patients with type 2 diabetes mellitus (T2DM) to electromagnetic radiation (EMR) from mobile phones or their base stations antenna may influence oxidative stress and development of diabetic complications. Here, we investigated the effects of exposing type 2 diabetic rats to EMR of 900 MHz emitted from GSM mobile phone antenna for 24 hours/day over a period of 28 days on hyperglycemia and hepatic oxidative stress. Male Sprague-Dawley rats were divided into 4 groups (12 rats/group): control rats, normal rats exposed to EMR, T2DM rats generated by nicotinamide/streptozotocin administration, and T2DM rats exposed to EMR. Our results showed that the exposure of T2DM rats to EMR nonsignificantly reduced the hyperglycemia and hyperinsulinemia compared to unexposed T2DM rats. The exposure of T2DM rats to EMR for 28 days increased the hepatic levels of MDA and Nrf-2 as well as the activities of superoxide dismutase (SOD) and catalase but decreased phosphorylated Akt-2 (pAkt-2) as compared to unexposed T2DM rats. Therefore, the decrease in the hepatic pAkt-2 in T2DM rats after the exposure to EMR may result in elevated level of hepatic MDA, even though the level of Nrf-2 and the activities of SOD and catalase were increased.

Abbreviations: BGL: blood glucose level; EMR: electromagnetic radiation; GSM: global system for mobile communication; H2O2: hydrogen peroxide; LSD: least significance difference; MDA:malondialdehyde; Nrf-2: nuclear factor erythroid 2- related factor 2; PI3K: phosphoinositide-3-kinase; pAkt-2: phosphorylated Akt-2; Akt-2: protein kinase; ROS: reactive oxygen species; SEM: standard error of the mean; STZ: streptozotocin; SOD: superoxide dismutase ; O2-: superoxide radical; CT: threshold cycle; T2DM: type 2 diabetes mellitus.

https://www.ncbi.nlm.nih.gov/pubmed/31304806

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Reaction of circulatory system to stress and electromagnetic fields emitted by mobile phones - 24-hour monitoring of ECG and blood pressure

Szyjkowska A, Gadzicka E, Szymczak W, Bortkiewicz A. [The reaction of the circulatory system to stress and electromagnetic fields emitted by mobile phones - 24-h monitoring of ECG and blood pressure]. [Article in Polish]. Med Pr. 2019 Jun 27. pii: 102360. doi: 10.13075/mp.5893.0080.

Abstract

BACKGROUND: Experimental studies have shown cardiovascular effects of electromagnetic fields (EMF) emitted by mobile phones (e.g., prolonged QTc interval and abnormal blood pressure [BP] values). Also, stress may have an impact on the cardiovascular function. However, there are practically no data regarding the joint effect of exposure to stress and EMF, with both factors pertaining, e.g., to employees of mobile network

operators.

MATERIAL AND METHODS: Out of 208 subjects who had taken part in survey research, 55 workers agreed to undergo resting ECG, 24-h ECG and ambulatory blood pressure monitoring (ABPM). Their health condition, occupational and life-stress levels and EMF exposure were also assessed.

RESULTS: Among the workers using mobile phones for more than 60 min daily, the systolic BP values in office measurement and at night-time in ABPM were significantly higher than among the workers spending less time talking on mobile phones ($p = 0.04$ and $p = 0.036$, respectively). The workers with the highest level of occupational stress showed significantly higher systolic 24-h BP ($p = 0.007$) and at day-time ($p = 0.002$), both during work ($p = 0.010$) and after work ($p = 0.005$), and higher diastolic BP values at day-time ($p = 0.028$). Cardiovascular response was strongly gender-related: males showed more BP abnormalities while females displayed more impairments in ECG records. The heart rate from 24 h was significantly correlated with the level of occupational stress, after adjusting for gender, life-stress and EMF.

CONCLUSIONS: The findings obtained thus far have indicated the need to conduct in-depth studies on the impact of stress and EMF emitted by mobile phones on the health effects, in order to clarify the observed gender-related differences in cardiovascular response to the combined exposure to stress and EMF

Open access paper: http://medpr.imp.lodz.pl/REAKCJA-UKLADU-KRAZENIA-NA-STRES-I-POLE-ELEKTROMAGNETYCZNE-EMITOWANE-PRZEZ-TELEFONY,102360,0,2.html

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Alteration of testicular regulatory and functional molecules following long-time exposure to 900 MHz RFW emitted from BTS

Azimzadeh M, Jelodar G. Alteration of testicular regulatory and functional molecules following long-time exposure to 900 MHz RFW emitted from BTS. Andrologia. 2019 Jul 26:e13372. doi: 10.1111/and.13372.

Abstract

The aim of this investigation was to evaluate changes in testosterone and some of the functional and regulatory molecules of testis such as P450scc, steroidogenic acute regulatory protein (StAR), tumour necrosis factor-α (TNF-α), interleukin-1α (IL-1α), interleukin-1β (IL-1β) and nerve growth factor (NGF) following exposure to 900 MHz radio frequency (RF). Thirty adult male Sprague Dawley rats (190 ± 20 g BW) were randomly classified in three equal groups, control (sham, without any exposure), short-time exposure (2 hr) (STE) and long-time exposure (4 hr) (LTE). The exposure was performed for 30 consecutive days. The testosterone level in both exposed groups was significantly less than control ($p < .05$). Level of TNF-α in both exposed groups was significantly greater than control ($p < .05$). IL-1α and NGF levels in LTE were significantly higher than the STE and control groups ($p < .05$). Level of IL-1β in LTE was significantly higher than control ($p < .05$). Expression of both P450scc and StAR mRNA was significantly down-regulated in both exposed groups compared to control ($p < .05$). Our results showed that RFW can affect testis and reproductive function through changes in factors, which are important during steroidogenesis, and also through changes in inflammatory factors, which regulate Leydig cell functions.

https://www.ncbi.nlm.nih.gov/pubmed/31347712

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Non-Ionizing Radiation Created by Mobile Phone Progresses Endometrial Hyperplasia: An Experimental Rat Study

Fadiloglu E, Tapisiz OL, Unsal M, Fadiloglu S, Celik B, Mollamahmutoglu L. Non-Ionizing Radiation Created by Mobile Phone Progresses Endometrial Hyperplasia: An Experimental Rat Study. Arch Med Res. 2019 Feb;50(2):36-43. doi: 10.1016/j.arcmed.2019.05.010.

Abstract

BACKGROUND: Non-ionizing radiation is related with many pathologies.

AIM: Determine association between non-ionizing radiation and endometrial hyperplasia.

METHODS: Fifty oopherectomized Wistar albino rats were administered Estradiol hemihydrate (4 mg/kg) to induce hyperplasia, and were exposed to 1800 MHz radiation created by a mobile phone and a signal generator working as base station. This study was carried out with 5 groups in two phases. The study groups were. Control group without any exposure; group receiving estrogen in first phase of the study; group receiving estrogen in both phases; group receiving estrogen in the first phase and exposed to non-ionizing radiation during second phase and group taking estrogen in both phases and exposed to non-ionizing radiation during the second phase. Following both phases, uterine horns were excised and evaluated based on glandular density (GD), epithelial cell height (ECH), and luminal epithelial cell height (LECH).

RESULTS: Estrogen increased all parameters during both phases (LECH, GD, and ECH values were 12,2 vs. 16,5 (p = 0.001), 34 vs. 47 (p <0.001), and 201 vs. 376.6 (p = 0.001), respectively during the first phase; LECH, GD and ECH values were 13,2 vs. 20,3 (p <0.001), 35.5 vs. 65,5 (p <0.001), 219.9 vs. 419.6 (p <0.001), respectively, during the second phase).Non-ionizing radiation increased all values without estrogen exposure (LECH, GD and ECH values were 13,2 vs. 17,2 (p = 0,074), 35,5 vs. 59 (p = 0.074), and 219 vs. 318.3 (p <0.001), respectively) or with estrogen exposure (LECH, GD, and ECH, values were 20,3 vs. 22,8 (p = 0,168), 65,5 vs. 77 (p = 0,058), and 419,6 vs. 541,6 (p = 0.004), respectively).

CONCLUSION: Non-ionizing radiation progressed endometrial hyperplasia in an experimental rat model with/without estrogen exposure.

https://www.ncbi.nlm.nih.gov/pubmed/31349952

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Effects of radiofrequency electromagnetic field exposure on neuronal differentiation and mitochondrial function in SH-SY5Y cells

von Niederhäusern N, Ducray A, Zielinski J, Murbach M, Mevissen M. Effects of radiofrequency electromagnetic field exposure on neuronal differentiation and mitochondrial function in SH-SY5Y cells. Toxicol In Vitro. 2019 Jul 24:104609. doi: 10.1016/j.tiv.2019.104609.

Abstract

Exposure to radiofrequency electromagnetic fields (RF-EMF) has dramatically increased in the last decades with expanding use of mobile phones worldwide. The aim of this study was to evaluate effects of RF-EMF on

neuronal differentiation and underlying signaling pathways involved in neuronal differentiation, neurodegeneration, and mitochondrial function. Differentiation of SH-SY5Y cells was performed using all-trans retinoic acid or staurosporine to obtain cholinergic and dopaminergic neurons. Exposure of SH-SY5Y cells at 935 MHz, 4 W/kg for 24 h did not alter the neuronal phenotypes quantitatively. Markers of the signaling pathways investigated, namely the mitogen-activated protein kinases (MAPK), extracellular signal-regulated kinases (Erk) 1 and 2 (p-Erk1/2) and protein kinase B (Akt), glycogen synthase kinase 3 β (GSK3β) and Wnt/β-catenin were not significantly affected by RF-EMF compared to sham. RF-EMF-impaired mitochondrial respiration in cells under glucose deprivation, but glutathione levels and mitochondrial fission and fusion markers were not altered. These findings indicate that RF-EMF might lead to an impairment of mitochondrial function that is only manifest at maximal respiration and additional stressors such as glucose deprivation. Further research is needed to investigate the effects of RF-EMF on mitochondrial function in detail because mitochondrial impairment is closely related to the pathogenesis of neurodegenerative diseases.

https://www.ncbi.nlm.nih.gov/pubmed/31351122

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Protective Effects of Zinc on 2.45 GHz Electromagnetic Radiation-Induced Oxidative Stress and Apoptosis in HEK293 Cells

Özsobacı NP, Ergün DD, Tunçdemir M, Özçelik D. Protective Effects of Zinc on 2.45 GHz Electromagnetic Radiation-Induced Oxidative Stress and Apoptosis in HEK293 Cells. Biol Trace Elem Res. 2019 Jul 17. doi: 10.1007/s12011-019-01811-6.

Abstract

Several epidemiological studies have shown that exposure to electromagnetic radiation (EMR) can be harmful to human health. The purpose of this study was to examine oxidative parameters and apoptosis induced by EMR in human kidney embryonic cells (HEK293) and to investigate whether zinc (Zn) has protective effect on EMR-induced apoptosis in HEK293 cells. For our experiment, HEK293 cells were divided into four main groups, control, EMR, 50 μM Zn + EMR, and 100 μM Zn + EMR. HEK293 cells of EMR groups were exposed to 2.45 GHz EMR for 1 h. In Zn groups, HEK293 cells were incubated with different concentrations of Zn for 48 h before EMR exposure. Oxidative stress parameters were determined by spectrophotometric method; bcl-2 and caspase-3 were assessed immunohistochemically and TUNEL method was performed for apoptotic activity. EMR group had higher malondialdehyde (MDA) level and lower superoxide dismutase (SOD) activity compared with control group. In Zn-applied groups, MDA was decreased and SOD activity was increased compared with EMR group. The number of the apoptotic cells and caspase-3 immunopositive cells at EMR group was increased significantly compared with the control group, whereas bcl-2 was decreased. Besides, Zn-treated groups showed a significant reduction in the number of apoptotic cells and caspase-3 from that of EMR group, whereas there was an increase in bcl-2 immunopositivity. Our findings show that EMR caused oxidative stress and apoptotic activation in HEK293 cells. Zn seems to have protective effects on the EMR by increasing SOD activity and bcl-2 immunopositivity, decreasing lipid peroxidation and caspas-3 immunopositivity.

https://www.ncbi.nlm.nih.gov/pubmed/31317470

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Untargeted metabolomics unveil alterations of biomembranes permeability in human HaCaT keratinocytes upon 60 GHz millimeter-wave exposure

Le Pogam P, Le Page Y, Habauzit D, Doué M, Zhadobov M, Sauleau R, Le Dréan Y, Rondeau D. Untargeted metabolomics unveil alterations of biomembranes permeability in human HaCaT keratinocytes upon 60 GHz millimeter-wave exposure. Sci Rep. 2019 Jun 27;9(1):9343. doi: 10.1038/s41598-019-45662-6.

Abstract

A joint metabolomic and lipidomic workflow is used to account for a potential effect of millimeter waves (MMW) around 60 GHz on biological tissues. For this purpose, HaCaT human keratinocytes were exposed at 60.4 GHz with an incident power density of 20 mW/cm², this value corresponding to the upper local exposure limit for general public in the context of a wide scale deployment of MMW technologies and devices. After a 24h-exposure, endo- and extracellular extracts were recovered to be submitted to an integrative UPLC-Q-Exactive metabolomic and lipidomic workflow. R-XCMS data processing and subsequent statistical treatment led to emphasize a limited number of altered features in lipidomic sequences and in intracellular metabolomic analyses, whatever the ionization mode (i.e 0 to 6 dysregulated features). Conversely, important dysregulations could be reported in extracellular metabolomic profiles with 111 and 99 frames being altered upon MMW exposure in positive and negative polarities, respectively. This unexpected extent of modifications can hardly stem from the mild changes that could be reported throughout transcriptomics studies, leading us to hypothesize that MMW might alter the permeability of cell membranes, as reported elsewhere.

Open access paper: https://www.nature.com/articles/s41598-019-45662-6

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CeO2NPs relieve radiofrequency radiation, improve testosterone synthesis, and clock gene expression in Leydig cells by enhancing antioxidation

Qin F, Shen T, Cao H, Qian J, Zou D, Ye M, Pei H. Int J Nanomedicine. CeO2NPs relieve radiofrequency radiation, improve testosterone synthesis, and clock gene expression in Leydig cells by enhancing antioxidation. 2019 Jun 24;14:4601-4611. doi: 10.2147/IJN.S206561.
Abstract

Introduction: The ratio of Ce^{3+}/Ce^{4+} in their structure confers unique functions on cerium oxide nanoparticles (CeO_2NPs) containing rare earth elements in scavenging free radicals and protecting against oxidative damage. The potential of CeO_2NPs to protect testosterone synthesis in primary mouse Leydig cells during exposure to 1,800 MHz radiofrequency (RF) radiation was examined in vitro.

Methods: Leydig cells were treated with different concentrations of CeO_2NPs to identify the optimum concentration for cell proliferation. The cells were pretreated with the optimum dose of CeO_2NPs for 24 hrs and then exposed to 1,800 MHz RF at a power density of 200.27 μW/cm^2 (specific absorption rate (SAR), 0.116 W/kg) for 1 hr, 2 hrs, or 4 hrs. The medium was used to measure the testosterone concentration. The cells were collected to determine the antioxidant indices (catalase [CAT], malondialdehyde [MDA], and total antioxidant capacity [T-AOC]), and the mRNA expression of the testosterone synthase genes (*Star, Cyp11a1*, and *Hsd-3β*) and clock genes (*Clock, Bmal1*, and *Rorα*).

Results: Our preliminary result showed that 128 μg/mL CeO_2NPs was the optimum dose for cell proliferation. Cells exposed to RF alone showed reduced levels of testosterone, T-AOC, and CAT activities, increased MDA

content, and the downregulated genes expression of *Star, Cyp11a1, Hsd-3β, Clock, Bmal1*, and *Rorα*. Pretreatment of the cells with 128 μg/mL CeO_2NPs for 24 hrs followed by RF exposure significantly increased testosterone synthesis, upregulated the expression of the testosterone synthase and clock genes, and increased the resistance to oxidative damage in Leydig cells compared with those in cells exposed to RF alone.

Conclusion: Exposure to 1,800 MHz RF had adverse effects on testosterone synthesis, antioxidant levels, and clock gene expression in primary Leydig cells. Pretreatment with CeO_2NPs prevented the adverse effects on testosterone synthesis induced by RF exposure by regulating their antioxidant capacity and clock gene expression in vitro. Further studies of the mechanism underlying the protective function of CeO_2NPs against RF in the male reproductive system are required.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6598754/

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Colony Collapse Disorder (CCD) in Honey Bees Caused by EMF Radiation

Santhosh Kumar S. Colony Collapse Disorder (CCD) in Honey Bees Caused by EMF Radiation. Bioinformation. 2018 Dec 21;14(9):421-424. doi: 10.6026/97320630014521.

Abstract

Honey bees are one of the treasures in the world. An increase of waveform communication leads to good information exchange of mankind. In the biological view, it causes a lot of side effects and lifestyle changes in other living organisms. The drastic changes are causing the natural imbalance in the ecosystem and become a global issue. There are significant reasons for bee colony collapse disorder (CCD) like pesticides, disease and climate change. Recent studies reveal that a cell phone tower and mobile phone handset are also causing side effects to honey bees due to radiation emission. Most of the researchers concentrated on biological and behavioral changes in a honey bee due to radiation effects. For that, the real-time radiation levels have experimented but the different technical perspectives such as radiationemission levels, handset radiation emission measures and multi-sources of radiation are needed to be considered during research. This study aimed to provide possible research extensions of colony collapse disorder caused by cell tower and mobile handsets.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6563664

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The potential for impact of man-made super low and extremely low frequency electromagnetic fields on sleep

Ohayon MM, Stolc V, Freund FT, Milesi C, Sullivan SS. The potential for impact of man-made super low and extremely low frequency electromagnetic fields on sleep. Sleep Med Rev. 2019 Jun 8;47:28-38. doi: 10.1016/j.smrv.2019.06.001.

Abstract

An ever-growing number of electromagnetic (EM) emission sources elicits health concerns, particularly stemming from the ubiquitous low to extremely low frequency fields from power lines and appliances, and the radiofrequency fields emitted from telecommunication devices. In this article we review the state of knowledge regarding possible impacts of electromagnetic fields on melatonin secretion and on sleep structure and the electroencephalogram of humans. Most of the studies on the effects of melatonin on humans have been conducted in the presence of EM fields, focusing on the effects of occupational or residential exposures. While some of the earlier studies indicated that EM fields may have a suppressive effect on melatonin, the results cannot be generalized because of the large variability in exposure conditions and other factors that may influence melatonin. For instance, exposure to radiofrequency EM fields on sleep architecture show little or no effect. However, a number of studies show that pulsating radiofrequency electromagnetic fields, such as those emitted from cellular phones, can alter brain physiology, increasing the electroencephalogram power in selective bands when administered immediately prior to or during sleep. Additional research is necessary that would include older populations and evaluate the interactions of EM fields in different frequency ranges to examine their effects on sleep in humans.

https://www.ncbi.nlm.nih.gov/pubmed/31252334

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Effect of Long-term Occupational Exposure to Extremely Low Frequency Electromagnetic Fields on Proinflammatory Cytokine and Hematological Parameters

Bagheri Hosseinabadi M, Khanjani N, Samaei E, Nazarkhani F. Effect of Long-term Occupational Exposure to Extremely Low Frequency Electromagnetic Fields on Proinflammatory Cytokine and Hematological Parameters. Int J Radiat Biol. 2019 Jul 22:1-23. doi: 10.1080/09553002.2019.1642542.

Abstract

Purpose: The present study aimed to investigate the effect of extremely low frequency electromagnetic fields (ELF-EMFs) on proinflammatory cytokines and hematological parameters, among the employees of a power plant, which are one of the most important occupational groups exposed to ELF-EMFs extensively.

Materials and methods: The studied population included 112 employees of a power plant as the exposed group and 138 unexposed employees who were enrolled based on inclusion and exclusion criteria. The magnetic flux density and the strength of the electric field were determined by spot measurements and according to the IEEE C95.3.1 standard. Proinflammatory cytokines including serum interleukin 1β (IL-1β), interleukin 6 (IL-6), and tumour necrosis factor-α (TNF-α); and hematologic parameters of all subjects were measured.

Results: The mean level of IL-1β and IL-6, white blood cell count (WBC) and red blood cell count (RBC), lymphocyte percentage (Lym%), Mean corpuscular volume (MCV), platelet count (PLT) and procalcitonin (PCT) were significantly more in the exposed group, than the unexposed group. The mean serum levels of IL-6, IL-1β and some of the hematological parameters including WBC, lymphocyte, RBC and haematocrit were higher in technicians which had the highest level of exposure to magnetic fields compared to other groups and these relations were linear.

Conclusions: Long-term exposure to ELF-EMFs probably affects immune responses, by stimulating the production of proinflammatory cytokines, and increasing some hematological parameters.

https://www.ncbi.nlm.nih.gov/pubmed/31329007

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Evaluating short-term exposure to Wi-Fi signals on students' reaction time, short-term memory and reasoning ability

Hosseini MA, Hosseini A, Jarideh S, Argasi H, Shekoohi-Shooli F, Zamani A, Taeb S, Haghani M. Evaluating short-term exposure to Wi-Fi signals on students' reaction time, short-term memory and reasoning ability. Radiat Prot Dosimetry. 2019 Jun 28. pii: ncz162. doi: 10.1093/rpd/ncz162.

Abstract

This study investigated the effect of short-term exposure to Wi-Fi signals on the cognitive functions of the mind. After obtaining permission from the local Ethics Committee of Shiraz University of Medical Sciences and approval by the Iranian Registry of Clinical Trials (IRCT2017041233398N1), 45 male and female students from Shiraz University of Medical Sciences volunteered to participate in this study. They were exposed to Wi-Fi signals in two sham and exposure sessions, each for 2 hours. After completion, they took part in reaction time, short-term memory, and reasoning ability tests. After scoring, the data were analysed by SPSS software. In addition, the electric field strength and power density were calculated. The results showed no statistically significant differences between the mean scores of reaction time, short-term memory, and reasoning ability in sham and exposure. Also, the obtained values from the electric field strength and power density (E = 4.1 Vm-1, P = 0.446 Wm-2) were lower than that of threshold values by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). Our results can greatly reduce concerns regarding the effects of short-term exposure to Wi-Fi waves on cognitive functions.

https://www.ncbi.nlm.nih.gov/pubmed/31251356

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Residential distance from high-voltage overhead power lines and risk of Alzheimer's dementia and Parkinson's disease: population-based case-control study

Gervasi F, Murtas R, Decarli A, Giampiero Russo A. Residential distance from high-voltage overhead power lines and risk of Alzheimer's dementia and Parkinson's disease: a population-based case-control study in a metropolitan area of Northern Italy. Int J Epidemiol. 2019 Jul 6. pii: dyz139. doi: 10.1093/ije/dyz139.

Abstract

BACKGROUND: The association between the extremely low-frequency magnetic field generated by overhead power lines and neurodegenerative disease is still a matter of debate.

METHODS: A population-based case-control study was carried out on the residents in the Milan metropolitan area between 2011 and 2016 to evaluate the possible association between exposure to extremely low-frequency magnetic fields generated by high-voltage overhead power lines and Alzheimer's dementia and Parkinson's disease. A statistical analysis was performed on cases and controls matched by sex, year of birth and municipality of residence (with a case to controls ratio of 1 : 4) using conditional logistic regression models adjusted for socio-economic deprivation and distance from the major road network as potential confounders.

RESULTS: Odds ratios for residents <50 m from the source of exposure compared with residents at ≥600 m turned out to be 1.11 (95% confidence interval: 0.95-1.30) for Alzheimer's dementia and 1.09 (95% confidence interval: 0.92-1.30) for Parkinson's disease.

CONCLUSIONS: The finding of a weak association between exposure to the extremely low-frequency magnetic field and neurodegenerative diseases suggests the continuation of research on this topic. Moreover, the low consistency between the results of the already existing studies emphasises the importance of increasingly refined study designs.

The results of this study do not disprove the hypothesis that the ELF-MF generated by high-voltage overhead power lines can increase the risk of Alzheimer's dementia and, to a lesser extent, Parkinson's disease. The repeated suggestions regarding the existence of an association between ELF-MF and neurodegenerative diseases, both for residential exposures and for occupational exposures, constitute an incentive to continue the evaluation through the planning of specific studies. The lack of univocal and definitive results emphasizes, however, the need to adopt, for this specific field of investigation, increasingly rigorous experimental designs, with particular reference to the selection of study subjects, the quantification of exposure and the definition of confounders.

https://www.ncbi.nlm.nih.gov/pubmed/31280302

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Effect of 50-Hz Magnetic Fields on Serum IL-1β and IL-23 and Expression of BLIMP-1, XBP-1, and IRF-4

Molaei S, Alahgholi-Hajibehzad M, Gholamian-Hamadan M, Zaerieghane Z, Zamani A. Effect of 50-Hz Magnetic Fields on Serum IL-1β and IL-23 and Expression of BLIMP-1, XBP-1, and IRF-4. Inflammation. 2019 Jul 8. doi: 10.1007/s10753-019-01042-w.

Abstract

Investigations demonstrated that magnetic fields (MFs) change cytokine production and expression of some immune system genes. This alteration can affect the immune system function and may lead to some diseases. Therefore, this study investigated two important inflammatory cytokines, i.e., IL-1β and IL-23 at two phases of pre- and post-immunization of the immune system. In addition, the expressions of three important genes in the humoral immunity, i.e., B lymphocyte-induced maturation protein-1 (BLIMP-1), X-box-binding protein-1 (XBP-1), and interferon regulatory factor-4 (IRF-4) were evaluated at post-immunization phase. Eighty adult male rats were divided into four experimental groups and a control. The experimental groups were exposed to 50-Hz MFs with magnetic flux densities of 1, 100, 500, and 2000 μT, 2 h/day for 2 months. The animals were injected by human serum albumin (100 μg/rat) on days 31, 44, and 58 of exposure. The cytokine levels in serum were measured with enzyme-linked immunosorbent assay (ELISA), and the expression of genes was evaluated with reverse transcription quantitative polymerase chain reaction (RT-qPCR). Serum IL-1β was decreased at pre-immunization phase after exposure to 1 and 100 μT of 50-Hz MFs. In contrast, serum IL-23 was increased at post-immunization phase in 100 μT group. No change was observed in serum IL-1β and IL-23 in each group at pre-immunization phase compared with post-immunization. Furthermore, exposure to 100 μT downregulated expression of BLIMP-1, XBP-1, and IRF-4. In conclusion, exposure to 50-Hz MFs may decrease inflammation at short time and increase it at longer time exposures. In addition, 50-Hz MF exposure may decrease the humoral immune responses. It seems that 50-Hz MFs cause more alteration in immune system function at lower densities (100 μT).

https://www.ncbi.nlm.nih.gov/pubmed/31286334

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Methyl and methylene vibrations response in amino acids of typical proteins in water solution under high-frequency electromagnetic field

Calabrò E, Magazù S. Methyl and methylene vibrations response in amino acids of typical proteins in water solution under high-frequency electromagnetic field. Electromagn Biol Med. 2019 Jul 11:1-8. doi: 10.1080/15368378.2019.1641720.

Abstract

The aim of this paper was to study the response of methyl (CH3) and methylene (CH2) vibration bands in amino acids of some typical proteins diluted in bidistilled water solution after exposure to a high-frequency electromagnetic fields using Fourier Transform Infrared (FTIR) Spectroscopy. Hemoglobin in H2O solution and bovine serum albumin and myoglobin diluted in different D2O solutions were exposed for 4 h to a power density of 0.95 W/m2 at the frequency of 1750 MHz, emitted by operational mobile phones Nokia model 105 and Samsung model GT-E1270, in order to study the response of stretching vibrations of CH3 and CH2 that are in amino acids of those proteins. The main result was that CH3 stretching bands increased significantly in myoglobin in D2O solution because this protein is represented by a single protein chain so that the torque induced by the applied field is larger than that induced on the other two proteins. Otherwise, CH2 stretching vibrations decreased in intensity significantly for all exposed proteins. This result can be explained as well, assuming that, given a fixed volume, a decrease of population of CH2 occurred after exposure because of the alignment of proteins α-helices along the direction of the applied electromagnetic field.

https://www.ncbi.nlm.nih.gov/pubmed/31293188

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Effects of long-term exposure to an extremely low frequency magnetic field (15 μT) on selected blood coagulation variables in OF1 mice

Vallejo D, Hidalgo MA, Hernández JM. Effects of long-term exposure to an extremely low frequency magnetic field (15 μT) on selected blood coagulation variables in OF1 mice. Electromagn Biol Med. 2019 Jul 13:1-8. doi: 10.1080/15368378.2019.1641719.

Abstract

The long-term exposure of OF1 mice to an extremely low frequency magnetic field (ELF-MF; 50 Hz, 15 μT [rms]) has been associated with the appearance of leukaemia. Neoplasms are usually accompanied by changes in haemostatic processes but reports on changes in blood coagulation following exposure to an ELF-MF are scarce and rather fragmentary. The aim of the present work was to determine whether any global or partial coagulation variables are modified after such long-term exposure. A parental generation of six week-old OF1 mice was exposed to an artificial ELF-MF for 14 weeks. Mating was then allowed, and the resulting filial generation raised until the age of 31-35 weeks within the same ELF-MF. Control animals were subjected only to the magnetic field of the Earth. Whole blood samples were extracted from the anesthetised filial generation

of mice by cardiac puncture. White blood cells (WBC) were counted, the activated partial thromboplastin time (APTT) and prothrombin time (PT) determined, and plasma fibrinogen, reptilase time (RT), and factor VIII activity examined. The similarity between the results for the present control animals and those recorded in the literature for human blood render OF1 mice a suitable study model. The differences in the studied coagulation variables were largely owed simply to sex. However, the females showed a very significant shortening of the PT time associated with ELF-MF exposure. Exposure also caused significant increases in the female APTT and RT values, and in general reduced the differences between the sexes.

https://www.ncbi.nlm.nih.gov/pubmed/31303067

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On the magnetosensitivity of lipid peroxidation: two- versus three-radical dynamics

Sampson C, Keens RH , Kattnig DR. On the magnetosensitivity of lipid peroxidation: two- versus three-radical dynamics. Phys Chem Chem Phys. 2019 Jun 26;21(25): 13526-13538. doi: 10.1039/c9cp01746a.

Abstract

We present a theoretical analysis of the putative magnetosensitivity of lipid peroxidation. We focus on the widely accepted radical pair mechanism (RPM) and a recently suggested idea based on spin dynamics induced in three-radical systems by the mutual electron-electron dipolar coupling (D3M). We show that, contrary to claims in the literature, lipid peroxides, the dominant chain carriers of the autoxidation process, have associated non-zero hyperfine coupling interactions. This suggests that their recombination could, in principle, be magnetosensitive due to the RPM. While the RPM indeed goes a long way to explaining magnetosensitivity in these systems, we show that the simultaneous interaction of three peroxyl radicals via the D3M can achieve larger magnetic field effects (MFE), even if the third radical is remote from the recombining radical pair. For randomly oriented three-radical systems, the D3M induces a low-field effect comparable to that of the RPM. The mechanism furthermore immunizes the spin dynamics to the presence of large exchange coupling interactions in the recombining radical pair, thereby permitting much larger MFE at magnetic field intensities comparable to the geomagnetic field than would be expected for the RPM. Based on these characteristics, we suggest that the D3M could be particularly relevant for MFE at low fields, provided that the local radical concentration is sufficient to allow for three-spin radical correlations. Eventually, our observations suggest that MFEs could intricately depend on radical concentration and larger effects could ensue under conditions of oxidative stress.

https://www.ncbi.nlm.nih.gov/pubmed/31210238

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Mobile Communications and Public Health

Edited by Marko Markov

Boca Raton, FL: CRC Press. June 2018. ISBN-13: 978-1-138-56842-6 (Hardback); 978-0-203-70510-0 (eBook)

https://www.taylorfrancis.com/books/e/9780203705100

This book represents a comprehensive overview of various forms of mobile communications devices, with increasing variations and intensities that constitute a serious hazard to both the biosphere and mankind. Contributors stress the lack of controls over mobile communication signal sources, as well as the absence of monitoring the health of individuals exposed to microwave radiation. The work also entails a review of the engineering behind mobile communication technology, including a summary of basic scientific evidence of the effects of biological exposure to microwaves, and unique coverage on potential hazards of mobile communication for children.

Marko S. Markov, Ph.D., has been professor and chairman of the Department of Biophysics and Radiobiology of Sofia University for more than 20 years. With over 45 years of basic science research experience, and over 40 years in the clinical application of electromagnetic fields, he is recognized as one of the world's best experts in the subject. His list of publications includes 196 papers and 18 books.

- Presents an overview of what modern science knows about mobile communications signals;
- Details the latest research on potential hazards related to uncontrolled use of mobile devices;
- Provides information related to children's organisms not developed biologically prior to exposure to microwave signals;
- Offers methods of control of the house and work environment; and
- Explores the link between science and electromagnetics hazards.

The 5G Appeal

By Rainer Nyberg, Lennart Hardell. pp. xii - xvi

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Mobile Communications and Public Health

by Marko S. Markov. Chapter 1: pp. 1-24.

Abstract

The last quarter of the 20th and the first two decades of the 21st centuries are characterized by increasing hazards of electromagnetic fields for the biosphere and public health. This anthropogenic factor has been considered in two distinct directions: low frequency electromagnetic fields (EMF) from power lines and high frequency EMF from cellular communications.

Public fear as well as scientific understanding have pointed to the serious problems for public health. World Health Organization (WHO) recognized the importance of this issue and originated "The international EMF project" which during the last two decades has organized a series of international meetings in different locations of the world with the intention to harmonize standards for EMF radiation and exposure. Unfortunately, this activity did not end with a more or less defined conclusion or at least a recommendation. With respect to EMF emitted for the purpose of mobile communications, the International Agency for Research on Cancer (IARC) has recognized the non-ionizing radiation from microwaves used in mobile communications as a possible carcinogenic source (category 2B).

This paper discussed the basic physics problems related to characterization of the non-ionizing radiation that are of importance for public health. Special attention is paid to missing definitions for basic terminology and to the non-thermal effects of EMF as well as the incorrect use of SAR [Specific Absorption Rate] for defining conditions of exposure. The core of the paper is the potential hazard of mobile communications for human health.

Conclusions

In conclusion, today the entire biosphere and mankind are subjected to signals from space and terrestrial sources, unknown by numbers and by their physical characteristics. We are at the bottom of the ocean of electromagnetic waves. What is worse—this global “experiment” is conducted without protocol, monitoring, and the possibility to produce any protections. The mobile communication industry is creating newer and newer tools in order to eventually increase the speed of communications. Smartphones and smart meters significantly change the electromagnetic environment not only for occupational conditions, but in every home. Billions of people are not informed about the fact that their homes and they themselves are subjected to the “new and advanced” technological developments. This cohort includes babies and elderly people, schoolboys and professionals.

What is even worse, the new 5G mobile technology is being introduced even before the development of industrial standards. No health hazard estimation is planned; no guidance for protection and standards are developed. It is time to ring the bell.

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Cell Phone Radiation: Evidence From ELF and RF Studies Supporting More Inclusive Risk Identification and Assessment

By Carl Blackman. Chapter 2: pp. 25-46.

Abstract

Many national and international exposure standards for maximum radiation exposure from the use of cell phones and other similar portable devices are ultimately based on the production of heat, particularly in regions of the head, that is, thermal effects (TE). The recent elevation in some countries of the allowable exposure, that is, averaging the exposure that occurs in a 6 minute period over 10 grams (g) of tissue rather than over 1 g, allows for greater heating in small portions of the 10-g volume compared to the exposure that would be allowed averaged over a 1-g volume. There is concern that ‘hot’ spots, that is, momentary higher intensities, could occur in portions of the 10-g tissue piece, which might have adverse consequences, particularly in brain tissue.

There is another concern about exposure to cell phone radiation that has been virtually ignored except for the National Council of Radiation Protection and Measurements (NCRP) advice given in a publication in 1986 (National Council for Radiation Protection and Measurements, Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields, National Council for Radiation Protection and Measurements, 1986, 400 pp.). This NCRP review and guidance explicitly acknowledged the existence of non-thermal effects (NTE), and included provisions for reduced maximum-allowable limits should certain radiation characteristics occur during the exposure.

If we are to take most current national and international exposure standards as completely protective of thermal injury for acute exposure only (6 min time period), then the recent evidence from epidemiological studies associating increases in brain and head cancers with increased cell phone use per day and per year over 8–12 years raises concerns about the possible health consequences of NTE first acknowledged in the NCRP 1986 report (National Council for Radiation Protection and Measurements, Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields, National Council for Radiation Protection and Measurements, 1986, 400 pp.).

This paper will review some of the salient evidence that demonstrates the existence of NTE and the exposure complexities that must be considered and understood to provide appropriate, more thorough evaluation and guidance for future studies and for assessment of potential health consequences. Unfortunately, this paper is necessary because most national and international reviews of the research area since the 1986 report (National Council for Radiation Protection and Measurements, Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields, National Council for Radiation Protection and Measurements, 1986,

400 pp.) have not included scientists with expertise in NTE, or have not given appropriate attention to their requests to include NTE in the establishment of public health-based radiation exposure standards. Thus, those standards are limited because they are not comprehensive.

Conclusions

There is substantial scientific evidence that some modulated fields (pulsed or repeated signals) are bioactive, which increases the likelihood that they could have health impacts with chronic exposure even at very low exposure levels. Modulation signals may interfere with normal, nonlinear biological processes. Modulation is a fundamental factor that should be taken into account in new public safety standards; at present it is not even a contributing factor. To properly evaluate the biological and health impacts of exposure to modulated RFR (carrier waves), it is also essential to study the impact of the modulating signal (lower frequency fields or ELF-modulated RF). Current standards have ignored modulation as a factor in human health impacts, and thus are inadequate in the protection of the public in terms of chronic exposure to some forms of ELF-modulated RF signals. The current Institute of Electrical and Electronic Engineers (IEEE) and International Commission on Non-Ionizing Radiation Protection (ICNIRP) standards are not sufficiently protective of public health with respect to chronic exposure to modulated fields (particularly new technologies that are pulse-modulated and heavily used in cellular telephony). The collective papers on modulation appear to be omitted from consideration in the recent World Health Organization (WHO) and IEEE science reviews. This body of research has been ignored by current standard setting bodies that rely only on traditional energy-based (thermal) concepts.

More laboratory as opposed to epidemiological research is needed to determine which modulation factors and combinations are bioactive and deleterious at low intensities, and are likely to result in disease-related processes and/or health risks; however, this should not delay preventative actions supporting public health and wellness. If signals need to be modulated in the development of new wireless technologies, for example, it makes sense to use what existing scientific information is available to avoid the most obviously deleterious exposure parameters and select others that may be less likely to interfere with normal biological processes in life.

The current membership on Risk Assessment committees needs to be made more inclusive by adding scientists experienced with producing nonthermal biological effects. The current practice of segregating scientific investigations (and resulting public health limits) by artificial, engineering-based divisions of frequency needs to be changed because this approach dramatically dilutes the impact of the basic science results and eliminates consideration of modulation signals, thereby reducing and distorting the weight of evidence in any evaluation process.

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Public Exposure to Radio Frequency Electromagnetic Fields

By Peter Gajšek. Chapter 3: pp. 47-64.

Abstract

The increasing use of various wireless devices and development of new telecommunication technologies has resulted in a fundamental change of radio frequency electromagnetic fields (RF-EMF) exposure in the everyday environment. In the last three decades, a large number of scientific studies on the exposure assessment of the general public to RF-EMF in different environments were completed. The results of numerous exposure assessment studies come to almost the same conclusions: that public RF-EMF exposures in different micro environments are only a small fraction of existing RF exposure standards.

Conclusions

In general, all the research studies related to exposure assessment of the general public to fixed RF-EMF sources in the environment including base stations, broadcasting, and wireless systems clearly demonstrated that the total mean value of the electric field was quite low and did not exceed 10% of the internationally recognized limit values.

It is expected that the strength and complexity of EMF exposures will increase continuously, especially in relation to expansion of the 5th generation of mobile telephony and other emerging technologies that will use different frequency bands. An increasing number of devices and processes employing these frequencies (household appliances, telecommunication, etc.) have already been introduced into everyday life. Almost nothing is known about these exposures and potential exposure levels.

It is expected that global mobile data traffic will grow at a compound annual rate of 45% in the coming years, which represents a tenfold increase between 2016 and 2022 (Ericsson, 2016). This increase is driven largely by the adoption of mobile video streaming. On top of that, the Internet of Things (IoT) is shifting from a vision to reality. The 29 billion connected devices by 2022 are expected to include 18 billion IoT or machine-to-machine (M2M) devices. Subsequently, the future 5G mobile networks will need to support new challenging and new use cases, which will demand more spectrum in ever higher frequency ranges.

Furthermore, emissions will continue to change in characteristics and levels due to new infrastructure deployments, smart environments, and novel wireless devices. Thus it is expected that the complexity of EMF exposures will increase in the future.

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Health Effects of Chronic Exposure to Radiation From Mobile Communication

By Igor Belyaev. Chapter 4: pp. 65-100.

Abstract

Due to strong evidence showing the critical role of the exposure duration for the effects of nonthermal microwaves (NT MW), studies with prolonged chronic exposures became of key importance in assessment of the MW health effects. Given the undoubted key role of specific signal characteristics such as frequency, modulation, and polarization, the studies with chronic exposures to real signals of mobile communication become of predominant importance for assessment of health effects from mobile communication. There were a number of such studies performed recently. Most of them confirmed results of animal studies with chronic MW exposure previously performed in Russia/The Soviet Union by showing detrimental health effects including those related to carcinogenesis.

Conclusions

Chronic exposure to nonthermal microwaves (NT MW) may result in various health effects affecting the central nervous system, fertility, immune functions, and causing/promoting cancer. Taken together, available studies indicate that response to NT MW depends on PD and duration exposure (7). The SAR based ICNIRP safety standards, which have been widely adopted for protection against acute thermal effects of MW, are insufficient to protect the public from chronic exposures to NT MW from mobile communication. New safety standards should commonly be adopted based on data from multiple studies on chronic exposures and mechanisms for nonthermal MW effects (106). It should be anticipated that definite parts of human population, such as children, pregnant women, and hypersensitive persons, which constitute about 1%–10% of the general population in economically developed counties (113), could be especially vulnerable to chronic NT MW exposures. In general, new signals of mobile communication should be tested with chronic exposures before being put into practice.

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Can Electromagnetic Field Exposure Caused by Mobile Communication Systems in a Public Environment Be Counted as Dominant?

By Jolanta Karpowicz, Dina Šimunić, Krzysztof Gryz. Chapter 5: 101-128.

Abstract

The core principle used by mobile communication systems to transfer information via the wireless links involves the emission and reception of the electromagnetic field in the radio frequency band. The entire population today is exposed to the electromagnetic field emitted by mobile terminals (mobile phone handsets, cordless phones, tablets, laptops, routers, etc.) and their base stations. The same frequency bands are also used by other technologies, such as radio and television broadcasting, wireless internet access, microwave heating, anti-theft systems, radio frequency identification systems, and so on. When discussing health hazards may be caused by electromagnetic field exposure from mobile communication systems, it must be remembered that in some cases, other sources of electromagnetic exposure may deliver a dominant or a significant exposure component of the total radio frequency electromagnetic exposure of particular individuals. This paper describes the technical aspects of various mobile communication systems. Exposure scenarios with various dominant sources of exposures are discussed in the chapter together with exposure evaluation techniques which may help recognize the exposure pattern.

Conclusions

The level of exposure to RF-EMF recorded in the discussed investigations performed in environments accessible to the public is usually significantly lower than the general public exposure limits provided by international guidelines and legislation established in various countries (4–61 V/m) (Council Recommendation, 1999, Gryz et al., 2014a, Stam, 2011). It is worth noting that, when approaching RF emitting antennas, especially BTS of mobile networks or RTV broadcasting, over a short distance the level of RF-EMF increases and may even significantly exceed the mentioned limits. However, the investigations show that in locations where many users of mobile communication tools are present in a crowded space, the components of RF-EMF exposure caused by their activities (which significantly vary over time) may together exceed components from the stationary emitters of RF-EMF (such as mobile networks base stations and RTV broadcasting antennas). Furthermore, other studies showed that local hot spots of exposure may also be created in such locations as a result of the multipath propagation of RF-EMF. Together, this is significant in the context of the safety of the vulnerable population, such as individuals with medical implants and users of telemedicine body worn sensors, because it may cause local hot spot overexposure with respect to the limit of radio frequency exposure, which may influence the function of electronic devices. In order to avoid medical device malfunction, it is usually recommended to maintain a distance from the transmitting terminals (handsets) greater than 1 meter....

It is also important to keep in mind that the rapidly developing mobile communication services are including continuously higher frequencies – AM and FM radio transmissions initially operated at kHz and MHz frequencies and analogue radiophones and cellular phones started from frequencies 27–450 MHz, whereas today's digital cellular phones use frequencies up to 2.2 GHz and wireless internet access explores frequencies up to almost 6 GHz, where the next generation of cellular phones is also going to be. Even much higher frequencies are explored by radio links, almost up to 100 GHz.

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Low-Level Thermal Signals: An Understudied Aspect of Radio Frequency Field Exposures with Potential Implications on Public Health

By Lucas A. Portelli. Chapter 6: 129-162.

Abstract

Protection from the hazards of radio frequency (RF) fields is currently aimed at confining the RF-induced thermal changes in tissue to within limits which are currently considered as safe. In this regard, hazardous effects of such exposures are traditionally investigated, catalogued, and interpreted from a perspective based on presumably adequate approximations and assumptions that simplify several dosimetric and biological aspects. While these simplifications are certainly useful and convenient, they tend to obscure the existence of dosimetric artifacts and subtle biological responses which may be of relevance to human health when observed from the microdosimetric or chronic perspectives. Increasingly realistic human models, for example, can unveil the existence of localized hot-spots and thermal transients which are invisible when using simpler models or space and time averaging as is customary for the safety regulatory practice. This results in exposures which can be in reality many times greater than the supposed and reported exposures. Similarly, from the biological perspective, the classical thermal hazard paradigm assumes that thermal damage only occurs after certain relatively high temperatures are reached for short amounts of time, inducing safety regulations to limit rather acute thermal exposures accordingly. However, while this perspective is practical and apparently sufficient to protect the population under the current paradigm, it is impervious to the possibility of the existence of the effects of chronic exposures to low-levels of thermal challenges. Such exposures may cause small amounts of thermal damage directly or indirectly (e.g., via the stimulation of compensatory physiological reactions) which may add up over time.

In this regard, one must recognize that localized thermal transients (collections of which form Thermal Signals) are an unavoidable result of exposure to modulated RF fields, even if the exposure is within the limits which are currently considered as safe. One can contemplate, for example, how such a thermal signal can appear when tissue is exposed to an intermittent RF field (e.g., …on-off-on-off…) as the deposited heat is actively or passively redistributed by physical or physiological means throughout the organism and back into the environment.

The fact that such signals are inherent to RF exposures alone makes the studying of their biological effects a necessity to guarantee human safety. Nevertheless, at present, the possibility of biological effects of thermal signals is not mentioned, contemplated or investigated since they are deemed inconsequential under the current paradigm. Yet, sensitivity to minute thermal changes is an inherent aspect of physicochemical laws which govern the dynamics and function of biochemical reactions and structures. Such structures and reactions can potentially act as transducers of thermal signals into the cellular processes, which may translate into biological and ultimately health effects. Consequently, the study of thermal signals may open a myriad of possibilities for noninvasive, nonchemical interaction with biochemical signals at the cellular level which may have broad implications in the scientific, industrial, regulatory, and therapeutic arenas.

Conclusions

It is an undeniable fact that complex biological systems, from the molecular to the full organism level, are built around very rigorous thermal specifications making them very sensitive and responsive to small temperature changes in their internal or external vicinity. Hence, thermal signals which are invariably linked to the imposition of RF fields have the potential to be accompanied by compensatory biochemical responses from tissue at a local or global level in the organism. Such thermal signals might initially have modest effects on biochemical reactions and structures, however, these effects may then be amplified by the biological system into relevant biological and health effects.

From the public health perspective, a necessary question to answer is: what are the biological effects of chronic exposures to low-level thermal signals and what are the relative health risks? (i.e., compared to a smoking certain number of cigarettes a day, for example). However, to date, our currently poor understanding about the true biological relevance of thermal signals is insufficient to draw useful scientific conclusions which can affect decisions, recommendations, and policy to protect the public from potential hazards. In fact, the amount of data available is much less than would be considered the bare minimum. How “small” a thermal

signal is can only be judged from a biological system perspective by generating the appropriate set of experiments and interpreting them from a paradigm that includes this possibility. While, in essence, the characteristics of this thermal signal will be a result of the antagonistic thermal processes (heat-in versus heat-out) specific to the details of the exposure, the need for consideration of the effects from the cellular spatio-temporal scale might require significant amounts of effort and complications. However, such apparent complications, in return, may hold substantial scientific, industrial, and therapeutic potential at best or understanding of realistic safety thresholds at worst.

Therefore, in view of the pervasiveness and potential relevance of low-level thermal signals, the paradigm centered around the notion of a “thermal damage threshold” on which the current safety standards and recommendations for mobile communications are currently based might be incomplete. For this reason alone, basic research in this area is imperative. Therefore, scientists and executives who are seriously concerned about the implications of mobile communications on public health must consider directing their scientific resources towards unveiling the true biological relevance of RF-induced small thermal signals to such a degree as these are directed towards the study of RF-induced “thermal” and “nonthermal” effects. In this regard, thermal signals may not only appear as a secondary effect in other instances of intermittent energy deposition (ultrasound or light), but it could also be purposely generated to achieve therapeutic levels, should these exist....

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How Cancer Can Be Caused by Microwave Frequency Electromagnetic Field (EMF) Exposures: EMF Activation of Voltage-Gated Calcium Channels (VGCCs) Can Cause Cancer Including Tumor Promotion, Tissue Invasion, and Metastasis via 15 Mechanisms

By Martin L. Pall. Chapter 7: pp. 163-186.

Abstract

Thirty reviews each argue that microwave frequency electromagnetic fields (EMFs) can and do cause cancer. These conclusions should be definitive and are further buttressed by the National Toxicology Program study on 2G cell phone radiation. However, there are still claims that there cannot be a mechanism for EMF cancer causation. Such EMFs are known to act via voltage-gated calcium channel (VGCC) activation and consequent downstream increases in intracellular calcium [Ca2+]i and peroxynitrite/free radicals/oxidative stress. Fifteen mechanisms are discussed here whereby these downstream effects can cause cancer. These include single strand and double strand DNA breaks and oxidized DNA bases; increased ornithine decarboxylase; lowered melatonin; increased NF-kappa B; increased tumor promotion via degradation of gap junction proteins; increased tumor promotion via DNA breaks/gene amplification; increased tissue invasion and metastasis via increased tight junction protein degradation; increased CaMKII via protein oxidation; calcium produced increased CaMKII; calcium-dependent phosphatidylserine flippase; c-src activation by calcium/calmodulin; calcium increased cellular oncogene transcription; calpain activation of tumor migration, tissue invasion, and metastasis. These 15 mechanisms and reviews on calcium roles in cancer causation together show that EMFs acting via VGCC activation can cause cancer initiation, promotion, and progression. We have, therefore, a large number of mechanisms by which microwave frequency EMFs can cause cancer.

Conclusions

This paper is based on three important findings. First, that microwave and lower frequency EMFs act via activation of VGCCs. Second, 29 different reviews have concluded that such EMFs cause cancer, raising the question of how VGCC activation can cause cancer. Third, because VGCC activation acts mainly via increased [Ca2+]i, it is reasonable to assume that cancer causation occurs via increased calcium signaling and via other downstream effects of [Ca2+]i. This paper finds that there are multiple mechanisms that fit each of these two descriptions that cause cancer based on the cancer literature. Many of them come from the downstream effects involving the peroxynitrite/free radical/oxidative stress pathway and one of the important consequences

of that pathway, elevated NF-kappa B. Those downstream effects are similar or identical to the effects that are central to inflammatory carcinogenesis in the literature. But, in addition, there are cancer causing effects that are caused by excessive calcium signaling and these are also discussed here.

These mechanisms are listed below. Mechanisms 1–6 are all reported to be raised following EMF exposures and are, therefore, particularly plausibly involved in EMF-caused carcinogenesis. Each of these 15 is produced as a consequence of either the peroxynitrite/free radical/oxidative stress pathway of action of as a consequence of excessive calcium signaling. Each is, therefore, highly plausible because each of these pathways of action are well documented downstream effects of EMF exposures....

We have, then, 15 well-documented mechanisms by which EMFs acting via VGCC activation can cause cancer. It is complete and utter to nonsense, therefore, to claim there are no such mechanisms.

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A Summary of Recent Literature (2007–2017) on Neurobiological Effects of Radio Frequency Radiation

By Henry Lai. Chapter 8: 187-222.

Abstract

Neurological effects are caused by changes in the nervous system. Factors that act directly or indirectly on the nervous system causing morphological, chemical or electrical changes in the nervous system can lead to neurological effects. The final manifestation of these effects can be seen as psychological/behavioral changes, for example, memory, learning, and perception. The nervous system is an electrical organ. Thus, it should not be surprising that exposure to electromagnetic fields could lead to neurological changes. Morphological, chemical, electrical, and behavioral changes have been reported in animals and cells after exposure to nonionizing electromagnetic fields (EMF) across a range of frequencies. The consequences of physiological changes in the nervous system are very difficult to assess. We do not quite understand how the nervous system functions and reacts to external perturbations. The highly flexible nervous system could easily compensate for external disturbances. On the other hand, the consequence of neural perturbation is also situation-dependent. For example, an EMF-induced change in brain electrical activity could lead to different consequences depending on whether a person is watching TV or driving a car.

Conclusions

1. A major concern is that in some of the studies, details of the exposure setup and dosimetry are not provided. This is important since details of the independent variables are very important in interpreting the validity of the experimental results, that is, dependent variables. In many of these studies, a cell phone was used in the exposure of animals and humans. But information on how the cell phone was activated, in many instances, was not provided. Thus, the amount of energy deposited in the body was not known....

2. Most of the studies were carried out with relatively high levels of RFR compared to environmental levels. However, if you look through the narratives, there are studies that reported effects at very low level, for example, Bak et al., (2010). Indeed, biological/health effects of RFR at levels much lower than most international RFR-exposure guidelines, for example, International Commission on Non-ionizing Radiation Protection (ICNIRP), have been reported (see table 1 in Levitt and Lai, 2010). This raises the question on whether the guidelines used in most countries nowadays are actually obsolete and new exposure guidelines have to be set.

3. Thus, there is ample evidence that RFR exposure affects the nervous system from both acute and long-term exposure experiments. Brain electric activities, nerve cell functions and chemistry, and behavior can be affected. Some explanatory mechanisms for these effects have emerged. One consistent finding is that animals exposed to RFR suffered from memory and learning deficits. These effects can be explained by the

results of numerous reports that showed RFR affected the hippocampus, a brain region involved in memory and learning. However, the location and configuration of the human hippocampus are quite different from those of a rodent. There have not been many studies on the effect of RFR on the human hippocampus. Several studies did report deficits in memory in human subjects exposed to RFR, particularly on short-term memory, a function specifically related to the hippocampus....

4. Another very consistent finding is that RFR affects free radical metabolism in the brain. This may explain some of the cellular and physiological effects of RFR on the nervous system. As a matter of fact, oxidative changes in cells and tissues after exposure to RFR is a very common phenomenon (cf. Yakymenko et al., 2016). This happens in many organs of the body and can provide explanation of many reported biological effects of RFR.

5. Many of the effects of RFR on the nervous system, for example, on the hippocampus, oxidative effects, and behavioral effects are also observed with exposure to extremely low frequency electromagnetic field (cf. my section on the neurological effects of ELF EMF in the Bioinitiative Report, www.bioinitiative.info/bioInitiativeReport2012.pdf). There has been speculation whether biological effects observed with low frequency modulated RFR were actually caused by the modulation. There are two reports published in the last decade that seemed to refute this hypothesis..... Another question is whether one type of modulation is different from another in causing biological effects. Cell phone technology advances from one generation to another. Do the research data of a 3G phone apply to 4G or 5G phone radiation? RFR is a complex entity. Its biological effects depend on many of its physical properties, for example, frequency, direction of the incident waves relative to the object exposed, dielectric properties, size and shape of the exposed object, polarization of the waves, and so on. Thus, it is unlikely that one can easily extrapolate the effects from one form of RFR to another. An assumption that 3G radiation is safe does not necessary imply that 5G radiation is safe. Each one of them has to be investigated separately.

6. An important area of research is on how RFR in the environment affects humans and wildlife. Environmental RFR level has become higher and higher over the past decades due to the employment of RFR wireless devices. Take the example of Bak et al. (2010) mentioned above, an effect on human event-related brain potential was reported after 20 min of exposure to a GSM signal at a power density of 0.0052 mW/cm2. This is very close to the levels found in some cities. The highest power density of ambient RFR measured near schools and hospitals in Chandigarh, India, was reported to be 0.001148 mW/cm2 in 2012 (Dhami, 2012). The maximum total RFR power density emitted by FM and TV broadcasting stations and mobile phone base stations in centers of the major cities in the West Bank-Palestine was 0.00386 mW/cm2 (Lahham and Hammash, 2012). One also has to take into consideration that exposure in the Bak et al. (2010) study was acute (20 min), whereas environmental exposure is chronic. Related to the neurological effect is the magnetic sense possessed by many species of animals. It is essential for their survival. Interference by RFR of magnetic compass orientation in animals has been reported (e.g., Landler et al., 2015; Malkemper et al., 2015; Pakhomov et al., 2017; Schwarze et al., 2016; Vácha et al., 2009). Understanding the effects could help in preserving the ecosystem and ensure survival of the species on this earth.

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Radiobiological Arguments for Assessing the Electromagnetic Hazard to Public Health for the Beginning of the Twenty-First Century: The Opinion of the Russian Scientist

By Yury G. Grigoriev. Chapter 9: 223-236.

Abstract

Over the past 25 years, there has been a global distribution of wireless communications which has significantly changed the electromagnetic pollution of the external environment and the methodology for assessing health risks for all population groups. In these difficult conditions, many specialists have neglected radiobiological

concepts, for example, the concept of a critical organ or critical system, the possibility of accumulating adverse effects, and the determination of residual damage (remote consequences). Almost daily life-long exposure of the RF EMF to the brain has not received attention. In many countries, there is complete disregard for the precautionary principle proposed by the WHO. Children for the first time in the entire period of civilization should be included in the risk group. Even before the era of the development of mobile communications, there were significant differences in the guidelines and standards for radio frequency radiation in the radio frequency range. This paper demonstrates the significance of biological responses to the nonthermal low RF EMF. Therefore, scientists should stand firm in this “electromagnetic chaos” in the habitat of the population.

Conclusions

At present, there are no unified approaches to assessing the health hazards of the RF EMF of mobile communications. There is a wide variation in the permissible RF EMF levels. The possibility of developing long-term consequences is underestimated. The technical solutions for the creation of new types of wireless communication outrun scientific research to assess the danger to the public. The precautionary principle is ignored when placing base stations. There is a desire to ensure that all schools use Wi-Fi.

The large spread, uncontrolled, use of this connection by all groups of the population, including children, continues although the mobile phone is an open source of radiation, and the critical body is the user’s brain.

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A Longitudinal Study of Psychophysiological Indicators in Pupils Users of Mobile Communications in Russia (2006–2017): Children Are in the Group of Risk

By Yury G. Grigoriev, Natalia I. Khorseva. Chapter 10: 237-252.

Abstract

The human brain is exposed to electromagnetic fields of the radio frequency range (RF EMF) constantly, around the clock, from the base stations. The decision of the IARC in 2011 has determined social and ethical problems for society and for scientists—the definition of risk for the population, including children. Children are the most active group of mobile communication users. Unfortunately, the current assessment of the impact of RF EMF on the children's brains through questionnaires conducted in epidemiological studies is not convincing. The chronic impact of RF EMR, including the radiation of mobile phones on the bodies of children and adolescents, in particular on their psychophysiological and cognitive functions, have not been studied.

This publication presents the results of a longitudinal study of the psychophysiological indicators of children and teenage mobile communication users conducted in Russia from 2006 to present. The patterns of the negative influence of mobile phone radiation on the auditory and visual system, fatigue and performance, and on the parameters of attention and memory are established. The undeniable advantage of these studies is not only the presence of a control group, but also the development and implementation of preventive measures to reduce the negative impact of mobile phone radiation.

Conclusions

....So, the longitudinal changes in the psychophysiological indicators of children who use mobile phones convincingly show that chronic exposure to electromagnetic radiation from a mobile phone may negatively affect the central nervous system of the child:

1. The reaction time to sound and light stimuli is increased;
2. There is an increase in the number of violations of phonemic perception and the number of missed signals when a sound stimulus is presented;
3. Indicators of arbitrary attention and semantic memory deteriorate;
4. There are increased parameters of fatigue and decreased parameters of working capacity

It should be especially noted that in most cases in children who are active users of mobile communication, changes in psychophysiological indicators either were within the lower limit of the norm or already go beyond it....

It was found that the safe mode of use (headphones, speakerphone, use of SMS, MMS) statistically significantly improve ALL psychophysiological indicators.

We believe that the results of our longitudinal observations clearly show that the RF EMF from mobile phones affects psychophysiological indicators of children and adolescents.

Based on our results, it can be confidently affirmed that children are located in the group at risk. It should be recognized and the efforts of the scientific community to reduce the risk of adverse effects on the organisms of children should be made. One of the possible ways of reducing the impact of electromagnetic fields on children is an understanding of the dangers by the parents and children, the use of mobile communication, and a voluntary choice of the form of communication, that is, the introduction of the concept of “voluntary risk.”

Index

pp. 253-264.

Effects of RF-EMF on the Human Resting-State EEG—the Inconsistencies in the Consistency. Part 1: Non-Exposure-Related Limitations of Comparability Between Studies

Danker-Hopfe H, Eggert T, Dorn H, Sauter C. Effects of RF-EMF on the Human Resting-State EEG—the Inconsistencies in the Consistency. Part 1: Non-Exposure-Related Limitations of Comparability Between Studies. Bioelectromagnetics. Published online June 18, 2019. https://doi.org/10.1002/bem.22194

Abstract

The results of studies on possible effects of radiofrequency electromagnetic fields (RF-EMFs) on human waking electroencephalography (EEG) have been quite heterogeneous. In the majority of studies, changes in the alpha-frequency range in subjects who were exposed to different signals of mobile phone-related EMF sources were observed, whereas other studies did not report any effects. In this review, possible reasons for these inconsistencies are presented and recommendations for future waking EEG studies are made. The physiological basis of underlying brain activity, and the technical requirements and framework conditions for conducting and analyzing the human resting-state EEG are discussed. Peer-reviewed articles on possible effects of EMF on waking EEG were evaluated with regard to non-exposure-related confounding factors. Recommendations derived from international guidelines on the analysis and reporting of findings are proposed to achieve comparability in future studies. In total, 22 peer-reviewed studies on possible RF-EMF effects on human resting-state EEG were analyzed. EEG power in the alpha frequency range was reported to be increased in 10, decreased in four, and not affected in eight studies. All reviewed studies differ in several ways in terms of the methodologies applied, which might contribute to different results and conclusions about the impact of EMF on human resting-state EEG. A discussion of various study protocols and different outcome parameters prevents a scientifically sound statement on the impact of RF-EMF on human brain activity in resting-state EEG. Further studies which apply comparable, standardized study protocols are recommended.

Open access paper: https://onlinelibrary.wiley.com/doi/full/10.1002/bem.22194

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Relationship between the use of electronic devices and susceptibility to multiple sclerosis

Khaki-Khatibi F, Nourazarian A, Ahmadi F, Farhoudi M, Savadi-Oskouei D, Pourostadi M, Asgharzadeh M. Relationship between the use of electronic devices and susceptibility to multiple sclerosis. Cogn Neurodyn. 2019 Jun;13(3):287-292. doi: 10.1007/s11571-019-09524-1.

Abstract

Multiple sclerosis (MS) is an autoimmune condition influenced by both genetic and environmental factors. Dirty electricity generated by electronic equipment is one of the environmental factors that may directly or indirectly impact MS susceptibility. The current Study aimed to evaluate the relationship between the usage time of electronic equipment and susceptibility to MS in North-West Iranian people. This approach was carried out upon 471 MS-diagnosed patients and 453 healthy participants as control group in East Province of Azerbaijan. By utilizing structured questionnaires, the information of all participants about usage status of some electronic devices was obtained. Data were analyzed by IBM SPSS Statistics version 18.0 and the quantitative variables were analyzed by Chi Square and Independent sample t tests. P values below or equal to 0.05 were considered as significant. Among the evaluated items in this approach, the utilization of cell phones and satellite television dishes were significantly higher in MS patients ($p < 0.001$, $p = 0.07$). Furthermore, a correlation was observed between sleeping with cell phone and/or laptop under the pillow ($p = 0.011$) and MS disease; however, there was no significant differences between MS patients and controls in computer using and television watching. Our study reinforces the concept that the utilization of some electronic devices and the continuous exposure to dirty electricity would increase the risk of MS disease thereupon by enhancing the cognizance of adverse effects of dirty electricity and reducing the time spent over electronic devices during adolescence and adulthood the occurrence probability of MS could be declined.

https://www.ncbi.nlm.nih.gov/pubmed/31168332

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Electromagnetic exposure from mobile phones in a city like environment: The case study of Leuven, Belgium

Iyare RN, Volskiy V, Vandenbosch GAE. Study of the electromagnetic exposure from mobile phones in a city like environment: The case study of Leuven, Belgium. Environmental Research. Available online 26 May 2019. https://doi.org/10.1016/j.envres.2019.05.029

Highlights

- Mobile phone (MP) exposure values are far above the exposures due to base stations.
- MP exposure is considerably higher for indoor environments compared to outdoor.
- Exposure is lower for locations close to base stations than locations further away.
- All exposures are in compliance with the SAR limit recommended by ICNIRP.

Abstract

A measuring campaign for the assessment of electromagnetic exposure levels from mobile phones in the city center of Leuven, Belgium, has been carried out. The main objective of the assessment is to study the dependency of the exposure of the user by his own mobile phone in terms of location in the city (very close to base stations and at randomly selected locations). The measurements were performed in both public and private areas in 60 outdoor and 60 indoor locations in Leuven. The campaign was focused on GSM 900 mobile communications. The results show that the exposure is considerably higher for indoor environments compared to outdoor environments, and at the randomly chosen locations compared to locations very close to base stations. However, the most important observation is that the average outdoor exposure in Leuven of the user

of a mobile phone is about 8 times higher than the average outdoor exposure by base stations. Indoors, this factor rises to about 30.

Excerpts

All results obtained in this measurement campaign are for a mobile phone with an active connection (a voice call). Field values were obtained through an app installed on a mobile phone. The app called Quanta pro [48] (shown in Figure 1) gets active (records the emissions from the mobile phone) immediately when a call is made with the mobile phone. This means that RF exposures were obtained during typical phone usage. During the exposure measurement, the mobile phone user makes a phone call of six minutes duration at a specific point in the measurement environment while the app concurrently keeps track of the power values transmitted by the antenna of the mobile phone.

Conclusions: The electromagnetic radiation exposure from mobile phones operating under GSM 900 in a typical city center, Leuven, Belgium, was assessed using a calibrated app installed on a representative mobile (smart) phone. The calibration was performed with a highly accurate spectrum analyzer based set-up. The levels averaged over the city center are: outdoors about 5.54 and 6.18 V/m for locations near base stations and arbitrarily chosen locations, respectively, and indoors about 10.36 and 30.87 V/m, also for locations near base stations and arbitrarily chosen locations, respectively. To the average, near base stations the indoor exposure is about a factor of two higher than the outdoor exposure. This smaller factor is due to the fact that the indoor exposure was measured at higher floors of buildings. At arbitrary locations the indoor exposure is about a factor of five higher than the outdoor exposure. These measurements were always done at floor level. All measured values are far above the values typically measured for the exposure due to base stations, even far above the maximum exposure level defined in the norm in Flanders, which is 3 V/m per antenna at 900 MHz. It can easily be concluded that the deployment of infrastructure, typically in the form of microcells, hotspots or distributed relays, should aim at minimizing mobile phone exposure and not necessarily the exposure by the base station itself. This may require a paradigm shift in the public opinion.

https://www.ncbi.nlm.nih.gov/pubmed/31154230

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Personal RF-EMF exposure from mobile phone base stations during temporary events

Ramirez-Vazquez R, Gonzalez-Rubio J, Arribas E, Najera A.Personal RF-EMF exposure from mobile phone base stations during temporary events. Environ Res. 2019 May 21;175:266-273. doi: 10.1016/j.envres.2019.05.033.

Abstract

BACKGROUND: In recent years, radiofrequency electromagnetic fields (RF-EMF) exposure has increased owing to new communication technologies. Simultaneously, increased exposure to RF-EMF has led to society's growing concern about the possible effects they may have on human health. Many studies have described personal RF-EMF exposure by using personal exposimeters to know a population's daily exposure to mobile phone base stations and to other sources whose installations tend to be permanent. Nonetheless during special events like concerts or fairs, where many people gather, permanent installations might not suffice to cover demand. So telephone companies install temporary stations for these events, and modify the exposure pattern of these areas or populations.

OBJECTIVE: To study if installing temporary antennae for large events, and high concentrations of mobile phones, modify the exposure pattern compared to usual situations.

METHODS: Personal RF-EMF exposure from mobile phones (uplink) and mobile phone base stations (downlink) installed at the 2017 Albacete Fair (Spain) was recorded. Between 7 and 17 September, more than

2,500,000 people visited this Fair. Measurements were taken by two Satimo EME SPY 140 personal exposimeters, placed one each side of a research team member's waist. These exposimeters were programmed to take measurements every 4 s at different time of day; morning, afternoon and night; and in several places, around the Fair Enclosure (zones Ejidos and Paseo) and inside the enclosure (Interior). These measurements were repeated on a weekday, at the weekend and the day after the Fair ended after temporary base stations had been removed. They were also taken for 1 h in all three zones, for each time of day; that is, 9 h were recorded for each study day.

RESULTS: The mean RF-EMF recorded exposure from base stations (downlink-DL) on the days the Fair opened (morning, afternoon and night) for the three studied zones was 791.8 μW/m2, while the exposure produced by mobile phones (uplink-UL) was 59.0 μW/m2. These values were 391.2 μW/m2 (DL) and 10.3 μW/m2 (UL) a few days after the event ended. In study zones Ejidos and Paseo, both outside, the highest mean exposure was recorded at the weekend as 1494.1 and 848.1 μW/m2 respectively. For the Interior zone, the mean value recorded during the Fair was 354.8 μW/m2. These values contrast with those recorded in the three zones after the event ended: 556.37 (Ejidos), 144.1 (Paseo); 473.21 μW/m2 (Interior). The fact that the mean exposure recorded at Interior was slightly higher after the Fair could be due to signal shielding by so many people. The reduction in exposure in Paseo after the Fair was outstanding, probably due to the antennae being placed on low towers. Major differences were also found in the RF-EMF exposure from UL. In this case, the weekend values taken during the Fair were between 28.2 μW/m2 at Interior (weekday) and 98.1 μW/m2 at Ejidos (weekend), which dropped to 5.5 at Paseo after the Fair, to 11.7 μW/m2 at Interior and to 13.6 μW/m2 at Ejidos.

CONCLUSIONS: Installing mobile phone base stations, and a dense public using mobile phones, imply a significant increase in personal RF-EMF exposure compared to that recorded during normal periods in the same area. However, the recorded measurements were below legally established limits.

https://www.ncbi.nlm.nih.gov/pubmed/31146098

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Emissions From Smart Meters and Other Residential Radiofrequency Sources

Aerts S, Verloock L, Van den Bossche M, Martens L, Vergara X, Joseph W. Emissions From Smart Meters and Other Residential Radiofrequency Sources. Health Phys. 2019 Jun;116(6):776-788. doi: 10.1097/HP.0000000000001032.

Abstract

The advent of the Internet of things comes with a huge increase in wirelessly communicating devices in our environment. For example, smart energy-consumption meters are being widely deployed in residences from which they communicate their state using radiofrequency networks. Accurate characterization of the radiofrequency emissions from emerging residential wireless solutions is important to inform the public about the potential impact on their exposure to radiofrequency electromagnetic fields. A new measurement procedure to determine the exposure from residential radiofrequency devices is proposed by assessing the peak emitted fields at various distances and the proportion of time they transmit (duty cycle). Radiofrequency emissions from 55 residential devices were measured in 10 residences (Belgium and France) and compared to environmental levels, emissions from 41 mobile phones, and international standards. Overall, residential levels of radiofrequency electromagnetic field exposure are low. In addition to the continuous environmental exposure, wireless access points (due to frequent use) and especially mobile phones and other personal communication devices (due to their use close to the body) continue to represent the bulk of the radiofrequency electromagnetic field exposure in the smart home. However, some residential devices can significantly increase the exposure if their duty cycles are high enough (>10%), especially when held or used close to the body. Individual smart meters, on the other hand, will contribute only little in general, despite emissions of up to 20 V m at 50 cm, due to their low duty cycles (maximum 1%) and locations.

https://www.ncbi.nlm.nih.gov/pubmed/30883437

Conclusions

In this study, a novel measurement method was designed to characterize in situ residential RF emissions from emerging wireless solutions (e.g., IoT sources and smart meters) by determining the RF transmission frequency, the peak emitted fields at various distances, and the proportion of transmission time (i.e., duty cycle), for which the spectrogram mode of a spectrum analyzer was used. This method was applied to a convenience sample of 10 residences in Belgium and France containing, in total, 55 IoT devices, smart meters, and other RF-emitting devices. The measured emissions were also compared to present levels of telecommunications and broadcasting signals, emissions by a mobile phone using three current telecommunications technologies (GSM, UMTS, and LTE), as well as to the ICNIRP guidelines for general public RF-EMF exposure.

Overall, low to very low emissions were measured for nearly all of the devices, and it is concluded that, in addition to the continuous exposure due to environmental sources, when used, wireless access points and especially mobile phones and other personal communication devices (e.g., DECT cordless phones, walkie-talkies) will continue to represent the bulk of our exposure to radiofrequency electromagnetic fields in the smart home, due to their typically high emissions and use close to the body. However, RF-emitting devices with high duty cycles (e.g., in this sample, motion sensor, baby monitor, and an IoT toothbrush) may significantly increase the potential for exposure, especially when used or located close to the body. The potential impact on the exposure due to individual smart meters, on the other hand, and in particular due to the communications modules wirelessly linked to a utility company's central network, is small, regardless of their emissions of up to 20 V m^{-1} at 0.2 m, given their rare transmissions and usual deployment away from the residents.

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Assessment of Personal Occupational Exposure to RF EMF in Libraries and Media Libraries, Using Calibrated On-Body Exposimeters

Massardier-Pilonchery A, Nerrière E, Croidieu S, Ndagijimana F, Gaudaire F, Martinsons C, Noé N, Hours M. Assessment of Personal Occupational Exposure to Radiofrequency Electromagnetic Fields in Libraries and Media Libraries, Using Calibrated On-Body Exposimeters. Int. J. Environ. Res. Public Health 2019, 16(12), 2087; https://doi.org/10.3390/ijerph16122087.

Abstract

Background and Objectives: With the spread of Wifi networks, safety concerns have arisen, with complaints of somatic disorders, notably in traditional libraries and media libraries. The aim of the present study was to describe the conditions and levels of exposure to radiofrequency electromagnetic fields in the real-life occupational conditions of those working in traditional libraries and media libraries.

Methods: Dynamic measurements, using an exposimeter, were taken in 20 radiofrequency bands from 88 to 5850 MHz. The activity of 28 library workers was analyzed on a space-time budget. An audit of exposure sources and static measurements enabled the work-places to be mapped.

Results: In seven libraries, 78,858 samples were taken over the 20 radiofrequency bands from 88 to 5850 MHz. Exposure was described for 28 working days. The median total field was 0.071 V/m (10th percentile: 0.022 V/m, 90th percentile: 0.534 V/m) and for Wifi the median field was 0.005 V/m (10th percentile: 0.005 V/m, 90th percentile: 0.028 V/m). Median individual exposure to Wifi frequency waves ranged from 0.005 to 0.040 V/m.

Conclusions: Overall, the occupational exposure in this sector was close to the exposure in the general population. Peaks were due to the use of walkie-talkies by security staff. Exposure due to external sources depended on geographic location. Exposure in this occupation is well below the general occupational exposure levels, notably as regards Wifi.

Conclusions

The aim of this study was to assess electromagnetic exposure of employees in libraries, notably, to Wifi.
On average, occupational exposure in this branch is close to that of the general population. The highest peaks were associated with walkie-talkie use by security staff. Exposure to outside sources depended on the geographic location. Employees' exposure was largely below the occupational norms, notably as regards Wifi. Static exposure from radiofrequency outdoor emissions (UMTS, GSTM) and from indoor Wifi spots is found to be 10 times lower than electromagnetic limit values defined by ICNIRP.
The exposure of workers to electromagnetic fields is rarely explored by occupational practitioners due to a lack of methodology to perform this evaluation. The present methodology for describing exposure could be transposed to other occupational radiofrequency exposure contexts, given persisting doubts about the health risks involved and the current legislation.

What is New in This Paper?
Exposure to radiofrequency electromagnetic fields due to new technologies in the real-life occupational conditions in library and media libraries is not well characterized. This study finds an exposure close to the general population. However, high peaks were due to the use of walkie-talkies by security staff. Exposure due to external sources depended on geographic location.

Open access paper: https://www.mdpi.com/1660-4601/16/12/2087/htm

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An Extremely Safe Low-SAR Antenna with Study of Its Electromagnetic Biological Effects on Human Head

Nazeri A, Abdolali A, Mehdi M. An extremely safe low-SAR antenna with study of its electromagnetic biological effects on human head. Wireless Personal Communications. 1-14. Published online May 17, 2019. https://doi.org/10.1007/s11277-019-06621-6

Abstract

In this paper, a new low-Specific Absorption Rate (SAR) antenna is proposed for the sake of safe communication in all situations. The proposed antenna involves a Microstrip patch antenna and a metallic casing loop which leads to SAR reduction. The structure operates at 0.9 GHz and 2.4 GHz which produces 0.52 W/kg and 0.25 W/kg SAR value on the human head, respectively. Then, in order to guarantee the antenna safety feature, the experiments are carried out when the human wear an earring. The impact of metallic earrings in different sizes on SAR distribution is investigated. Also, the antenna orientation and rotation effect is considered in detail. It is concluded that the change of Antenna position or use of metallic earrings makes an extremely significant impact on SAR value. But, the results of the presented antenna demonstrate that the produced SAR value in all positions, do not exceed the safe rate. It makes the antenna a suitable candidate for employing in most telecommunication applications.

Conclusions

In this paper, a novel low-SAR Microstrip Antenna for using in a safe communication is designed. The proposed antenna produces 0.52 W/kg and 0.25 W/kg SAR value on the head at 0.9 and 2.4 GHz. The antenna is created of a microstrip patch and a metallic loop. An extensive study is accomplished on the destructive effects of EM-waves on the human body. Also, the effect of the human head on the antenna performance is investigated. In addition, earrings with several different sizes are employed to consider the

cases which make the worst destructive effect on the human head. The effect of antenna rotation and changes in its orientation is studied as well. It is concluded that antenna rotation causes a significant impact on SAR value when earrings are used. At last, this study guarantees that the presented antenna make a safe SAR for most of the situations.

https://link.springer.com/article/10.1007/s11277-019-06621-6

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Effects of Radiofrequency Exposure and Co-Exposure on Human Lymphocytes: Influence of Signal Modulation and Bandwidth

Romeo S, Sannino A, Zeni O, Angrisani L, Mass R, Scarfi MR. Effects of radiofrequency exposure and co-exposure on human lymphocytes: The influence of signal modulation and bandwidth. IEEE Journal of Electromagnetics, RF and Microwaves in Medicine and Biology, May 20, 2019. DOI: 10.1109/JERM.2019.2918023

Abstract

The occurrence of modulation-specific effects after co-exposures to Radiofrequency (RF) and other agents has been discussed in the literature. In this paper, the influence of modulation and bandwidth in eliciting the DNA damage of RF alone and in combination with mitomycin-C (MMC), is analyzed in human lymphocytes. Blood cultures from healthy donors were exposed to 1950 MHz, and Continuous Wave (CW), Wideband Direct-Sequence Code Division Multiple Access (WCDMA, 4.5 MHz bandwidth), and Additive White Gaussian Noise (AWGN, 9 MHz bandwidth) signals were considered. For each signal, SAR values of 0.15, 0.3, 0.6, 1.25 W/kg were tested. RF exposure alone never induced DNA damage in the micronucleus assay. When RF exposure was followed by MMC treatment, the effect depended on modulation and bandwidth. CW exposure never altered the MMC-induced DNA damage, while such damage was reduced when either signals WCDMA at 0.3 W/kg SAR or AWGN at 0.15 and 0.3 W/kg were applied. These results indicate the influence of modulation for the occurrence of the protective effect, with a relation between the bandwidth and the power absorbed by samples. If confirmed in vivo, clinical applications using modulated RF signals could be devised, to protect cells from side effects of therapeutic treatments.

RF electromagnetic fields reduce the DNA damage induced by the chemical agent Mitomycin-C (MMC) in human lymphocytes. The effect is dependent on signal modulation and bandwidth.

Conclusions

The results of the present investigation provide further evidence that RF exposure can prompt a protective effect in mammalian cells against subsequent genotoxic insults. Moreover, in the current experimental conditions, taking advantage of a systematic comparison with the CW exposure, our findings highlight the modulation scheme and the signal bandwidth as crucial factors for the occurrence of the protective effect.

Having said the above, if proved in in vivo models, a new research horizon lies ahead of us, as a potential, innovative clinical application of RF electromagnetic fields, exploiting the protective effect, could be proved. In radio-biology the AR phenomenon has been proposed as a way to protect healthy cells from side effects of chemo/radio-therapeutic treatments, by pre-treatments with low doses of ionizing radiation. However, such proposal never moved into clinical practice due to the risk of cellular transformation as a biological consequence of protracted, low-dose rate exposures to ionizing radiation [35]. The possibility of inducing AR by RF pre-treatments may overcome this issue, due to the non-ionizing nature of these fields. Moreover, RF-induced protection has been here proved to be a tunable phenomenon de-pending on the electromagnetic conditions adopted, which could be able to target different cell types located at different depths in the body. In addition, potential biomedical applications exploiting the protective effect of RF could benefit from the availability of commercially established, low-cost RF sources.

Take-Home Messages

The innovative feature of RF electromagnetic fields shown here, consists in offering protection to human cells against the damaging action of a chemical agent.
The protective effect of RF electromagnetic fields occurs in presence of modulated signals and depends on signal bandwidth, as well as on SAR level.
RF-induced protective effect has been here proved, on an in vitro model, to be a tunable phenomenon depending on the electromagnetic conditions adopted, which provides a step towards applications targeting cells located at different depths in the body.
These findings suggest the existence of a complex interaction between modulated RF fields and biological systems. Such interaction becomes detectable when samples are appropriately sensitized, such as when RF exposure is combined with other chemical or physical treatments.

https://ieeexplore.ieee.org/document/8718560

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Thermal Analysis Complementary to Standardized Experimental Dosimetry of SAR in Human Head

Ilie-Săndoiu AM, Morega M, Morega AM. Thermal Analysis Complementary to Standardized Experimental Dosimetry of SAR in Human Head. 2019 11th International Symposium on Advanced Topics in Electrical Engineering (ATEE). 28-20 March 2019. DOI: 10.1109/ATEE.2019.8724859

Abstract

Cellular phones (CPs) intensive, long-term usage may raise concerns regarding collateral effects such as hyperthermia through direct exposure to electromagnetic field, and direct thermal contact to the outer ear.Among other methods used to evaluate the thermal menace posed by CPs, the physical experiments, conducted on equivalent phantoms play an important role. Replacing the head content with biologically–equivalent fluid is considered to provide for satisfactory experimental conditions with the aim to assess realistic "specific energy absorption rate" (SAR) levels and the pending thermal load. Moreover, numerical experiments may complement physical experiments, strengthening the predictive consistency of this already standardized lab approach.A numerical model of the human head and radiation source is designed and validated in compliance with experimental electromagnetic dosimetry standards with the aim of extending and processing useful information from limited experimental output. The current study goes further by exploring the heat absorption from the CP used nearby the head, making use of numerical simulation of the coupled electromagnetic and thermal problems, applied on models with varying degrees of realism. The analysis presented here concentrates on the assessment of cumulative contributions - energy absorption through SAR and direct contact with the heated CP device - on raising the temperature.

Conclusions

Present work shows some results from a numerical study performed on a phantom-like head model, the SAM head, described by international standards that are used for the certification of mobile phone devices [6], [7]. This benchmark numerical model was initially developed and validated through experiment for SAR dosimetry [8], but its applicability is extended here for heating estimates. A combined thermal dosimetry analysis is performed, taking two heating sources into account, i.e. the well-documented temperature rise from radiofrequency power absorption and additional warming from direct contact of the ear with the casing of the phone (heated by power dissipation inside the device). The results show a highly non-uniform distribution of the temperature inside the target volume, as much as a slight increase of the local temperature on the hot spots, due to the additional ear surface warming.

One could see that all the analysis was performed on a very simplified numerical model, if compared against true anatomy and functionality of the human head (i.e. non-homogeneous anatomical structure with specific

physical properties and energy transfer under the influence of subtle physiology mechanisms – metabolism, blood perfusion); realistic conditions could bring substantial differences. However, the cumulative effect of the heating sources is a reality; it depends on the emitted power and complexity of the phone and operation conditions and it is commonly sensed during long conversations because it creates discomfort to the phone user. This aspect needs to be considered more carefully in the assessment of bio-thermal effects and human protection.

https://ieeexplore.ieee.org/document/8724859

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Evaluation of the Effect of Cellular Phones on Salivary Levels of IL-10

Pedrami A, Arbabi-Kalati F. Evaluation of the Effect of Cellular Phones on Salivary Levels of IL-10. Iran J Public Health. 2019 Feb; 48(2): 367–368.

No abstract.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6556189/

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Glioma incidence and survival variations by county-level socioeconomic measures

Cote DJ, Ostrom QT, Gittleman H, Duncan KR, CreveCoeur T, Kruchko C, Smith TR, Stampfer MJ, Barnholtz-Sloan J. Glioma incidence and survival variations by county-level socioeconomic measures. Cancer. 2019 Jun 17. doi: 10.1002/cncr.32328.

Abstract

BACKGROUND: Multiple studies have reported higher rates of glioma in areas with higher socioeconomic status (SES) but to the authors' knowledge have not stratified by other factors, including race/ethnicity or urban versus rural location.

METHODS: The authors identified the average annual age-adjusted incidence rates and calculated hazard ratios for death for gliomas of various subtypes, stratified by a county-level index for SES, race/ethnicity, US region, and rural versus urban status.

RESULTS: Rates of glioma were highest in counties with higher SES (rate ratio, 1.18; 95% CI, 1.15-1.22 comparing the highest with the lowest quintiles [P < .001]). Stratified by race/ethnicity, higher rates in high SES counties persisted for white non-Hispanic individuals. Stratified by rural versus urban status, differences in incidence by SES were more pronounced among urban counties. Survival was higher for residents of high SES counties after adjustment for age and extent of surgical resection (hazard ratio, 0.82; 95% CI, 0.76-0.87 comparing the highest with the lowest quintile of SES [P < .001]). Survival was higher among white Hispanic, black, and Asian/Pacific Islander individuals compared with white non-Hispanic individuals, after adjustment for age, SES, and extent of surgical resection, and when restricted to those individuals with glioblastoma who received radiation and chemotherapy.

CONCLUSIONS: The incidence of glioma was higher in US counties of high compared with low SES. These differences were most pronounced among white non-Hispanic individuals and white Hispanic individuals residing in urban areas. Better survival was observed in high SES counties, even when adjusting for extent of surgical resection, and when restricted to those who received radiation and chemotherapy for glioblastoma. Differences in incidence and survival were associated with SES and race, rather than rural versus urban status.

Conflict of Interest Disclosures

Quinn T. Ostrom was supported by a Research Training Grant from the Cancer Prevention and Research Institute of Texas (RP160097T). Meir J. Stampfer has served as a paid expert witness for Verizon (represented by the Alston Bird Law firm) in a lawsuit regarding the alleged link between cell phones and brain cancer for work performed outside of the current study. The law firm and company had no knowledge of or influence on the current study. The other authors made no disclosures.

https://www.ncbi.nlm.nih.gov/pubmed/31206646

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Controversies around electromagnetic fields and electromagnetic hypersensitivity. The construction of "low noise" public problems

Dieudonné M. [Controversies around electromagnetic fields and electromagnetic hypersensitivity. The construction of "low noise" public problems]. [Article in French] . Sante Publique. 2019 January February;Vol. 31(1):43-51. doi: 10.3917/spub.191.0043.

Abstract

For two decades, health effects of electromagnetic fields (EMF) and electromagnetic hypersensitivity (EHS) have become increasingly controversial topics in France. They constitute "low noise" public problems, whose construction seems impossible to complete : they can neither be eliminated from the political agenda nor durably included. This article analyses the political process leading to this situation using qualitative data. In line with previous studies of the dispute surrounding mobile phone base stations, it shows how the controversy around EMF health effects emerged from an urban planning problem subsequently converted into a public health issue. This conversion gave rise to a spin-off controversy surrounding EHS, which quickly grew to become a controversy of its own. The study of these controversies reveals how the democracy crisis affecting public risk management increases the risk of false health alarms. It also explains why EHS fails to get as medically recognized as other functional somatic syndromes, like fibromyalgia. Medically unexplained symptoms thus appear likely to contribute significantly to health controversies.

https://www.ncbi.nlm.nih.gov/pubmed/31210515

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Chronotoxicity of 1.8 GHz radio-frequency radiation on plasma stress hormones and immune factors in mice

Qin F, Shen T, Li J, Xu B, Chen Y, Zheng ZA, Zou D. [Chronotoxicity of 1.8 GHz radio-frequency radiation on plasma stress hormones and immune factors in mice]. [Article in Chinese]. Wei Sheng Yan Jiu. 2019 May;48(3):482-487.

Abstract

OBJECTIVE: To study the chronotoxicity of radio-frequency radiation(RF) on the plasma stress hormones and immune factors in mice.

METHODS: A total of 72 healthy C57 BL mice with circadian rhythm were divided into twelve groups: 6 Sham group and 6 RF groups. RF groups were exposed to 1.8 GHz RF at 226 μW/cm~2 for 60 days with 2 h/day respectively at corresponding zeitgeber time(ZT 0:00, ZT 4:00, ZT 8:00, ZT 12:00, ZT 16:00, ZT 20:00). The Sham group mice were exposed to the same condition without electromagnetic signal. At the end of last RF

exposure, blood samples were collected from each animal. The concentrations of plasma stress hormones(ACTH, CORT) and immune factors(GM-CSF, TNF-α) were determined by enzyme linked immunosorbent assay(ELISA) method.

RESULTS: The daily average levels of ACTH, CORT, GM-CSF and TNF-α were 84.12, 60.14, 1112.02 and 594.49 ng/L, which were decreased to 62.07, 41.21, 84.18 and 305.08 ng/L after 60 days of RF exposure. Compared to sham-exposed animals, the daily average levels of ACTH, CORT, GM-CSF and TNF-α were all significantly decreased($P<0.05$). Circadian rhythms in the secreting of CORT, GM-CSF, TNF-α were disappeared($P>0.05$), circadian rhythms of ACTH was shifted in RF-exposed mice, with the amplitude reduced from 12.45 to 4.88 and peak time postponed from 1:39 to 5:29.

CONCLUSION: 1.8 GHz RF may weaken the function of stress and immune, and disturb their circadian rhythmicities.

https://www.ncbi.nlm.nih.gov/pubmed/31133139

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Sensitivity of EMF effects on childhood leukemia to confounding by residential mobility

Amoon AT, Arah OA, Kheifets L. The sensitivity of reported effects of EMF on childhood leukemia to uncontrolled confounding by residential mobility: a hybrid simulation study and an empirical analysis using CAPS data. Cancer Causes Control. 2019 May 29. doi: 10.1007/s10552-019-01189-9.

Abstract

PURPOSE: Residential mobility is considered as a potential source of confounding in studies assessing environmental exposures, including in studies of electromagnetic field (EMF) exposures and childhood leukemia.

METHODS: We present a hybrid simulation study where we simulate a synthetic dataset based on an existing study and use it to assess the sensitivity of EMF-leukemia associations to different scenarios of uncontrolled confounding by mobility under two major hypotheses of the infectious etiology of childhood leukemia. We then used the findings to conduct sensitivity analysis and empirically offset the potential bias due to unmeasured mobility in the California Power Line Study dataset.

RESULTS: As expected, the stronger the assumed relationship between mobility and exposure and outcome, the greater the potential bias. However, no scenario created a bias strong enough to completely explain away previously observed associations.

CONCLUSIONS: We conclude that uncontrolled confounding by residential mobility had some impact on the estimated effect of EMF exposures on childhood leukemia, but that it was unlikely to be the primary explanation behind previously observed largely consistent, but unexplained associations.

https://www.ncbi.nlm.nih.gov/pubmed/31144088

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Amplitude-modulated RF EMF blocks growth of hepatocellular carcinoma via voltage-gated calcium channels and calcium ion influx

Jimenez H, Wang M, Zimmerman JW, et al. ..., Blackman CF, Pasche BC. Tumour-specific amplitude-modulated radiofrequency electromagnetic fields induce differentiation of hepatocellular carcinoma via targeting Cav3.2 T-type voltage-gated calcium channels and Ca2+ influx. EBioMedicine. 2019 May 24. pii:

S2352-3964(19)30342-1. doi: 10.1016/j.ebiom.2019.05.034. [Epub ahead of print]

Abstract

BACKGROUND: Administration of amplitude modulated 27·12 MHz radiofrequency electromagnetic fields (AM RF EMF) by means of a spoon-shaped applicator placed on the patient's tongue is a newly approved treatment for advanced hepatocellular carcinoma (HCC). The mechanism of action of tumour-specific AM RF EMF is largely unknown.

METHODS: Whole body and organ-specific human dosimetry analyses were performed. Mice carrying human HCC xenografts were exposed to AM RF EMF using a small animal AM RF EMF exposure system replicating human dosimetry and exposure time. We performed histological analysis of tumours following exposure to AM RF EMF. Using an agnostic genomic approach, we characterized the mechanism of action of AM RF EMF.

FINDINGS: Intrabuccal administration results in systemic delivery of athermal AM RF EMF from head to toe at levels lower than those generated by cell phones held close to the body. Tumour shrinkage results from differentiation of HCC cells into quiescent cells with spindle morphology. AM RF EMF targeted antiproliferative effects and cancer stem cell inhibiting effects are mediated by Ca2+ influx through Cav3·2 T-type voltage-gated calcium channels (CACNA1H) resulting in increased intracellular calcium concentration within HCC cells only.

INTERPRETATION: Intrabuccally-administered AM RF EMF is a systemic therapy that selectively block the growth of HCC cells. AM RF EMF pronounced inhibitory effects on cancer stem cells may explain the exceptionally long responses observed in several patients with advanced HCC.

FUND: Research reported in this publication was supported by the National Cancer Institute's Cancer Centre Support Grant award number P30CA012197 issued to the Wake Forest Baptist Comprehensive Cancer Centre (BP) and by funds from the Charles L. Spurr Professorship Fund (BP). DWG is supported by R01 AA016852 and P50 AA026117.

Open access paper: https://www.ebiomedicine.com/article/S2352-3964(19)30342-1/fulltext

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Synergistic Effect of Radiofrequency EMF of Dental Light Cure Devices and Mobile Phones Accelerates Microleakage of Amalgam Restorations

Mortazavi SMJ, Dehghani Nazhvani A, Paknahad M. Synergistic Effect of Radiofrequency Electromagnetic Fields of Dental Light Cure Devices and Mobile Phones Accelerates the Microleakage of Amalgam Restorations: An in vitro Study. J Biomed Phys Eng. 2019 Apr 1;9(2):227-232.

Abstract

Background: Previous studies have shown that exposure to electromagnetic fields produced by magnetic resonance imaging or mobile phones can lead to increased microleakage of dental amalgam.

Objective: The aim of the present study was to investigate the effect of electromagnetic field of a commercial dental light cure device and a common GSM mobile phone on microleakage of amalgam restorations.

Materials and Methods: Identical class V cavities were prepared on the buccal surfaces of 60 non-carious extracted human teeth. The samples were randomly divided into 4 groups of 20 samples each. The samples in the first group were not exposed to electromagnetic fields, while the second and the third groups were exposed to electromagnetic fields produced by a commercial light cure device, or mobile phone radiation (60 min), respectively. The fourth group was exposed to electromagnetic radiations emitted by both mobile phone for 60

min and light cure device. Then, teeth samples were scored for microleakage according to a standard dye penetration protocol by examination under a stereomicroscope.

Results: The mean score of microleakage in the fourth group (light cure + mobile phone) was significantly higher than that of the control group (P =0.030). Moreover, the scores of microleakage in this group were significantly higher than that of the second group (light cure only) (P= 0.043).

Conclusion: Exposure of amalgam restorations to electromagnetic fields produced by both light cure devices and mobile phones can synergistically increase the microleakage of amalgam restorations.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6538905/

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Significant Cellular Viability Dependence on Time Exposition at ELF-EMF and RF-EMF In Vitro Studies

García-Minguillán López O, Jiménez Valbuena A, 2 Maestú Unturbe C. Significant Cellular Viability Dependence on Time Exposition at ELF-EMF and RF-EMF In Vitro Studies. Int. J. Environ. Res. Public Health 2019, 16(12), 2085; https://doi.org/10.3390/ijerph16122085.

Abstract

The human concern about the effect of electromagnetic fields (EMFs) has changed over time from the effects produced by EMFs of extremely low frequencies (ELFs) to the effects produced by exposure to a radio frequency (RF), with concerns shifting toward EMFs due to the development of new technologies and forms of communication. Previous studies have analysed the effects produced at different frequencies without considering in detail the effect of the time of exposure. Therefore, in the present study, we analysed in vitro the effect produced by a 100 μT EMF at different ELFs and exposure times in glioblastomas, as well as the effect produced in a fibroblast by an RF-EMF of 2.54 GHz. Our results indicate a significant time dependence in cell viability of fibroblasts exposed to an RF-EMF of 2.54 GHz and a non-time-dependent effect in cell viability of glioblastomas exposed to an ELF-EMF, highlighting the possible relation between frequency and time of exposure.

Conclusions

In most of the in vitro studies that have been done with EMFs, the time of exposure has not been considered in detail, even though cellular responses, such as cell proliferation, viability and death, clearly vary between chronic and acute exposure.

Our results demonstrate a time dependence of NIH/3T3 cell viability when exposed to an RF-EMF of 2.54 GHz, which decreases with time to obtain a 71.12% decline in viability after 21 h of exposure.

On the other hand, our results for an ELF-EMF of 100 μT have demonstrated non-time-dependent effects. Frequency dependence effects were observed, obtaining a primary increase in cell viability at 50 Hz and a reduction in cell viability at 30 Hz, showing that even the recommended exposure level affects cell viability.

Therefore, the relationship between the frequency and time of exposure could determine the cellular response, demonstrating a need for further research.

Open access paper: https://www.mdpi.com/1660-4601/16/12/2085/htm

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DNA effects of low level occupational exposure to extremely low frequency electromagnetic fields

(50/60 Hz)

Zendehdel R, Yu IJ, Hajipour-Verdom B, Panjali Z. DNA effects of low level occupational exposure to extremely low frequency electromagnetic fields (50/60 Hz).
Toxicol Ind Health. 2019 May 28:748233719851697. doi: 10.1177/0748233719851697.

Abstract

AIMS: Exposure to extremely low frequency magnetic fields (ELF-MF) occurs from natural and artificial sources. Although ELF-MF has been classified as a suspected humans carcinogen agent by the International Agency for Research on Cancer, little is known of the effects of ELF-MF at lower exposure levels of the recommended range. In the present study, DNA damage in the peripheral blood cells of power line workers was investigated.

MATERIALS AND METHODS: Occupational exposure to ELF-MF in a power plant was measured using the National Institute for Occupational Safety and Health (NIOSH) manual. Single-strand breaks (SSBs) in DNA were evaluated in 29 male utility workers as the exposed population and 28 male support personnel as the control subjects using the comet assay. Effects of ELF-MF on subjects were evaluated using DNA percent in tails, tail length, olive length, and tail moment.

RESULTS: Occupational exposure levels to ELF-MF in the utility workers were less than the threshold limit values (TLV) recommended by the American Conference of Government Industrial Hygienist (ACGIH). The median value of the magnetic field at the working sites was 0.85 μT. Induction of DNA damage was observed for the exposed workers compared with the controls. Olive length, tail moment, and tail DNA percent increased significantly ($p < 0.05$) in the utility workers.

CONCLUSIONS: Exposure to ELF-MF at levels less than the ACGIH exposure limit can produce DNA strand breaks.

https://www.ncbi.nlm.nih.gov/pubmed/31138035

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Impact of RF and LEDs on plants growth

Al Saadi A, ; Al Rashdi M, Al-Nassri H, Nadir Z, Khan M. Impact of RF and leds on plants growth. 7th Brunei International Conference on Engineering and Technology 2018 (BICET 2018). 12-14 Nov. 2018. DOI: 10.1049/cp.2018.1500.

Abstract

The agriculture sector is one of the most important sectors supporting the Gross National Product of many countries throughout globe. Improving the agricultural productivity with minimal natural resources is the possible solution to mitigate the worldwide food shortage. This paper discusses a new useful agricultural method by using electromagnetic fields to improve the seed germination and crop yields. Also, this study explored the possible impacts of LEDs with different colours to enhance seed germination. These applications may also have had a positive effect on increasing crop production in the longer term. This research focuses in studying the impact of electromagnetic field, red and blue LEDs on cucumber and marigold plants and analysing the plants after the application of these electromagnetic field treatments. The EM field wasproduced using RF transmitter of 2.4 GHz with horn antenna to expose the experiment plants to the maximum in order to get the best possible outcome.

Conclusion

Overall results exhibited that the exposure to electromagnetic field treatment yielded a slightly stressed environment, which affected the cucumber plant growth and especially marigold plants development. Increasing the electromagnetic field yielded to reduce plant length and flowering rate. Higher electrolyte leakage coupled with reduced plant growth may be a function of free radical processes. It has been reported earlier that free radicals are potentially detrimental in disrupting biological systems e. g. membrane (lipid peroxidation), DNA, proteins, damage. Apparently, our preliminary results showed similar mechanism of free radical process a source of abiotic stress factor in plants; however
repeated experiments on diverse crops are underway to validate our initial results on marigold. The plants in different light boxes were affected with the heat produced by the LEDs. This factor should be taken seriously in any upcoming work with limited closed space. Also, the Biology or microscopic analysis is recommended to investigate it in more
depth to conclude accordingly. The cucumber seeds inside the boxes did not germinate because of external effects (not related to our system) since even the seeds outside the boxes did not germinate.

https://ieeexplore.ieee.org/document/8726925

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Effects of Mobile Phone Exposure on Mast Cells in Rat Dura Mater

Tumkaya L, Kalkan Y, Gokce FM, Erdivanli B, Yilmaz A, Bahceci I, Yazici ZA, Mercantepe T. The Effects of Mobile Phone Exposure on Mast Cells in Rat Dura Mater. Int J Morphology. 37(2):719-723. Jun 2019.

Abstract

Mobile phone use has increased rapidly. The central nervous system has been shown to be adversely affected by its electromagnetic field (EMF) resulting in headache and sleep disturbances. How the cells make up the CNS and are affected by EMF is unclear. However, because of their central role in inflammation through diverse stimuli including radiation, this study aimed to investigate the effects of electromagnetic fields induced by mobile phones on mast cells in rat dura mater. A total of 18 adult, female, Sprague-Dawley rats were divided into two groups. The choice of female rats for his study was based on recent surveys demonstrating that mobile phone use is more frequent and prolonged among females. The study group was exposed to 900 MHz electromagnetic field (1 h/day for 45 days). In the end of the study, duramater tissue was extracted and stained using Toluidine blue. Mast cells were counted and results were analysed using Student t test. Mean mast cell number was 202.33 +/- 982 and 456.78 +/- 35.01 in the control and study groups, respectively ($p<0.05$). Analysis of serum electrolyte and immunoglobulin E levels showed no statistically significant difference between the two groups ($p>0.05$). The study showed that mobile phone exposure increased mast cell number and degranulation in rat dura mater. Further studies arc required to evaluate the clinical implications of these findings.

Open access paper: https://scielo.conicyt.cl/pdf/ijmorphol/v37n2/0717-9502-ijmorphol-37-02-00719.pdf

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Effect of Extremely Low-Frequency (ELF) Electromagnetic Fields on Musculoskeletal Disorders and Role of Oxidative Stress

Hosseinabadi MB, Khanjani N. The Effect of Extremely Low-Frequency Electromagnetic Fields on the Prevalence of Musculoskeletal Disorders and the Role of Oxidative Stress. Bioelectromagnetics. Published online June 18, 2019. https://doi.org/10.1002/bem.22198

Abstract

Extremely low-frequency electromagnetic fields (ELF-EMFs) may cause negative health effects. This study

aimed to investigate the direct and indirect effects of chronic exposure to extremely low-frequency electric and magnetic fields on the prevalence of musculoskeletal disorders (MSDs).

In this cross-sectional study, 152 power plant workers were enrolled. The exposure level of employees was measured based on the IEEE Std C95.3.1 standard. Superoxide dismutase (SOD), catalase (Cat), glutathione peroxidase (GPx), total antioxidant capacity (TAC), and malondialdehyde (MDA) (independent variables) were measured in the serum of subjects. The Nordic musculoskeletal questionnaire was used to assess MSDs (dependent variable).

The mean exposure of electric and magnetic fields were 4.09 V/m (standard deviation [SD] = 4.08) and 16.27 μT (SD = 22.99), respectively. Increased levels of SOD, Cat, GPx, and MDA had a direct significant relation with MSDs. In the logistic regression model, SOD (odds ratio [OR] = 0.952, P = 0.026), GPx (OR = 0.991, P = 0.048), and MDA (OR = 0.741, P = 0.021) were significant predictors of MSDs.

ELF-EMFs were not related to MSDs directly; however, increased levels of oxidative stress may cause MSDs.

https://onlinelibrary.wiley.com/doi/abs/10.1002/bem.22198

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Evidence of plasma membrane-mediated ROS generation upon ELF exposure in neuroblastoma cells

Merla C, Liberti M, Consales C, Denzi A, Apollonio F, Marino C, Benassi B. Evidences of plasma membrane-mediated ROS generation upon ELF exposure in neuroblastoma cells. Biochim Biophys Acta Biomembr. 2019 Jun 11. pii: S0005-2736(19)30137-3. doi: 10.1016/j.bbamem.2019.06.005.

Abstract

BACKGROUND: Molecular mechanisms of interaction between cells and extremely low frequency magnetic fields (ELF-MFs) still represent a matter of scientific debate. In this paper, to identify the possible primary source of oxidative stress induced by ELF-MF in SH-SY5Y human neuroblastoma cells, we estimated the induced electric field and current density at the cell level.

METHODS: We followed a computational multiscale approach, estimating the local electric field and current density from the whole sample down to the single cell level. The procedure takes into account morphological modeling of SH-SY5Y cells, arranged in different topologies. Experimental validation has been carried out: neuroblastoma cells have been treated with Diphenyleneiodonium (DPI) -an inhibitor of the plasma membrane enzyme NADPH oxidase (Nox)- administered 24 h before exposure to 50 Hz (1 mT) MF.

RESULTS: Macroscopic and microscopic dosimetric evaluations suggest that increased current densities are induced at the plasma membrane/extra-cellular medium interface; identifying the plasma membrane as the main site of the ELF-neuroblastoma cell interaction. The in vitro results provide an experimental proof that plasma membrane Nox exerts a key role in the redox imbalance elicited by ELF, as DPI treatment reverts the generation of reactive oxygen species induced by ELF exposure.

GENERAL SIGNIFICANCE: Microscopic current densities induced at the plasma membrane are likely to play an active physical role in eliciting ELF effects related to redox imbalance. Multiscale computational dosimetry, supported by an in vitro approach for validation, is proposed as the innovative and rigorous paradigm to unveil mechanisms underlying the complex ELF-MF interactions.

https://www.ncbi.nlm.nih.gov/pubmed/31199897

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Extremely low frequency electromagnetic radiation enhanced energy metabolism and induced oxidative stress in Caenorhabditis elegans

Sun YY, Wang YH, Li ZH, Shi ZH, Liao YY, Tang C, Cai P. [Extremely low frequency electromagnetic radiation enhanced energy metabolism and induced oxidative stress in Caenorhabditis elegans]. [Article in Chinese] . Sheng Li Xue Bao. 2019 Jun 25;71(3):388-394.

Abstract

The aim of this study was to determine the effects of extremely low frequency electromagnetic field (ELF-EMF) on energy metabolism and oxidative stress in Caenorhabditis elegans (C. elegans). Worms in three adult stages (young adult stage, egg-laying stage and peak egg-laying stage) were investigated under 50 Hz, 3 mT ELF-EMF exposure. ATP levels, ATP synthase activity in vivo, reactive oxygen species (ROS) content, and changes of total antioxidant capacity (TAC) were detected, and worms' oxidative stress responses were also evaluated under ELF-EMF exposure. The results showed that ATP levels were significantly increased under this ELF-EMF exposure, and mitochondrial ATP synthase activity was upregulated simultaneously. In young adult stage, worms' ROS level was significantly elevated, together with upregulated TAC but with a decreased ROS-TAC score indicated by principal component analysis. ROS level and TAC of worms had no significant changes in egg-laying and peak egg-laying stages. Based on these results, we concluded that ELF-EMF can enhance worm energy metabolism and elicit oxidative stress, mainly manifesting as ATP and ROS level elevation together with ATP synthase upregulation and ROS-TAC score decrease in young adult C. elegans.

https://www.ncbi.nlm.nih.gov/pubmed/31218329

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Effect of low frequency electromagnetic radiation on the morphology of dental and periodontal tissues

Markovskaya IV. The effect of low frequency electromagnetic radiation on the morphology of dental and periodontal tissues (experimental investigation). Wiad Lek. 2019;72(5 cz 1):773-778.

Abstract

OBJECTIVE: Low intensity electromagnetic effects possess a high biological activity, reduce the adaptive reserves of the body, impair immunity, adversely affect the functional state of the organs and body systems. The aim of the study was to identify in the experiment the effect of low-frequency electromagnetic radiation on the morphological state of the dental and periodontal tissue.

PATIENTS AND METHODS: The experiment was conducted on WAG rats weighing 180-200 g, during which two groups were formed: group 1 (control group) included 12 WAG rats, which were not performed any manipulations; the rats of group 2 (investigation group) (n=12) for 30 days were exposed to a 70 kHz low-frequency alternating electric field (5th frequency range) daily from 9.00 to 12.00. To simulate a low-frequency 70 kHz alternating electric field, certified experimental equipment was used. The study material was the upper jaw tissue. Histological and histochemical staining methods were used. Morphometric study was conducted.

RESULTS: Complex morphological study on the experimental material allowed identifying the damaging effect of low-frequency electromagnetic radiation on the structural components of tooth and periodontal tissues.

CONCLUSION: Our findings suggest that the workers who are exposed to occupational low-frequency electromagnetic radiation should be included in the risk group for developing diseases of the dentomandibular system in order to carry out timely therapeutic and preventive measures.

https://www.ncbi.nlm.nih.gov/pubmed/31175771

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Are increases in EMF in the human environment interacting with environmental pollution the tipping point for increases in neurological deaths?

Pritchard C, Silk A, Hansen L. Are rises in Electro-Magnetic Field in the human environment, interacting with multiple environmental pollutions, the tipping point for increases in neurological deaths in the Western World? Med Hypotheses. 2019 Jun;127:76-83. doi: 10.1016/j.mehy.2019.03.018.

Abstract

Whilst humans evolved in the earth's Electro-Magnetic-Field (EMF) and sun-light, both being essential to life but too much sun and we burn. What happens if background EMF rise to critical levels, coinciding with increasing environmental pollutants? Two of the authors can look back over 50 clinical years and appreciate the profound changes in human morbidity across a range of disparate conditions - autoimmune diseases, asthma, earlier cancer incidence and reduced male sperm counts. In particular have been increased autism, dyslexia, Attention Deficit Hyperactivity Disorder and neurological diseases, such as Amyotrophic Lateral Sclerosis, Multiple Sclerosis, Parkinson's Disease, Early Onset Dementia, Multiple System Atrophy and Progressive Supranuclear Palsy. What might have caused these changes-whilst genetic factors are taken as given, multiple environmental pollutants are associated with neurological disease although the mechanisms are unclear. The pace of increased neurological deaths far exceeds any Gompertzian explanation - that because people are living longer they are more likely to develop more age-related problems such as neurological disease. Using WHO global mortality categories of Neurological Disease Deaths (NDD) and Alzheimer's and Dementia deaths (Alz), updated June 2018, together they constitute Total Neurological Mortality (TNM), to calculate mortality rates per million for people aged 55-74 and for the over-75's in twenty-one Western countries. Recent increases in American people aged over-75's rose 49% from 1989 to 2015 but US neurological deaths increased five-fold. In 1989 based on Age-Standardised-Deaths-Rates America USA was 17th at 324 pm but rising to 539 pm became second highest. Different environmental/occupational factors have been found to be associated with neuro-degenerative diseases, including background EMF. We briefly explore how levels of EMF interact upon the human body, which can be described as a natural antennae and provide new evidence that builds upon earlier research to propose the following hypothesis. Based upon recent and new evidence we hypothesise that a major contribution for the relative sudden upsurge in neurological morbidity in the Western world (1989-2015), is because of increased background EMF that has become the tipping point-impacting upon any genetic predisposition, increasing multiple-interactive pollutants, such as rises in petro-chemicals, hormone disrupting chemicals, industrial, agricultural and domestic chemicals. The unprecedented neurological death rates, all within just twenty-five years, demand a re-examination of long-term EMF safety related to the increasing background EMF on human health. We do not wish to 'stop the modern world', only make it safer.

https://www.ncbi.nlm.nih.gov/pubmed/31088653

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The possible global hazard of cell phone radiation on thyroid cells and hormones: a systematic review

Asl JF, Larijani B, Zakerkish M, Rahim F, Shirbandi K, Akbari R. The possible global hazard of cell phone radiation on thyroid cells and hormones: a systematic review of evidences. Environ Sci Pollut Res Int. 2019 May 6. doi: 10.1007/s11356-019-05096-z.

Abstract

The aim of this review was to investigate the effects of possible harmful waves from either cell phone use or being within the range of the cell phone from 450 to 3800 MHz on the thyroid cells and hormones. Eight electronic datasets were systematically searched using MeSH terms, including "cell phone," "mobile phone,"

"GSM," "radio frequency," "smartphone," "triiodothyronine," "thyroxin," "thyroid-stimulating hormone," "T3," "T4," "TSH," and "morphological" and all possible combinations, to identify relevant studies published up to Dec 2018. We also manually searched the reference lists of potentially selected studies to identify further relevant publications. About 161 relevant studies were initially found. After screening titles and abstracts, 139 studies were excluded, and finally 22 studies (comprising 7182 cases) were included in the qualitative synthesis. Of the 22 included studies, 11 studies reported changes in T3 and T4 levels (six reported a decrease in T3 levels and one reported increase in it); moreover, five found decreased T4 levels and two studies an increased level. In other 10 studies, TSH alteration was reported. Of these, two studies reported a decrease in TSH level and one reported an increase in the hormone levels, while in the remaining studies non-significant changes were reported. Finally, seven studies examined histological changes in the thyroid gland follicles and showed that the volume of these cells was reduced. Based on the evidence discussed above, the reduction in diameter of thyroid follicles is potentially linked with cell phone radiation. Exposure may negatively influence the iodine uptake in the thyroid gland or increases temperature effect on the thyroid gland. However, further research are needed in order to show that the level of TSH and thyroid hormone suppression by microwave.

https://www.ncbi.nlm.nih.gov/pubmed/31062236

Also see: https://www.saferemr.com/2014/07/is-mobile-phone-use-contributing-to.html

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Effect of mobile phone radiofrequency signal on the alpha rhythm of human waking EEG: A review

Wallace J, Selmaoui B. Effect of mobile phone radiofrequency signal on the alpha rhythm of human waking EEG: A review. Environmental Research. Published online May 12, 2019. https://doi.org/10.1016/j.envres.2019.05.016

Abstract

In response to the exponential increase in mobile phone use and the resulting increase in exposure to radiofrequency electromagnetic fields (RF-EMF), there have been several studies to investigate via electroencephalography (EEG) whether RF-EMF exposure affects brain activity. Data in the literature have shown that exposure to radiofrequency signals modifies the waking EEG with the main effect on the alpha band frequency (8–13 Hz). However, some studies have reported an increase in alpha band power, while others have shown a decrease, and other studies showed no effect on EEG power. Given that changes in the alpha amplitude are associated with attention and some cognitive aspects of human behavior, researchers deemed necessary to look whether alpha rhythm was modulated under RF-EMF exposure. The present review aims at comparing and discussing the main findings obtained so far regarding RF-EMF effects on alpha rhythm of human waking spontaneous EEG, focusing on differences in protocols between studies, which might explain the observed discrepancies and inconclusive results.

Excerpts

Overview of 30 total selected studies which investigated the effect of the radiofrequency electromagnetic fields on human waking spontaneous EEG … 47% of studies found a significant modification exclusively of the alpha band, the 30% found a significant modification of the alpha band and other frequency bands (delta, theta, beta and gamma), the 3% (only one study) found an effect on the gamma and beta band, without any effect on the alpha rhythm, the 20% reported no significant effect on the EEG.

… MP-RF [mobile phone - radio frequency] can affect normal brain physiology and that the most consistent effect observed is in the alpha frequency. This effect is also observed after RF-EMF exposure. Some studies on adolescents (two studies included 2G system and one study included 3G system) did not indicate a higher sensitivity of this age group compared to adults. Conversely, four studies with epileptic patients showed an

effect on their brain's electrophysiology related to 2G exposure. Previous systematic reviews and meta-analyses indicated that acute MP exposures did not have any cognitive or psychomotor effects (Valentini et al., 2011), with a negligible impact on attention and working memory (Barth et al., 2007).

https://www.sciencedirect.com/science/article/pii/S0013935119302749

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Mobile phones: A trade-off between speech intelligibility and exposure to noise levels and to radio-frequency electromagnetic fields

Thielens A, Bockstael A, Declerck S, Aminzadeh R, Aerts S, Botteldooren D, Martens L, Wout J.Mobile phones: A trade-off between speech intelligibility and exposure to noise levels and to radio-frequency electromagnetic field. Environmental Research. Published online May 8, 2019. https://doi.org/10.1016/j.envres.2019.05.006.

Highlights

• First time measurement of simultaneous head exposure to RF-EMF and sound pressure during smartphone usage.
• Three use cases are compared: smartphone use at the ear, in speaker mode, and with a headset.
• We demonstrate that exposure to RF-EMF and sound pressure is highest when a phone held at the ear during calls.
• Speech intelligibility is more favourable when the phone is held at the ear in different background noise conditions.
• We demonstrate that reductions in exposure might come at a cost of speech intelligibility during wireless phone calls.

Abstract

When making phone calls, cellphone and smartphone users are exposed to radio-frequency (RF) electromagnetic fields (EMFs) and sound pressure simultaneously. Speech intelligibility during mobile phone calls is related to the sound pressure level of speech relative to potential background sounds and also to the RF-EMF exposure, since the signal quality is correlated with the RF-EMF strength. Additionally, speech intelligibility, sound pressure level, and exposure to RF-EMFs are dependent on how the call is made (on speaker, held at the ear, or with headsets). The relationship between speech intelligibility, sound exposure, and exposure to RF-EMFs is determined in this study. To this aim, the transmitted RF-EMF power was recorded during phone calls made by 53 subjects in three different, controlled exposure scenarios: calling with the phone at the ear, calling in speaker-mode, and calling with a headset. This emitted power is directly proportional to the exposure to RF EMFs and is translated into specific absorption rate using numerical simulations. Simultaneously, sound pressure levels have been recorded and speech intelligibility has been assessed during each phone call. The results show that exposure to RF-EMFs, quantified as the specific absorption in the head, will be reduced when speaker-mode or a headset is used, in comparison to calling next to the ear. Additionally, personal exposure to sound pressure is also found to be highest in the condition where the phone is held next to the ear. On the other hand, speech perception is found to be the best when calling with a phone next to the ear in comparison to the other studied conditions, when background noise is present.

Excerpt

To our knowledge, this is the first study that reports SAR values and emitted powers obtained using actual phone calls made by several volunteers in controlled exposure conditions. In addition, it is also to the authors' best knowledge, the first paper studying the joint exposure to sound and RF-EMF....

Conclusions

In this study, the transmitted radio-frequency electromagnetic field (RF-EMF) power was recorded for 53 subjects who carried out phone calls in three controlled exposure scenarios: calling with the phone at the ear, calling in speaker-mode, and calling with a headset. Phone calls were carried out using the Wideband Code Division Multiple Access (WCDMA) and Global System for Mobile communication (GSM) technologies. For both communication technologies, the emitted power of the phone at the ear was higher than the emitted power in the two other exposure conditions. Moreover, Finite-Difference Time-Domain simulations for a fixed emitted power showed that the brain-averaged specific absorption rate (SARbrain) was higher when the emitting antenna was located close to the ear than in speaker-mode and headset (94–350 times higher). The SARbrain values were then rescaled using the measured powers emitted using GSM technology during the experiments in order to estimate the RF-EMF absorption in the three studied scenarios. It was concluded that the SARbrain will be reduced by more than a factor 100 when either speaker-mode or a headset are used, in comparison to calling next to the ear. These results can be used as additional input for governmental institutions that issue guidelines on smart phone usage with the aim of lowering exposure. Furthermore, in conditions where background noise was present, speech perception was found to be the best when the phone was held at the ear in comparison to using the phone in speaker mode or with a headset. However, the exposure to sound pressure was also found to be the highest in the at-ear configuration, while it was lowest with the phone in speaker mode. Overall, the speaker-mode condition was found to be the configuration in which both exposures to RF-EMFs (in terms of SARbrain) and sound pressure were lowest, although reducing exposure by changing to this configuration does come at a cost in terms of speech intelligibility, in particular in noisy environments. Using a wired headset, on the other hand, was found to significantly reduce SARbrain while only reducing speech intelligibility by a small, yet significant in noisy conditions, amount in comparison to using the phone at the ear. These results are important for smartphone users that might be concerned about both exposure during their calls and about the quality of their calls.

https://www.sciencedirect.com/science/article/pii/S0013935119302580

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Effects of smartphone overuse on headache, sleep and quality of life in migraine patients

Demir YP, Sumer MM. Effects of smartphone overuse on headache, sleep and quality of life in migraine patients. Neurosciences (Riyadh). 2019 Apr;24(2):115-121. doi: 10.17712/nsj.2019.2.20180037.

Abstract

OBJECTIVE: To investigate the effects of smartphone overuse on headache, sleep quality, daytime sleepiness and quality of life in migraine patients.

METHODS: This study is a single-center, cross sectional comparative study. This study was conducted between July and September 2017 in the Neurology Clinic of a private hospital. Migraine disability assessment (MIDAS) questionnaire was used to evaluate the disability status, and Mobile Phone Problematic Use Scale (MPPUS) was used to evaluate smartphone use frequency. The Visual Analogue Scale (VAS), 24-h Migraine Quality of Life Questionnaire (24-h MQoLQ), Pittsburgh Sleep Quality Index (PSQI) and Epworth Sleepiness Scale (ESS) were used to evaluate the pain intensity, quality of life, sleep quality and daytime sleepiness, respectively.

RESULTS: The study included a total of 123 patients. There was a significant difference between the groups in terms of pain intensity, frequency and duration as well as VAS, PSQI, 24-h MQoLQ and ESS (p less than 0.05) scores. There was a negative correlation between MPPUS and PSQI (r=-0.367, p less than 0.05); a strong positive correlation between MPPUS and ESS (r=0.675, p less than 0.05) and a negative correlation between MPPUS and 24-h MQoLQ (r=-0.508, p less than 0.05).

CONCLUSION: Smartphone use has been observed to increase headache duration and frequency in migraine patients. Its overuse in migraine patients is related to poor sleep quality and daytime sleepiness; furthermore, as the smartphone use increases, sleep quality decreases, daytime sleepiness increases and quality of life decreases.

https://www.ncbi.nlm.nih.gov/pubmed/31056543

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Analysis of biological effects of cell phone radiation on human body using specific absorption rate and thermoregulatory response

Tanghid B. Rashid TB, Song HH. Analysis of biological effects of cell phone radiation on human body using specific absorption rate and thermoregulatory response. Microwave and Optical Technology Letters. 61(6):1482-1490. 2019. https://doi.org/10.1002/mop.31777

Abstract

Health and science have reached a point of intersection which has never existed before. With the recent rapid increase in the use of cellular phones and long periods of usage of these devices near the human body, public concern regarding potential health hazards due to absorption of electromagnetic energy has been growing. To address these issues, this research evaluates the average Specific Absorption Rate in different human tissues by varying source to antenna distance and radiated power using the ANSYS 3D human body model. The Pennes bioheat transfer equation was solved analytically to calculate the longtime exposure effect and temperature rise. The results show that regardless of the frequency, if the antenna radiated power is low (less than 125 mW), temperature increase within the human tissues is low; however if the antenna operates at high radiated power (1 W), temperature tends to increase eight and a half times.

Excerpts

The simulation was performed for five different frequencies (850 MHz, 900 MHz, 2.1 GHz, 2.6 GHz, and 5.1 GHz). To obtain the average SAR values on different scenarios, at each frequency antenna radiated power were varied four different times (0.125 W, 1 W, 1.5 W, and 2 W) and head to antenna distance varied three different times (0 mm, 10 mm, and 20 mm).

In head tissues, at higher frequencies (2.1 GHz, 2.6 GHz, and 5.1 GHz) at 125 mW radiated and when there is no distance between head and antenna, average SAR values are higher in all tissues except fat tissues as shown in Table 3-5. Maximum average SAR values are found in CSF, dura, brain, skin, and bone tissues at 5.1 GHz frequency, which are 11.4 W/kg, 10.89 W/kg, 10.77 W/kg, 10.51 W/kg, and 9.3 W/kg, respectively, as shown in Table 4. Average SAR values are high at higher frequencies because tissues have relatively high conductively. In high frequency at high radiated power of 1 W, average SAR values in all tissues are very high. The maximum average SAR value found in CSF tissue was 91.2 W/kg. This means if the antenna is operating at a high power level, there is a high chance of tissues being affected.

The above discussion proves that there is an inversely proportional relationship between SAR and the distance between the body model and the excitation source. For instance, increasing the distance between the source and the head model from 0 mm to 10 mm causes the SAR to decrease by approximately three times at lower frequency, and it decreases approximately five and a half times at higher frequency.

The research concludes, for the long time exposure, and even for the worst possible radiated power level, the temperature rise caused in the human tissues is not close to the dangerous [thermal] limit [42 degrees centigrade].

https://onlinelibrary.wiley.com/doi/abs/10.1002/mop.31777

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Trends in the incidence of primary brain, central nervous system and intracranial tumors in Israel, 1990-2015

Keinan-Boker L, Friedman E, Silverman BG. Trends in the incidence of primary brain, central nervous system and intracranial tumors in Israel, 1990-2015. Cancer Epidemiol. 2018 Oct;56:6-13. doi: 10.1016/j.canep.2018.07.003.

Highlights

• Exponential growth in cellphone use fueled concerns regarding brain and CNS tumors.
• Results so far are inconsistent. Studying cancer incidence trends may thus be informative.
• We studied brain tumor trends from 1990 to 2015 in Israel, when cellphone use dramatically increased.
• Results do not support a substantial role for cellphone use; smaller risks in special subgroups may exist.
• Future research is needed; implementation of the precautionary principle is prudent.

Abstract

BACKGROUND: The association between cellphone technology and brain, central nervous system (CNS) and intracranial tumors is unclear. Analysis of trends in incidence of such tumors for periods during which cellphone use increased dramatically may add relevant information. Herein we describe secular trends in the incidence of primary tumors of the brain and CNS from 1990 to 2015 in Israel, a period during which cellphone technology became extremely prevalent in Israel.

METHODS: All cases of primary brain, CNS and intracranial tumors (excluding lymphomas) diagnosed in Israel from 1990 to 2015 were identified in the Israel National Cancer Registry database and categorized by behavior (malignant; benign/uncertain behavior) and histologic type. Annual age-standardized incidence rates by sex and population group (Jews; Arabs) were computed, and the annual percent changes and 95% confidence intervals per category were calculated using Joinpoint software.

RESULTS: Over 26 years (1990-2015) no significant changes in the incidence of malignant brain, CNS and intracranial tumors were observed, except for an increase in malignant glioma incidence in Jewish women up to 2008 and Arab men up to 2001, which levelled off in both subgroups thereafter. The incidence of benign/uncertain behavior brain, CNS and intracranial tumors increased in most population groups up to the mid-2000s, a trend mostly driven by changes in the incidence of meningioma, but either significantly decreased (Jews) or stabilized (Arabs) thereafter.

CONCLUSIONS: Our findings are not consistent with a discernable effect of cellphone use patterns in Israel on incidence trends of brain, CNS and intracranial tumors.

https://www.ncbi.nlm.nih.gov/pubmed/30015055

Excerpts

"When cancer occurrence rates referred to glioblastomas only, Joinpoint analysis of incidence trends was restricted to the period from 1995 to 2015 due to small numbers of cases in the Arab population prior to 1995. Stable incidence trends were noted, with non-significant APCs, in all population subgroups: APC1995–2015 for Jewish men was +0.6% (95%CI -0.4%,+1.6%); APC1995–2015 for Jewish women was +0.6% (95%CI -0.1%,+1.6%); APC1995–2015 for Arab men was -1.6% (95%CI -3.9%,+0.8%); APC1995–2015 for Arab women was +0.4% (95%CI -2.9%,+3.8%).

Analysis of time trends by age groups disclosed stable trends in most population- age- and sex groups, except for a mild increase in Jewish males aged 65 and over (APC1990–2015 +1.2%, $p < 0.05$) and in Arab males aged 20–64 (APC1990–2015 +1.5%, $p < 0.05$). In the population of Arab females, lack of cases in the age groups of 20–64 and 65+ in certain years prevented an analysis of trends."

"However, ecologic studies, of which ours is an example, may be insensitive to excess in risk which is restricted to certain groups (for example, heavy users or subjects exposed from very young ages) or to certain tumor types (e.g., tumors that are very rare, that involve specific anatomical sites, or that have unusually long latency periods) [34]. Little et al. [35] also commented that the predicted rates of glioma based on data derived from the small proportion of highly exposed people in the Interphone study, could be consistent with the observed rates in their study [35]. Therefore, although a substantial risk is not very plausible, smaller risks cannot be ruled out and future research should address specific exposure groups, and tumor types and sites, and should allow for longer follow up periods."

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Incidence trends of adult malignant brain tumors in Finland, 1990-2016

Natukka T, Raitanen J, Haapasalo H, Auvinen A. Incidence trends of adult malignant brain tumors in Finland, 1990-2016. Acta Oncol. 2019 Apr 15:1-7. doi: 10.1080/0284186X.2019.1603396.

Abstract

BACKGROUND: Several studies have reported increased incidence trends of malignant gliomas in the late 1900s with a plateau in the 2000s, but also some recent increases have been reported. The purpose of our study was to analyze incidence trends of malignant gliomas in Finland by morphology and tumor location.

MATERIAL AND METHODS: Data on 4730 malignant glioma patients were obtained from case notifications to the nationwide, population-based Finnish Cancer Registry (FCR), and less detailed data on 3590 patients up to 2016. Age-standardized incidence rates (ASR) and average annual percent changes (APCs) in the incidence rates were calculated by histological subtype and tumor location.

RESULTS: The incidence rate of gliomas was 7.7/100,000 in 1990-2006 and 7.3 in 2007-2016. The incidence of all gliomas combined was stable during both study periods, with no departure from linearity. In an analysis by age group, increasing incidence was found only for ages 80 years and older (1990-2006). During both study periods, incidence rates were increasing in glioblastoma and decreasing in unspecified brain tumors. In 1990-2006, rates were also increasing for anaplastic oligodendroglioma, oligoastrocytoma and unspecified malignant glioma, while decreasing for astrocytoma. As for tumor location, incidence in 1990-2006 was increasing for frontal lobe and brainstem tumors, as well as those with an unspecified location, but decreasing for the parietal lobes, cerebrum and ventricles.

CONCLUSIONS: No increasing incidence trend was observed for malignant gliomas overall. An increasing incidence trend of malignant gliomas was found in the oldest age group during 1990-2006.

https://www.ncbi.nlm.nih.gov/pubmed/30985227

Excerpts

The incidence trend of glioblastoma was slightly increasing (APC: +0.8%; 95% CI: 0.0, +1.7 for 1990–2006 and +1.9%; 95% CI: +0.2, +3.5 for 2007–2016; Tables 2 and
3).

Incidence of glioblastoma increased slightly throughout the study period, while unspecified tumors of the brain showed a decreasing incidence trend.

We also found a slightly increasing incidence trend for the most common histological subtype, glioblastoma, which is consistent with several other studies [1,5,7–9,11,17,18]. A study from United States showed an increasing incidence trend for gliomas in the frontal lobe and decreasing trends for the cerebrum, ventricles and overlapping subtypes [17].

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The Prevalence of People With Restricted Access to Work in Man-Made Electromagnetic Environments

Bevington M. The Prevalence of People With Restricted Access to Work in Man-Made Electromagnetic Environments. Journal of Environment and Health Science. Published online Jan 18, 2019.

Abstract

Some surveys have identified people who have restricted access to work in environments with man-made electromagnetic exposures. This study attempts to determine their prevalence, an aspect not previously investigated in its own right. It is based on analyses of the two different types of surveys of people with Idiopathic Environmental Intolerance attributed to Electromagnetic Fields (IEI-EMF), or Electromagnetic Hyper-Sensitivity (EHS), either of the general population or of people with IEI-EMF/EHS. In addition, there are different definitions of IEI-EMF/EHS, with a range of subconscious, mild, moderate or severe symptoms, potentially leading in three stages to hyper-sensitivity. The current evidence is assessed as indicating that, in addition to subconscious sensitivity, the prevalence of IEI-EMF/EHS is between about 5.0 and 30 per cent of the general population for mild cases, 1.5 and 5.0 per cent for moderate cases and < 1.5 per cent for severe cases. The prevalence of people restricted in their access to work in a man-made electromagnetic environment is estimated at 0.65 per cent of the general population, at about 18% of the general population with moderate IEI-EMF/EHS. The estimate of 0.65% equates to 435,500 people in the UK's population of 67 million. Some reasons for possible under-reporting are discussed. Adjustments can enable some people with this disability to remain in employment, suggesting that rates of restriction in access to work may fall as employers become aware of what adjustments are needed.

Open access paper: https://www.ommegaonline.org/article-details/The-Prevalence-of-People-With-Restricted-Access-to-Work-in-Man-Made-Electromagnetic-Environments/2402

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Disturbance in haematological parameters induced by EMF exposure: Review paper

Jbirea JM, Azab AE, Elsayed ASI. Disturbance in haematological parameters induced by exposure to electromagnetic fields. Hematology & Transfusion International Journal. 6(6):242-251. 2018.

Abstract

Background: The use of mobile phones, wireless, and electrical devices has gradually increased throughout the last century, and scientists have suggested that electromagnetic fields (EMFs) generated by such devices may have harmful effects on living creatures. Many studies revealed that the EMFs might produce a variety of adverse effects on human health as headaches, chronic fatigue, heart problems, stress, nausea, chest pain, and also some bad effects on central nervous, endocrine and immune systems. Exposure to EMF result in deterioration of RBCs function and metabolic activity, it was expected that, the increase of toxicity in specific organs was a result of the RBCs functional failure. The mechanisms by which the electromagnetic fields cause their bad effects may be by causing deterioration in cellular large molecules, imbalance in ionic equilibrium and generation of reactive oxygen species (ROS). These reactive oxygen species can damage cellular components such as proteins, lipids and DNA. Measurements of blood parameters are of the most important diagnostic methods by which we can determine the health status of human and animals for certain diseases as anemia, leukemia and also detect the presence of the inflammations.

Objectives: This study aimed to present an overview on the previous works from 1997 to 2018 on the varying effects of electromagnetic fields on haematological data in human and different species of experimental models by using different frequencies, intensities, and different sources of electromagnetic fields for different periods. The hematological parameters are fluctuating across the exposure period to the EMFs suggesting the possible induction of hazardous biological effects during the exposure to magnetic field.

Conclusion: It can be concluded that exposure of human and experimental animals to EMFs cause harmful effects on blood cells. These effects were disturbance in haematological parameters depending on species, the sources of EMFs, frequencies, intensities and duration of exposure.

Open access paper: https://medcraveonline.com/HTIJ/HTIJ-06-00193.pdf

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Conflicts of Interest and Misleading Statements in Official Reports about the Health Consequences of Radiofrequency Radiation and Some New Measurements of Exposure Levels

Pockett S. Conflicts of Interest and Misleading Statements in Official Reports about the Health Consequences of Radiofrequency Radiation and Some New Measurements of Exposure Levels. Magnetochemistry 2019, 5(2), 31; https://doi.org/10.3390/magnetochemistry5020031

Abstract
Official reports to governments throughout the Western world attempt to allay public concern about the increasing inescapability of the microwaves (also known as radiofrequency radiation or RF) emitted by “smart” technologies, by repeating the dogma that the only proven biological effect of RF is acute tissue heating, and assuring us that the levels of radiation to which the public are exposed are significantly less than those needed to cause acute tissue heating. The present paper first shows the origin of this “thermal-only” dogma in the military paranoia of the 1950s. It then reveals how financial conflict of interest and intentionally misleading statements have been powerful factors in preserving that dogma in the face of now overwhelming evidence that it is false, using one 2018 report to ministers of the New Zealand government as an example. Lastly, some new pilot measurements of ambient RF power densities in Auckland city are reported and compared with

levels reported in other cities, various international exposure limits, and levels shown scientifically to cause biological harm. It is concluded that politicians in the Western world should stop accepting soothing reports from individuals with blatant conflicts of interest and start taking the health and safety of their communities seriously.

Conclusions

It is time to stop believing ICNIRP spin. Tissue heating is not the only biological effect of radiofrequency radiation. The thermal-only exposure limit is not safe.

Like tobacco smoke, low intensity radiofrequency radiation has multiple harmful effects on human health. Unlike secondhand smoke, secondhand radiation is fast becoming inescapable. The present situation is thus worse than Big Tobacco redux.

Elected politicians should stop accepting biased reports from individuals with blatant conflicts of interest and start taking seriously the health and safety of their constituents; or at least of their own children and grandchildren.

The unchecked expansion of Big Wireless permitted by ICNIRP's thermal-only guidelines is actively harmful to all biological inhabitants of planet Earth. Further expansion to 5G technology will inevitably involve yet more radiation exposure. The fact that this exposure will not breach the ludicrously high ICNIRP-based standard is no defense at all.

Open access paper: https://www.mdpi.com/2312-7481/5/2/31/htm

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Spatial and temporal variability of Rf-Emf exposure levels in urban environments in Flanders, Belgium

Velghe M, Wout J, Debouvere S , Aminzadeh R, Martens L, Thielens A. Characterisation of spatial and temporal variability of Rf-Emf exposure levels in urban environments in Flanders, Belgium. Environmental Research. Published online May 22, 2019.https://doi.org/10.1016/j.envres.2019.05.027Get rights and content

Highlights
• Comparison of population exposure to RF-EMF in 5 densely populated cities with similar characteristics within Flanders, Belgium.
• The first findings that indicate the effects of regulations on exposure levels.
• Repeatability and representativeness of the used method are shown, which is important for future research.
• Application of this method outside of office hours renders new insights in daily behaviour of exposure.
• On-body calibration of the measurement device allowed us to, in contrast to most other similar studies, quantify the on-body measurement uncertainty.

Abstract

Personal exposure to Radio-Frequency Electromagnetic Fields (RF-EMFs) was studied using personal measurements in five different microenvironments in each of five cities (Brussels, Antwerp, Ghent, Bruges and Hasselt) in Flanders, Belgium. These measurements were carried out by two researchers using on-body calibrated personal exposimeters. In three out of the five studied cities (Brussels, Ghent and Bruges), temporal aspects of personal exposure to RF-EMFs were studied as well. Measurements during and outside of rush hours (7:00–9:15 and 16:30–19:00) were compared. Likewise, measurements were executed during night time and compared to the ones measured during working hours. Representativeness and repeatability of the measurement method was studied as well.

The highest mean total exposure was found in Brussels (2.63 mW/m2), the most densely populated city in this study. However, we measured higher downlink exposure in Antwerp than in Brussels, which might be an effect of the stronger legislation on base stations in Brussels. The measurements and used protocol were found to be both repeatable over time (r = 0.95 for median total exposure) and representative for the studied

microenvironments in terms of path selection (r = 0.88 for median total exposure). Finally, in 10 out of the 13 on-body calibrated frequency bands we found that the measurement devices underestimate the intensity of the incident RF-EMFs with median underestimations up to 68%.

Conclusions

Personal exposure to RF-EMFs was studied using microenvironmental measurements in five cities in Flanders and the Brussels Capital Region. Highest total exposure values were found in Brussels (2.63 mW/m2 averaged over five microenvironments). Our analysis showed that the amount of RF-EMF radiation in a certain environment was dependent on the population density within that environment. A higher average downlink exposure was measured in Antwerp in comparison to Brussels whilst having a lower population density. This might be an effect of the stronger legislation on base stations in Brussels. Downlink was the largest contributor to total exposure. The total RF-EMF exposure was significantly higher during rush than during non-rush hours. Furthermore, the total exposure was highest at night compared to other timeslots. The selected paths showed to be representative for exposure in their respective microenvironments. The results were also found to be repeatable. The used measurement devices were calibrated on the body of the researchers that wore them during measurements. These calibrations showed that the devices underestimate the personal exposure since median underestimations were measured in a majority of the studied frequency bands on the bodies of the two individual researchers, respectively.

https://www.sciencedirect.com/science/article/pii/S0013935119302853?via%3Dihub

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Evaluation of Temperature Elevation in Human Ocular Tissues due to Wireless Eyewear Devices

Lan J, Du G. Evaluation of temperature elevation in human ocular tissues due to wireless eyewear devices. ACES Journal. 34(1):17-24. 2019.

Abstract

In this paper, a numerical study is proposed to evaluate the temperature variation in the human ocular tissues during the electromagnetic radiation exposure from wireless eyewear device. The results show that the temperature in the whole eyeball increases gradually as the exposure time goes on and could reach the thermal steady state at about 30 minutes. During this process, the temperature increments in different ocular tissues are between 1.1°C and 1.7°C. The results also show the maximal ratio of temperature increments in the initial 5 and 10 minutes to that of the whole steady state could reach to 42.9% and 69.2%, respectively. Therefore, we believe that electromagnetic radiation from wireless eyewear device might pose a threat on the health of the human eyes. People should decrease the talk time as soon as possible to protect their eyes from the possible health hazards. Finally, attention is paid to evaluate the relationship between the maximal SAR and the temperature increments. The results show the temperature increments do not increase in direct proportion to the maximal SAR, which indicates that the maximal SAR and the temperature increments should be taken into account simultaneously while evaluating the biological effect of microwave on the ocular tissues.

Conclusions

Based on the results evaluated in this paper, we find that the temperature in the whole eyeball increases gradually and reaches the thermal steady state at about 30 minutes during the EM exposure of wireless eyewear device. The temperature increments in different ocular tissues are from 1°C to 1.7°C. We, therefore, believe EM exposure from wireless eyewear device may pose a threat on the health of the eyes, especially for the lens which suffer from the maximal temperature increments. Meanwhile, the results also show that the maximal ratio of temperature increments in the initial 5 and 10 minutes exposure time to that of the complete thermal steady state could reach to 42.9% and 69.2%, respectively. Hence, wireless eyewear device users should shorten the usage time as soon as possible to protect their eyes from the possible health hazards.

Finally, we evaluate the relationship between the maximal SAR and the temperature increments in the ocular tissues. We find that the temperature increments do not increase in direct proportion to the maximal SAR. Therefore, we believe the maximal SAR and the temperature increments should be taken into account simultaneously while evaluating the biological effect of microwave on the ocular tissues. This paper could provide valuable data for the establishment of related safety standards and future researches in the biological effect of microwave and human eyes. However, limited by the experimental condition, the experiment is not included. Therefore, conclusions presented in this paper are just indicative but not definitive.

Open access paper: http://www.aces-society.org/includes/downloadpaper.php?of=ACES_Journal_January_2019_Paper_3&nf=19-1-3

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Millimeter Wave Radiation Activates Leech Nociceptors via TRPV1-Like Receptor Sensitization

Romanenko S, Harvey AR, Hool L, Fan S, Wallace VP. Millimeter Wave Radiation Activates Leech Nociceptors via TRPV1-Like Receptor Sensitization. Biophys J. 2019 Apr 25. pii: S0006-3495(19)30340-6. doi: 10.1016/j.bpj.2019.04.021.

Abstract

There is evidence that millimeter waves (MMWs) can have an impact on cellular function, including neurons. Earlier in vitro studies have shown that exposure levels well below the recommended safe limit of 1 mW/cm2 cause changes in the action potential (AP) firing rate, resting potential, and AP pulse shape of sensory neurons in leech preparations as well as alter neuronal properties in rat cortical brain slices; these effects differ from changes induced by direct heating. In this article, we compare the responses of thermosensitive primary nociceptors of the medicinal leech under thermal heating and MMW irradiation (80-170 mW/cm2 at 60 GHz). The results show that MMW exposure causes an almost twofold decrease in the threshold for activation of the AP compared with thermal heating (3.9 ± 0.4 vs. 8.3 ± 0.4 mV, respectively). Our analysis suggests that MMWs-mediated threshold alterations are not caused by the enhancement of voltage-gated sodium and potassium conductance. We propose that the reduction in AP threshold can be attributed to the sensitization of the transient receptor potential vanilloid 1-like receptor in the leech nociceptor. In silico modeling supported our experimental findings. Our results provide evidence that MMW exposure stimulates specific receptor responses that differ from direct thermal heating, fostering the need for additional studies.

https://www.ncbi.nlm.nih.gov/pubmed/31103236

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Can Low-Level RF Exposure Affect Cognitive Behaviour in Lab Animals? Literature Review of Spatial Learning and Place Memory

Sienkiewicz Z, van Rongen E. Can Low-Level Exposure to Radiofrequency Fields Effect Cognitive Behaviour in Laboratory Animals? A Systematic Review of the Literature Related to Spatial Learning and Place Memory. Int J Environ Res Public Health. 2019 May 8;16(9). pii: E1607. doi: 10.3390/ijerph16091607.

Abstract

This review considers whether exposure to low-level radiofrequency (RF) fields, mostly associated with mobile phone technology, can influence cognitive behaviour of laboratory animals. Studies were nominated for inclusion using an a priori defined protocol with preselected criteria, and studies were excluded from analysis if they did not include sufficient details about the exposure, dosimetry or experimental protocol, or if they lacked a sham-exposed group. Overall, 62 studies were identified that have investigated the effects of RF fields on spatial memory and place learning and have been published since 1993. Of these, 17 studies were excluded,

20 studies reported no significant field-related effects, 21 studies reported significant impairments or deficits, and four studies reported beneficial consequences. The data do not suggest whether these outcomes are related to specific differences in exposure or testing conditions, or simply represent chance. However, some studies have suggested possible molecular mechanisms for the observed effects, but none of these has been substantiated through independent replication. Further behavioural studies could prove useful to resolve this situation, and it is suggested that these studies should use a consistent animal model with standardized exposure and testing protocols, and with detailed dosimetry provided by heterogeneous, anatomically-realistic animal models.

Open access paper: https://www.mdpi.com/1660-4601/16/9/1607

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Protective role of spermine against male reproductive aberrations induced by EMF exposure in the rat

Shahin NN, El-Nabarawy NA, Gouda AS, Megarbane B. The protective role of spermine against male reproductive aberrations induced by exposure to electromagnetic field - An experimental investigation in the rat. Toxicology and Applied Pharmacology. 370:117-130. May, 2019. DOI: 10.1016/j.taap.2019.03.009

Highlights

• Exposure to electromagnetic field (EMF) impairs spermatogenesis and steroidogenesis.
• EMF toxicity is mediated by oxidative, inflammatory, apoptotic and DNA perturbations.
• Spermine exhibits protective effects against EMF-induced alteration in male fertility.
• Protection is at least in part due to anti-oxidative and anti-apoptotic effects.

Abstract

The exponentially increasing use of electromagnetic field (EMF)-emitting devices imposes substantial health burden on modern societies with particular concerns of male infertility. Limited studies have addressed the modulation of this risk by protective agents. We investigated the hazardous effects of rat exposure to EMF (900 MHz, 2 h/day for 8 weeks) on male fertility and evaluated the possible protective effect of the polyamine, spermine, against EMF-induced alterations. Exposure to EMF significantly decreased sperm count, viability and motility, and increased sperm deformities. EMF-exposed rats exhibited significant reductions in serum inhibin B and testosterone along with elevated activin A, follicle-stimulating hormone, luteinizing hormone and estradiol concentrations. Testicular steroidogenic acute regulatory protein (StAR), c-kit mRNA expression and testicular activities of the key androgenic enzymes 3 beta- and 17 beta-hydroxysteroid dehydrogenases were significantly attenuated following exposure to EMF. Exposure led to testicular lipid peroxidation, decreased catalase and glutathione peroxidase activities and triggered nuclear factor-kappa B p65, inducible nitric oxide synthase, cyclooxygenase-2 and caspase-3 overexpression. EMF-exposed rats showed testicular DNA damage as indicated by elevated comet parameters. Spermine administration (2.5 mg/Kg/day intraperitoneally for 8 weeks) prevented EMF-induced alterations in the sperm and hormone profiles, StAR and c-kit expression and androgenic enzyme activities. Spermine hampered EMF-induced oxidative, inflammatory, apoptotic and DNA perturbations. Histological and histomorphometric analysis of the testes supported all biochemical findings. In conclusion, rat exposure to EMF disrupts sperm and hormone profiles with underlying impairment of steroidogenesis and spermatogenesis. Spermine confers protection against EMF-associated testicular and reproductive aberrations, at least in part, via antioxidant, anti-inflammatory and anti-apoptotic mechanisms.

Excerpt

Rats were exposed to the EMF at 900 MHz frequency and 0.02 mW/cm2 power density during 2 h/day over a period of eight consecutive weeks, as previously described (Kesari et al., 2011). The average specific absorption rate was 1.075 W/Kg, as calculated by the Finite-Difference-Time-Domain. Non-exposed rats were placed in the same device with exposure off, used in similar environmental conditions.

https://www.sciencedirect.com/science/article/pii/S0041008X19300912

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Interaction of low frequency external electric fields and pancreatic β-cell: a mathematical modeling approach to identify the influence of excitation parameters

Farashi S, Sasanpour P, Rafii-Tabar H. Interaction of low frequency external electric fields and pancreatic β-cell: a mathematical modeling approach to identify the influence of excitation parameters. Int J Radiat Biol. 2018 Nov;94(11):1038-1048. doi: 10.1080/09553002.2018.1478162.

Abstract

PURPOSE: Although the effect of electromagnetic fields on biological systems has attracted attraction in recent years, there has not been any conclusive result concerning the effects of interaction and the underlying mechanisms involved. Besides the complexity of biological systems, the parameters of the applied electromagnetic field have not been estimated in most of the experiments.

MATERIALS AND METHODS: In this study, we have used computational approach in order to find the excitation parameters of an external electric field which produces sensible effects in the function of insulin secretory machinery, whose failure triggers the diabetes disease. A mathematical model of the human β-cell has been used and the effects of external electric fields with different amplitudes, frequencies and wave shapes have been studied.

RESULTS: The results from our simulations show that the external electric field can influence the membrane electrical activity and perhaps the insulin secretion when its amplitude exceeds a threshold value. Furthermore, our simulations reveal that different waveforms have distinct effects on the β-cell membrane electrical activity and the characteristic features of the excitation like frequency would change the interaction mechanism.

CONCLUSION: The results could help the researchers to investigate the possible role of the environmental electromagnetic fields on the promotion of diabetes disease.

https://www.ncbi.nlm.nih.gov/pubmed/29792541

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Safety Management of Electromagnetic Fields in the Work Environment

Koppel T. Safety Management of Electromagnetic Fields in the Work Environment. Ph.D. Thesis. Tallinn, Estonia: Tallinn University of Technology. Nov 2019.

Abstract

Occupational exposure to electromagnetic fields is a known risk factor and considered the most complicated physical hazard in the workplace. The legislation requires measures to be taken to reduce exposure and to mitigate risks in order to guarantee worker safety. Electromagnetic fields are considered a new and emerging risk factor. Assessing risks in the electromagnetic domain is a challenge as whole extent of the health implications of different types and forms of exposure is unknown.

EMFs were studied using both quantitative and qualitative approaches, including measurements, questionnaires, interviews and in-situ workplace observations. The research addressed current practices and rules of managing safety from electromagnetic fields. Safety compliance analyses were conducted with regard

to legislative requirements. This endeavor was guided by the new requirements for health and safety with regard to electromagnetic fields.

This study was intended to help improve management's safety knowledge of this risk factor, by encompassing scientifically reasonable approaches in designing EMF safety.
The study included analysis of the exposure levels of workers, and development of methods to reduce exposure, with respect to the new occupational EMF legislation. The author analyzed the EMF exposure in different settings, including means of work, encompassing industrial, office, and public settings. The EMF safety compliance of companies
was investigated. New, safer ways to work when exposed to electromagnetic fields were proposed.

The author proposed and tested methods of EMF exposure reduction, which can be used by employers to demonstrate compliance with the occupational exposure norms, and public safety norms. As a result, a model was developed introducing a system for managing EMF safety. The model prescribes a set of hierarchical steps to mitigate risks from the workers' exposure to EMFs.

The research improved the scientific understanding of consequences from exposure to electromagnetic fields (EMF). There are long term health effects from occupational exposure to extremely low frequency (ELF) electromagnetic fields that are not currently covered by safety legislation.

Significantly elevated radiofrequency (RF) EMF hotspots were measured in open spaces resulting from poor set up of RF antennas. Investigations also revealed that industrial workers are exposed to high levels of magnetic radiation from production devices that to a large extent is unnecessary. By following the technical and administrative intervention solutions developed by the author, the workers' exposure could be drastically reduced.

Contributing to safety education of both the workers and the working environment specialists will have a positive effect on safety compliance and other related safety issues within the company. Working environments specialists reported higher compliance with EMF safety arrangements compared to the workers, but overall, safety management practices were still poor relative to the legislative requirements. In comparison to workers, working environment specialists also reported better addressing the needs of workers in risk groups.

There are several steps the worker can take to control his/her overall exposure without significant additional effort or expense. Rearrangement of devices and adoption of new operational habits can reduce exposure to the EMFs even by orders of magnitude. Intervention measures may include increasing the distance from the source of the EMF and shielding the EMF source. The best reduction of EMF exposure will be achieved when several measures are implemented simultaneously.

In managing EMF safety, the author advises the employer to proceed step by step. The hierarchical process starts with the employer informing the worker about EMF conditions. Secondly, the employer should educate the worker how to reduce his/her exposure. Thirdly, the employer should motivate the worker to follow the EMF safety management procedures. And lastly, the employer should conduct regular reviews on the implementation and operational effectiveness of the EMF safety management system. "

https://digi.lib.ttu.ee/i/?11585

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Top 100 cited noninvasive neuromodulation clinical trials

Lucena MFG, Teixeira PEP, Bonin Pinto C, Fregni F. Top 100 cited noninvasive neuromodulation clinical trials. Expert Rev Med Devices. 2019 May 16. doi: 10.1080/17434440.2019.1615440.

Abstract

Transcranial direct current stimulation (tDCS) and transcranial magnetic stimulation (TMS) are noninvasive neuromodulation techniques used as therapeutic and research tools for several neuropsychiatric conditions. Given the exponential scientific growth of this field we aimed to systematically review the most cited clinical trials using TMS or tDCS. Areas covered: A de-novo keyword search strategy identified and characterized the 100 most-cited trials. Total citation count for the most cited trials was 13,204. Articles were published between 2008 and 2014 in 50 different journals with a median impact factor of 6.52 (IQR 3.37). Almost half of the top cited papers were investigating mechanisms of action in healthy subjects. Most studies were feasibility trials and only 5 were pivotal trials, including the ones used for recent FDA approval. Seven articles were interlinked with another article by at least 25 citations and eight authors had collaborated with at least one other author. Expert Commentary: Although there has been a significant increase in interest for rTMS and tDCS, most of the cited clinical trials are still small feasibility studies, what reinforced the need for more robust clinical trials (larger samples sizes and effects sizes) to better define clinical effectiveness.

https://www.ncbi.nlm.nih.gov/pubmed/31092060

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2100 MHz mobile phone radiation damages DNA in onion roots

Chandel S, Kaur S, Issa M, Singh HP, Batish DR, Kohli RK. Appraisal of immediate and late effects of mobile phone radiations at 2100 MHz on mitotic activity and DNA integrity in root meristems of Allium cepa. Protoplasma. 2019 May 21. doi: 10.1007/s00709-019-01386-y.

Abstract

The present study evaluated the potential of 2100 MHz radiofrequency radiations to act as cytotoxic and genotoxic agent. Fresh onion (Allium cepa L.) roots were exposed to electromagnetic field radiations (EMF-r) for different durations (1 h and 4 h) and evaluated for mitotic index (MI), phase index, chromosomal aberrations, and DNA damage. DNA damage was investigated with the help of the comet assay by assessing various parameters like % head DNA (HDNA), % tail DNA (TDNA), tail moment (TM), and olive tail moment (OTM). Effects of EMF-r exposure were also compared with that of methyl methanesulfonate (MMS; 90 μM), which acted as a positive control. The post-exposure effects of EMF-r after providing the test plants with an acclimatization period of 24 h were also evaluated. Compared to the control, a significant increase in the MI and aberration percentage was recorded upon 4 h of exposure. However, no specific trend of phase index in response to exposure was detected. EMF-r exposure incited DNA damage with a significant decrease in HDNA accompanied by an increase in TDNA upon exposure of 4 h. However, TM and OTM did not change significantly upon exposure as compared to that of control. Analysis of the post-exposure effects of EMF-r did not show any significant change/recovery. Our data, thus, suggest the potential cytotoxic and genotoxic nature of 2100 MHz EMF-r. Our study bears great significance in view of the swiftly emergent EMF-r in the surrounding environment and their potential for inciting aberrations at the chromosomal level, thus posing a genetic hazard.

https://www.ncbi.nlm.nih.gov/pubmed/31115694

Conclusions

It is apparent from the present study that radiofrequency radiations at 2100 MHz have a potential for inciting cytotoxic and genotoxic effects in A. cepa root meristems. The observed biological effects were dependent on the duration of exposure, and the maximum alterations were found upon 4 h of exposure. As the concentration of EMF waves by man-made devices like mobile phones is increasing in the environment at a very fast rate, we cannot afford to ignore the biological effects of these radiations. Our study holds great significance in view of this rapidly emergent EMF-r in the surrounding environment and their potential for inciting aberrations and damage at the chromosomal level, thus posing a genetic hazard. The study calls for a proper risk assessment

in terms of impacts on the environment and public health of the increasing electromagnetic smog and development of strategies to reduce EMF-r pollution in the natural environment.

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Effects of 50 Hz magnetic field-exposed cell culture medium on cellular functions in human amniotic epithelial cells

Fei Y, Su L, Lou H, Zhao C, Wang Y, Chen G. The effects of 50 Hz magnetic field-exposed cell culture medium on cellular functions in FL cells. J Radiat Res. 2019 May 21. pii: rrz020. doi: 10.1093/jrr/rrz020.

Abstract

Although extremely low frequency magnetic fields (ELF-MFs) have been classified as a possible carcinogen for humans by the International Agency for Research on Cancer (IARC), their biological effects and underlying mechanisms are still unclear. Our previous study indicated that ELF-MF exposure influenced the relative permittivity of the saline solution, suggesting that the MF exposure altered physical properties of the solution. To explore the biophysical mechanism of ELF-MF-induced biological effects, this study examined the effects of 50 Hz sinusoidal MF at 0-4.0 mT on the permittivity of culture medium with phase-interrogation surface plasmon resonance (SPR) sensing. Then, the biological effects of MF pre-exposed culture medium on cell viability, the mitogen-activated protein kinase (MAPK) signaling pathways, oxidative stress, and genetic stabilities were analyzed using Cell Counting Kit-8, western blot, flow cytometry, γH2AX foci formation, and comet assay. The results showed that SPR signals were decreased under MF exposure in a time- and dose-dependent manner, and the decreased SPR signals were reversible when the exposure was drawn off. However, MF pre-exposed culture medium did not significantly change cell viability, intracellular reactive oxygen species level, activation of the MARK signaling pathways, or genetic stabilities in human amniotic epithelial cells (FL cells). In conclusion, our data suggest that the relative permittivity of culture medium was influenced by 50 Hz MF exposure, but this change did not affect the biological processes in FL cells.

https://www.ncbi.nlm.nih.gov/pubmed/31111909

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Maternal Cell Phone Use During Pregnancy, Pregnancy Duration And Fetal Growth In Four Birth Cohorts

Tsarna E, Reedijk M, Birks LE, Guxens M, Ballester F, Ha M, Jiménez-Zabala A, Kheifets L, Lertxundi A, Lim HR, Olsen J, Safont LG, Sudan M, Cardis E, Vrijheid M, Vrijkotte T, Huss A, Vermeulen R. Maternal Cell Phone Use During Pregnancy, Pregnancy Duration And Fetal Growth In Four Birth Cohorts. Am J Epidemiol. 2019 Apr 17. pii: kwz092. doi: 10.1093/aje/kwz092.

Abstract

Previous studies evaluating potential effects of prenatal exposure to radiofrequency fields from cell phones on birth outcomes are inconsistent. We explored if maternal cell phone use was associated with pregnancy duration and fetal growth. We used information from 55,507 pregnant women and their children from Denmark (1996-2002), the Netherlands (2003-2004), Spain (2003-2008) and Korea (2006-2011). Based on self-reported number of cell phone calls per day, exposure was grouped as none, low (reference level), intermediate, and high. We examined pregnancy duration (gestational age at birth, preterm/postterm birth), fetal growth (birth weight ratio, small/large for gestational age), and birth weight, low and high birth weight, and meta-analyzed cohort specific estimates. The intermediate exposure group had higher risk of giving birth at lower gestational age (Hazard Ratio=1.04, 95%CI 1.01, 1.07), and exposure-response relationships were found for shorter pregnancy duration (P<0.001) and preterm birth (P=0.003). We observed no association with fetal growth or birth weight. In conclusion, maternal cell phone use during pregnancy may be associated with shorter

pregnancy duration and increased risk for preterm birth. Results should be interpreted with caution, as they may reflect stress during pregnancy or other residual confounding, rather than direct effect of cell phone exposure.

https://www.ncbi.nlm.nih.gov/pubmed/30995291

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Mother's Exposure to Electromagnetic Fields before and during Pregnancy is Associated with Risk of Speech Problems in Offspring

Zarei S, Vahab M, Oryadi-Zanjani MM, Alighanbari N, Mortazavi SM. Mother's Exposure to Electromagnetic Fields before and during Pregnancy is Associated with Risk of Speech Problems in Offspring. J Biomed Phys Eng. 2019 Feb 1;9(1):61-68.

Abstract

BACKGROUND: Rapid advances in technology, especially in the field of telecommunication, have led to extraordinary levels of mothers' exposures to radiofrequency electromagnetic fields (RF-EMFs) prior to or during pregnancy.

OBJECTIVE: The main goal of this study was to answer this question whether exposure of women to common sources of RF-EMFs either prior to or during pregnancy is related to speech problems in the offspring.

MATERIALS AND METHODS: In this study, mothers of 110 three-to-seven-year-old children with speech problems and 75 healthy children (control group) were interviewed. These mothers were asked whether they had exposure to different sources of EMFs such as mobile phones, mobile base stations, Wi-Fi, cordless phones, laptops and power lines. Chi square test was used to analyze the differences observed between the control and exposed groups.

RESULTS: Statistically significant associations were found between the use of cordless phone and offspring speech problems for both before pregnancy and during pregnancy maternal exposures (P=0.005 and P=0.014, respectively). However, due to high rate of mobile phone use in both groups, this study failed to show any link between mobile phone use and speech problems in offspring. Furthermore, significant associations were observed between living in the vicinity of power lines and speech problems again for both before pregnancy and during pregnancy maternal exposures (P=0.003 and P=0.002, respectively). However, exposure to other sources of non-ionizing radiation was not linked to speech problems. Moreover, exposure to ionizing radiation (e.g. radiography before and during pregnancy) was not associated with the occurrence of speech problems.

CONCLUSION: Although this study has some limitations, it leads us to this conclusion that higher-than-ever levels of maternal exposure to electromagnetic fields could be linked to offspring speech problems.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6409372/

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Maternal proximity to extremely low frequency electromagnetic fields and risk of birth defects

Auger N, Arbour L, Luo W, Lee GE, Bilodeau-Bertrand M, Kosatsky T. Maternal proximity to extremely low frequency electromagnetic fields and risk of birth defects. Eur J Epidemiol. 2019 Apr 11. doi: 10.1007/s10654-019-00518-1.

Abstract

Causes of birth defects are unclear, and the association with electromagnetic fields is inconclusive. We assessed the relationship between residential proximity to extremely low frequency electromagnetic fields from power grids and risk of birth defects. We analyzed a population-based sample of 2,164,246 infants born in Quebec, Canada between 1989 and 2016. We geocoded the maternal residential postal code at delivery and computed the distance to the nearest high voltage electrical transmission line or transformer station. We used log-binomial regression to estimate risk ratios (RR) and 95% confidence intervals (CI) for the association of residential proximity to transmission lines and transformer stations with birth defects, adjusting for maternal and infant characteristics. The prevalence of birth defects within 200 m of a transmission line (579.4 per 10,000 per live births) was only slightly higher compared with distances further away (568.7 per 10,000). A similar trend was seen for transformer stations. Compared with 200 m, a distance of 50 m was not associated with the risk of birth defects for transmission lines (RR 1.00, 95% CI 1.00-1.01) and transformer stations (RR 1.01, 95% CI 1.00-1.03). There was no consistent association when we examined birth defects in different organ systems. We found no compelling evidence that residential proximity to extremely low frequency electromagnetic fields from electrical power grids increases the risk of birth defects. Women residing near electrical grids can be reassured that an effect on the risk of birth defects is unlikely.

https://www.ncbi.nlm.nih.gov/pubmed/30977029

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Microwave Emissions From Cell Phones Exceed Safety Limits in Europe and the US When Touching the Body

Gandhi OP. Microwave Emissions From Cell Phones Exceed Safety Limits in Europe and the US When Touching the Body. IEEE Access. 7:47050-47052. Apr 11, 2019. DOI: 10.1109/ACCESS.2019.2906017

Abstract

In our publications, we have shown both from measurements and computer modeling that the specific absorption rate (SAR) reduces by 10%–15% for every millimeter separation of the cell phone on account of rapidly diminishing EM fields in the near-field region of the cell phone antenna. This rapid reduction of SAR depending on the antenna and its location on the handset has been shown, both computationally and experimentally, regardless of the phantom model such as a flat phantom suggested for SAR compliance testing of devices in contact with the body, for a sphere phantom, and for head-shaped models used for SAR compliance testing of cell phones. Unfortunately, our observations in the past were based on SARs of only three cell phones. Expecting that the SARs for cell phones may exceed the safety limits for body contact, cell phone manufacturers have started to recommend that the devices can be used at 5–25 mm from the body even though it is difficult to see how to maintain this distance correctly under mobile conditions. The National Agency ANFR of France recently released the cell phone SAR test data for 450 cell phones that measure 10-g SARs reducing by 10%–30% for each millimeter distal placement from the planar body phantom. Their data corroborate our findings that most cell phones will exceed the safety guidelines when held against the body by factors of 1.6–3.7 times for the European/ICNIRP standard or by factors as high as 11 if 1-g SAR values were to be measured as required by the U.S. FCC.

Open access paper: https://ieeexplore.ieee.org/document/8688629

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On Measuring Electromagnetic Fields in 5G Technology

Pawlak R, Krawiec P, Żurek J. On Measuring Electromagnetic Fields in 5G Technology. IEEE Access. 7: 29826-29835. March 5, 2019. DOI: 10.1109/ACCESS.2019.2902481

Abstract

At the awakening of the new 5G network as the network of services, issues related to electromagnetic fields (EMFs) will become one of the key aspects for the cost-effective establishment of the 5G infrastructure. The new 5G services will meet the rigorous demand for bandwidth through the implementation of a large number of densely located base stations operating in the millimeter-wave range. Introduction of new emission sources, working in parallel with already existing 2G/3G/4G mobile technologies, raises concerns about exceeding the admissible EMF exposure limits. This paper analyzes issues and challenges related to EMF measurements in 5G technology, which are crucial for the assessment of EMF compliance with regulatory limits. We point out that the existing methodologies, dedicated to EMF measurements in 2G, 3G, and 4G networks, are not suitable for 5G. The reason is the use of new techniques, such as massive MIMO and precise beamforming together with higher frequency bands so that the existing measurement methods can lead to significantly overestimated results when they will be applied to 5G networks. Such results, in conjunction with the restrictive legislation on the EMF limits that apply in some countries, may have the negative impact on 5G network deployment, making it difficult to achieve the intended 5G network capabilities. We also propose an alternative method of EMF exposure assessment that is based on calculations and simulations and allows obtaining an accurate estimation of the EMF distribution in the 5G environment.

Open access paper: https://ieeexplore.ieee.org/document/8660395

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On The Assessment of Human Exposure to Electromagnetic Fields Transmitted by 5G Base Stations

Keller H. On the assessment of human exposure to electromagnetic fields transmitted by 5G NR base stations. Health Phys. 2019 Apr 23. doi: 10.1097/HP.0000000000001089.

Abstract

The fifth-generation new radio cellular network will be rolled out within the next few years. Several assessment methods of human exposure to electromagnetic fields transmitted by fifth-generation new radio base stations are discussed. Currently no method exists that allows extrapolation to the maximum theoretical exposure. Thus two new extrapolation methods are proposed. A 95th percentile exposure can be derived from the maximum theoretical exposure by an agreed-upon reduction factor if a more realistic exposure assessment is required.

https://www.ncbi.nlm.nih.gov/pubmed/31022013

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Electromagnetic field Measurement for Public Safety Exposure Level

Khan ZI, Razak AZA, Zakaria NA, Rashid NEA, Othman, KA. Electromagnetic field (EMF) Measurement for Public Safety Exposure Level. 2018 International Conference on Radar, Antenna, Microwave, Electronics, and Telecommunications (ICRAMET). 1-2 Nov. 2018. Serpong, Indonesia. Added to IEEE Xplore: 09 April 2019. pp. 66-69.

Abstract

This paper presents the level of Radio Frequency electromagnetic fields from Global System for Mobile communications (GSM) and Long Term Evolution (LTE) base station antennas. The exposure of Electromagnetic field towards public is being discuss widely due to the fact that it effects the human lives that is surrounded by these communication developments. Certain area was investigated earlier in order to obtain the strongest point of exposure. The location chosen in this paper was based on the red zone detected in the earlier drive test measurement. The measurement was conducted during morning, afternoon and night for 3 days. Data was collected using isotropic antenna and spectrum analyzer. The E-field exposure levels were

found to be lower than the maximum level set by international commission on Non-Ionizing radiation protection (ICNIRP) for the general public.

Conclusion

Overall LTE 2.6 GHz has a highest maximum E-field value compare to the other frequency. The high value of Efield could be related to the mobile traffic and also the higher power need for transmitting higher frequency. Lower frequency like GSM900 can travel further even though it requires less power because the properties of the wave itself. Higher frequencies require more power to travel longer distances. Based on all the data and analyzation done, all of the value gain are below the limit set by ICNIRP.

https://ieeexplore.ieee.org/document/8683911

Note: Industry representatives typically argue that exposures from 4G (LTE) are less than from 2G (GSM) cell towers. This study found the opposite.

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A Multi-Band Body-Worn Distributed Exposure Meter for Personal Radio-Frequency Dosimetry in Diffuse Indoor Environments

Aminzadeh R, Thielens A, …, Wout J. (19 authors). A multi-band body-worn distributed exposure meter for personal radio-frequency dosimetry in diffuse indoor environments. IEEE Sensors Journal. April 29, 2019. DOI: 10.1109/JSEN.2019.2913309

Abstract

A multi-band body-worn distributed exposure meter (BWDM) is designed and calibrated for diffuse fields in a reverberation chamber (RC) for personal exposure assessment in indoor environments. The BWDM uses 22 nodes distributed over the torso and measures the incident power density (Sinc) on body for 11 telecommunication bands in the frequency range 790-5513 MHz. In order to calibrate the measurement device in diffuse fields, a protocol is proposed for on-body calibration of the BWDM. This protocol is applicable to wearable personal exposure meters in general. The BWDM and the proposed calibration protocol are validated in five indoor locations and five frequency bands (the downlink bands at 800, 900, 1800 and 2100 MHz and WiFi 2 GHz) using a tri-axial broadband antenna and a spectrum analyzer (SA). The calibration shows that the BWDM has a relatively low measurement uncertainty with a 68% confidence interval on its antenna apertures, in the range 3.4-5.5 dB. A maximum difference of 0.9 dB is obtained for the total exposure in the test areas between the measurements of the BWDM and SA, which is an excellent agreement.

https://ieeexplore.ieee.org/document/8701577

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A systematic review of in vitro and in vivo radio frequency exposure methods

Hansen JW, Swartz EM, Cleveland JD, Asif SM, Brooks B, Braaten BD, Ewert D. A systematic review of in vitro and in vivo radio frequency exposure methods. IEEE Rev Biomed Eng. 2019 Apr 18. doi: 10.1109/RBME.2019.2912023. [Epub ahead of print]

Abstract

The interests in the effects of radio frequency (RF) on biological systems has increased. This interest has increased partially due to the advancements and increase implementations of RF into technology. As research in the area has progressed, the reliability and reproducibility of those experiments has not crossed

multidisciplinary boundaries. Therefore, as researchers, it is imperative to understand the various exposure systems available as well as the aspects, both electromagnetic and biological, needed to produce a sound exposure experiment. This systematic review examines common radio frequency exposure methods for both in vitro and in vivo studies. For in vitro studies, discussion of possible biological limitations to consider were also emphasized. The validity of the examined methods, for both in vitro and in vivo, were analyzed by discussing the advantages and disadvantages of each. This review offers guidance for researchers to assist in the development of an RF exposure experiment that crosses current multidisciplinary boundaries.

https://www.ncbi.nlm.nih.gov/pubmed/30998481

Conclusion

In a field that continues to struggle with reproducible results, the use of detailed, rigorous, reproducible, and transparent methodologies are critical moving forward. This detail needs to be thoroughly recorded for both the electromagnetic and the biological components of these exposure studies in order for the results to be reliable. Biological conditions and controls need to be considered as well in order to produce a reliable and reproducible experiment. Consideration of both the electromagnetic and biological components of the study should be detailed within these methodologies in order to provide reproducibility to the field. In addition, the realization that researchers are investigating a complex adaptive system is important in determining the impact of comparisons made between study and methods due to the difficulty in determining if the result is due to test exposure or because of the nature of the system. This review provides a systematic overview of common exposure methods in both in vitro and in vivo exposures, as well as providing advantages and disadvantages of each method. The goal of this being that researchers have a better understanding of methods they decide to use, and conclusions made given the results of studies which share similar scopes.

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Direct and indirect effects of exposure to 900 MHz GSM RF EMF on CHO cell line: Evidence of bystander effect by non-ionizing radiation

Jooyan N, Goliaei B, Bigdeli B, Faraji-Dana R, Zamani A, Entezami M, Mortazavi SMJ. Direct and indirect effects of exposure to 900 MHz GSM radiofrequency electromagnetic fields on CHO cell line: Evidence of bystander effect by non-ionizing radiation. Environ Res. 2019 Apr 1. pii: S0013-9351(19)30197-5. doi: 10.1016/j.envres.2019.03.063.

Highlights

• Short-term exposure to radiofrequency radiation (RFR) emitted from mobile phones may cause genotoxic effects.
• RFR has both targeted and non-targeted effects on cells.
• RFR-induced non-targeted effects include bystander effect.
• The biological effects of RFR are possibly mediated by oxidative stress.
• Extracellular ROS can trigger molecular signals in non-targeted cells.

Abstract

INTRODUCTION: The rapid rise in global concerns about the adverse health effects of exposure to radiofrequency radiation (RFR) generated by common devices such as mobile phones has prompted scientists to further investigate the biological effects of these environmental exposures. Non-targeted effects (NTEs) are responses which do not need a direct exposure to be expressed and are particularly significant at low energy radiations. Although NTEs of ionizing radiation are well documented, there are scarcely any studies on non-targeted responses such as bystander effect (BE) after exposure to non-ionizing radiation. The main goal of this research is to study possible RFR-induced BE.

MATERIAL AND METHODS: Chinese hamster ovary cells were exposed to 900 MHz GSM RFR at an average specific absorption rate (SAR) of 2 W/kg for 4, 12 and 24 hours (h). To generate a uniformly distributed electromagnetic field and avoid extraneous RF exposures a cavity was desined and used. Cell membrane permeability, cell redox activity, metabolic and mitotic cell death and DNA damages were analyzed. Then the most effective exposure durations and statistically significant altered parameters were chosen to assess the induction of BE through medium transfer procedure. Furthermore, intra and extra cellular reactive oxygen species (ROS) levels were measured to assess the molecular mechanism of BE induced by non-ionizing radiation.

RESULTS: No statistically significant alteration was found in cell membrane permeability, cell redox activity, metabolic cell activity and micronuclei (MN) frequency in the cells directly exposed to RFR for 4, 12, or 24 h. However, RFR exposure for 24 h caused a statistically significant decrease in clonogenic ability as well as a statistically significant increase in olive moment in both directly exposed and bystander cells which received media from RFR-exposed cells (conditioned culture medium; CCM). Exposure to RFR also statistically significant elevated both intra and extra cellular levels of ROS.

CONCLUSION: Our observation clearly indicated the induction of BE in cells treated with CCM. To our knowledge, this is the first report that a non-ionizing radiation (900 MHz GSM RFR) can induce bystander effect. As reported for ionizing radiation, our results proposed that ROS can be a potential molecule in indirect effect of RFR. On the other hand, we found the importance of ROS in direct effect of RFR but in different ways.

https://www.ncbi.nlm.nih.gov/pubmed/31036329

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Effects of Mobile Phone EMF on β-Amyloid-Induced Oxidative Stress in Human and Rat Primary Astrocytes

Tsoy A, Saliev T, Abzhanova E, Turgambayeva A, Kaiyrlykyzy A, Akishev M, Saparbayev S, Umbayev B, Askarova S. The Effects of Mobile Phone Radiofrequency Electromagnetic Fields on β-Amyloid-Induced Oxidative Stress in Human and Rat Primary Astrocytes. Neuroscience. Published online Apr 3, 2019. https://doi.org/10.1016/j.neuroscience.2019.03.058

Highlights

• EMF of 918 MHz decreases Aß42- induced cellular and mitochondrial ROS in human and rat primary astrocytes.
• EMF of 918 MHz increases mitochondrial membrane potential in rat primary astrocytes.
• EMF of 918 MHz suppresses induced by Aß42 activation of NADPH oxidase in rat primary astrocytes.
• EMF of 918 MHz suppresses H2O2–induced phosphorylation of p38MAPK and ERK ½ in rat primary astrocytes.

Abstract

Amyloid beta peptide (Aβ) is implicated in the development of pathological reactions associated with Alzheimer's disease (AD), such as oxidative stress, neuro-inflammation and death of brain cells. Current pharmacological approaches to treat AD are not able to control the deposition of Aβ and suppression of Aβ-induced cellular response. There is a growing body of evidence that exposure to radiofrequency electromagnetic field (RF-EMF) causes a decrease of beta-amyloid deposition in the brains and provides cognitive benefits to Alzheimer's Tg mice. Herein, we investigated the effects of mobile phone radiofrequency EMF of 918 MHz on reactive oxygen species (ROS) formation, mitochondrial membrane potential (MMP), activity of NADPH-oxidase, and phosphorylation of p38MAPK and ERK1/2 kinases in human and rat primary astrocytes in the presence of Aβ42 and H2O2. Our data demonstrate that EMF is able to reduce Aβ42- and H2O2–induced cellular ROS, abrogate $A\beta_{42}$-induced production of mitochondrial ROS and the co-localization

between the cytosolic (p47-phox) and membrane (gp91-phox) subunits of NADPH oxidase, while increasing MMP, and inhibiting H2O2–induced phosphorylation of p38MAPK and ERK1/2 in primary astrocytes. Yet, EMF was not able to modulate alterations in the phosphorylation state of the MAPKs triggered by Aβ42. Our findings provide an insight into the mechanisms of cellular and molecular responses of astrocytes on RF-EMF exposure and indicate the therapeutic potential of RF-EMF for the treatment of Alzheimer's disease.

Excerpt

In summary, our data showed that EMF treatment of brain cells with parameters similar to irradiation from the ordinary mobile phone (918 MHz; GSM) was capable of suppressing oxidative stress triggered by $A\beta_{42}$ and H_2O_2, thus indicating its possible therapeutic benefit. Our data conform to the previous reports on beneficial impact of EMF that can be employed for the treatment of neurodegenerative disorders such as Alzheimer's disease. However, further studies are needed to validate the effectiveness and safety of EMF application in AD patients.

https://www.sciencedirect.com/science/article/abs/pii/S0306452219302337

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Radiophysical Microwave Installation for Investigating Biological Effects in Mice with Tumor

Kryukova OV, Pyankov VF, Salomatov YP, Kopylov AF. Radiophysical microwave installation for investigating biological effects in mice with tumor. 2019 IEEE Conference of Russian Young Researchers in Electrical and Electronic Engineering (EIConRus). 28-31 Jan. 2019. DOI: 10.1109/EIConRus.2019.8657031.

Abstract

Designing radiophysical devices for investigating the effect of microwave radiation on biological objects is one of the main directions in applied modern radio-electronics. An installation for investigating the radiophysical microwave radiation effects on laboratory animals has been developed, with the frequency being 915 MHz, power of electromagnetic radiation being 10 μW/cm2. The results obtained demonstrate the survival rate of mice with tumor under the influence of electromagnetic field.

Excerpts

The laboratory animals were exposed to microwave EMR at a frequency of 915 MHz, with the energy flux density being 10 μW / cm2 and 100 μW / cm2....

As a model tumor, Ehrlich ascites carcinoma was used. Ehrlich ascites carcinoma is one of the most common tumors used as a model in scientific research....

After the tumor transplantation the animals were divided into three groups: the control and two experimental ones. (EMR group exposed to 10 μW\cm2 and EMR group exposed to 100μW\cm2). The animals of the experimental groups were daily subjected to electromagnetic radiation for 1 hour during 10 days. The control group was kept under the same conditions without the influence of the electromagnetic radiation. In the course of the experiment the mortality of the animals was recorded during 45 days after the beginning of the tumor transplantation.

Thus, independently on the power, the impact of microwave radiation changes the lifetime of the animals with Ehrlich ascites carcinoma. In this case, using the power of 10 μW /cm2 slows down the animal death and the power of 100 μW/cm2 decreases the lifetime of the animals. However, in the group exposed to 100 μW/cm2 no tumor developed after the transplantation. Using the mathematical methods of analysis the author [10], [11] show that there is a connection between the development of cancer diseases among the population and the main factors of the electromagnetic load due to EMR when using MRT as a carcinogenic factor or a factor

contributing to cancer genesis. Moreover, some researchers suggest that radiofrequency fields can act as cancer promoters [12]. Thus, it is important to study the impact of electromagnetic microwave radiation on the growth dynamics of tumor cells and their functional condition, for example, in order to estimate the degree of risk of tumor progressing. Consequently, it is necessary to develop a method of estimating the carcinogenic risk under the impact of microwave radiation, in particular to improve the suggested and implemented measures for minimizing unfavorable and harmful effects. It is dangerous to underestimate as well as to overestimate the risk of the impact for the given widely spread factor.

https://ieeexplore.ieee.org/document/8657031

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Long-term exposure of 2450 MHz electromagnetic radiation induces stress and anxiety like behavior in rats

Gupta SK, Patel SK, Tomar MS, Singh SK, Mesharam MK, Krishnamurthy S. Long-term exposure of 2450 MHz electromagnetic radiation induces stress and anxiety like behavior in rats. Neurochemistry International. Publ. online Apr 4, 2019.

Highlights

• EMR-2450 MHz induces stress and aggravates anxiety-like symptoms in rats.
• Exposure of EMR-2450 MHz increases plasma corticosterone level and, expression of CRH-2 and GR in amygdala.
• Increased expression of cytochrome-C and caspase-9 indicating mitochondrial dysfunction and activation of apoptosis.
• Change in expression of mitochondrial Bax: Bcl_2 ratio indicating modulation of apoptosis.
• EMR-2450 MHz exposure causes both amygdalar necrotic and apoptotic cell death.

Abstract

Long term exposure of electromagnetic radiations (EMR) from cell phones and Wi-Fi hold greater propensity to cause anxiety disorders. However, the studies investigating the effects of chronic exposure of EMR are limited. Therefore, we investigated the effects of repeated exposure of discrete frequency of EMR in experimental animals. Male rats were exposed to EMR (900, 1800 and 2450 MHz) for 28 (1 h/day) days. Long term exposure of EMR (2450 MHz) induced anxiety like behavior. It deregulated the hypothalamic pituitary adrenal (HPA) axis in rats as observed by increase in plasma corticosterone levels apart from decreased corticotrophin releasing hormone-2 (CRH-2) and Glucocorticoid receptor (GR) expression in amygdala. Further, it impaired mitochondrial function and integrity. The expression of Bcl2 showed significant decrease while Bax and ratio of Bax: Bcl2 were increased in the mitochondria and vice versa in cytoplasm indicating altered regulation of apoptosis. EMR exposure caused release of cytochrome-c and expression of caspase-9 ensuing activation of apoptotic cell death. Additional set of experiments performed to estimate the pattern of cell death showed necrotic and apoptotic amygdalar cell death after EMR exposure. Histopathological studies also revealed a significant decrease in neuronal cells in amygdala. The above findings indicate that long-term exposure of EMR radiation (2450 MHz) acts as a stressor and induces anxiety-like behaviors with concomitant pathophysiological changes in EMR subjected rats.

Excerpts

The average power density was 0.1227 W/m2. The whole body SAR values was found in between the 0.025–0.070 W/kg range, representing an average SAR value to be approximately 0.042 W/kg. The value of SAR in head region was found to be 0.131 W/kg (900, 1800 and 2450 MHz) with a value of power density 0.1227 W/m2....

All the rats were distributed into four different groups of six each. They were designated as control, EMR-900,

EMR-1800 and EMR-2450.... The groups, EMR-900 MHz, EMR-1800 MHz and EMR-2450 MHz were continuously exposed to electromagnetic radiations between 10 a.m. and 1 p.m. for 1 h for 28 days beginning from D-1. After 15 min of EMR exposure on D-1 to D-28 at 7 day interval, behavioral assessments were performed....

In this study, we have shown that rats sub-chronically exposed to EMR at a frequency of 2450 MHz exhibited anxiety-like symptoms. Repeated EMR-2450 MHz exposure caused an increase in corticosterone levels while the expression of CRH-2 and GR expression were significantly reduced in amygdala. EMR exposed animals showed alterations in the mitochondrial function and integrity. It also induced apoptotic factors leading to decrease of neuronal cells in the amygdalar region....

https://www.ncbi.nlm.nih.gov/pubmed/30954502

Note: This was not Wi-Fi because the signals were not modulated.

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Effects of 220 MHz Pulsed Modulated Radiofrequency Field on the Sperm Quality in Rats

Guo L, Lin JJ, Xue YZ, An GZ, Zhang JP, Zhang KY, He W, Wang H, Li W, Ding GR. Effects of 220 MHz Pulsed Modulated Radiofrequency Field on the Sperm Quality in Rats. Int J Environ Res Public Health. 2019 Apr 10;16(7). pii: E1286. doi: 10.3390/ijerph16071286.

Abstract

Under some occupational conditions, workers are inevitably exposed to high-intensity radiofrequency (RF) fields. In this study, we investigated the effects of one-month exposure to a 220 MHz pulsed modulated RF field at the power density of 50 W/m² on the sperm quality in male adult rats. The sperm quality was evaluated by measuring the number, abnormality and survival rate of sperm cells. The morphology of testis was examined by hematoxylin-eosin (HE) staining. The levels of secreting factors by Sertoli cells (SCs) and Leydig cells (LCs) were determined by enzyme linked immunosorbent assay (ELISA). The level of cleaved caspase 3 in the testis was detected by immunofluorescence staining. Finally, the expression levels of the apoptosis-related protein (caspase 3, BAX and BCL2) in the testis were assessed by Western blotting. Compared with the sham group, the sperm quality in the RF group decreased significantly. The levels of secreting factors of SCs and the morphology of the testis showed an obvious change after RF exposure. The level of the secreting factor of LCs decreased significantly after RF exposure. The levels of cleaved caspase 3, caspase 3, and the BAX/BCL2 ratio in the testis increased markedly after RF exposure. These data collectively suggested that under the present experimental conditions, 220 MHz pulsed modulated RF exposure could impair sperm quality in rats, and the disruption of the secreting function of LCs and increased apoptosis of testis cells induced by the RF field might be accounted for by this damaging effect.

https://www.ncbi.nlm.nih.gov/pubmed/30977029

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Assessment of the effects of radiofrequency radiation on human colon epithelium cells

Tomruk A, Terzi YK, Guler GO. Assessment of the effects of radiofrequency radiation on human colon epithelium cells. Bratisl Lek Listy. 2019;120(4):299-308. doi: 10.4149/BLL_2019_050.

Abstract

OBJECTIVES: The aim of the study was to investigate the possible effects of radiofrequency radiation (RFR) at different frequencies for different exposure durations on caspase-dependent apoptosis pathways in human

colon adenocarcinoma (HT-29).

METHODS: HT-29 cells were exposed to 1800 MHz; 2100 MHz and 2600 MHz RFR for 3 h cont., 6 h int. and 6 h cont.. Cell viability measurements were performed by Trypan Blue exclusion assay and the gene expressions of CASP8, CASP9, CASP3 and CASP12 were analyzed using qRT-PCR.

RESULTS: Exposure to 2100 MHz RFR for all 3 durations of exposures was more effective for the ratio of the number of viable HT-29 cells w.r.t 1800 MHz RFR and 2600 MHz RFR exposures. After 2100 MHz RFR exposure, caspase activation increased significantly (for 3h cont. and 6 h int. exposures CASP8 and CASP9 levels; for 6 h cont. exposure CASP3 levels) (p 0.05).

CONCLUSION: Decreases in the cell viability of HT-29 cells for certain frequencies and also durations are consistent with significant increases in caspase activations. The results of caspase activation after 1800 MHz or 2600 MHz RFR exposures can be interpreted as the activation of different types of cell death pathway by caspase signaling cascades (Fig. 15, Ref. 56).

https://www.ncbi.nlm.nih.gov/pubmed/31023054

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Effect of cell phone radiation on neutrophil of mice

Pei Y, Gao H, Li L, An X, Tian Q. Effect of cell phone radiation on neutrophil of mice. Int J Radiat Biol. 2019 Apr 23:1-22. doi: 10.1080/09553002.2019.1607605.

Abstract

Purpose The present study aims to evaluate the effect of cell phone radiation on neutrophil of mice.

Materials and methods 40 male BALB/C mice were randomly broken up into 4 groups as control, blank control, TD-CDMA and LTE-Advanced groups respectively. Mice were exposed to cell phone radiation for a period of 6 weeks. Then numbers of neutrophil were detected by fully automatic haematology analyzer. Soft agar diffusion method was performed to assess the chemotaxis of neutrophils while the phagocytosis of neutrophils was determined by measuring the staphylococcus albus phagocytosis percentage. Apoptosis was analyzed by flow cytometry.

Results No significant differences were observed among the control and exposure groups regarding the numbers of neutrophils after 2 weeks' exposure to cell phone radiation, while the numbers of neutrophils in TD-SCDMA and LTE-Advanced groups were seen to rise after an exposure of 4 or 6 weeks. No effect was observed on chemotaxis of neutrophils due to phone radiation. The phagocytosis of neutrophils was decreased while the apoptosis were increased both in TD-SCDMA and LTE-Advanced groups after 6 weeks exposure.

Conclusions Mobile phone radiation could give rise to increase of neutrophil numbers yet with no effect whatever on neutrophils chemotaxis, and the radiation was likely to cause decrease of phagocytosis and induced apoptosis of neutrophils.

https://www.ncbi.nlm.nih.gov/pubmed/31012799

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Effects of 50 Hz magnetic fields on circadian rhythm control in mice

Lundberg L, Sienkiewicz Z, Anthony DC, Broom KA. Effects of 50 Hz magnetic fields on circadian rhythm control in mice. Bioelectromagnetics. 2019 Apr 4. doi: 10.1002/bem.22188.

Abstract

Artificial light and power frequency magnetic fields are ubiquitous in the built environment. Light is a potent zeitgeber but it is unclear whether power frequency magnetic fields can influence circadian rhythm control. To study this possibility, 8-12-week-old male C57BL/6J mice were exposed for 30 min starting at zeitgeber time 14 (ZT14, 2 h into the dark period of the day) to 50 Hz magnetic fields at 580 μT using a pair of Helmholtz coils and/or a blue LED light at 700 lux or neither. Our experiments revealed an acute adrenal response to blue light, in terms of increased adrenal per1 gene expression, increased serum corticosterone levels, increased time spent sleeping, and decreased locomotor activity (in all cases, $P < 0.0001$) compared to an unexposed control group. There appeared to be no modulating effect of the magnetic fields on the response to light, and there was also no effect of the magnetic fields alone (in both cases, $P > 0.05$) except for a decrease in locomotor activity ($P < 0.03$). Gene expression of the cryptochromes cry1 and cry2 in the adrenals, liver, and hippocampus was also not affected by exposures (in all cases, $P > 0.05$). In conclusion, these results suggest that 50 Hz magnetic fields do not significantly affect the acute light response to a degree that can be detected in the adrenal response.

https://www.ncbi.nlm.nih.gov/pubmed/30945762

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The cellular effects of Pulsed Electromagnetic Fields on osteoblasts: A review

Galli C, Pedrazzi G, Guizzardi S. The cellular effects of Pulsed Electromagnetic Fields on osteoblasts: A review. Bioelectromagnetics. 2019 Mar 25. doi: 10.1002/bem.22187.

Abstract

Electromagnetic fields (EMFs) have long been known to interact with living organisms and their cells and to bear the potential for therapeutic use. Among the most extensively investigated applications, the use of Pulsed EMFs (PEMFs) has proven effective to ameliorate bone healing in several studies, although the evidence is still inconclusive. This is due in part to our still-poor understanding of the mechanisms by which PEMFs act on cells and affect their functions and to an ongoing lack of consensus on the most effective parameters for specific clinical applications. The present review has compared in vitro studies on PEMFs on different osteoblast models, which elucidate potential mechanisms of action for PEMFs, up to the most recent insights into the role of primary cilia, and highlight the critical issues underlying at least some of the inconsistent results in the available literature

https://www.ncbi.nlm.nih.gov/pubmed/30908726

Excerpt

Two main stimulation regimes possess the most evidence supporting their biological action: a 75 Hz, 1.5–2.5 mT PEMF stimulation with trapezoidal waves and a 0.3–1.8 mT, 15 Hz PRF PEMF stimulation with carrier frequency of about 4 kHz, which correspond to the most common, commercially available clinical stimulation devices. These choices appear to be rooted in habit or equipment availability rather than a systematic screening, which is still needed in the osteoblast field.

Taken together, the literature on in vitro studies on osteoblasts seem to solidly support an effect of PEMFs on osteoblastic differentiation, and several works have reported a modulation of the RANKL/OPG axis [Chang et al., 2005; Borsje et al., 2010; Jansen et al., 2010; He et al., 2018; Wang et al., 2018], which is central to bone homeostasis. Moreover, there is robust and consistent evidence that BMP-2 [Bodamyali et al., 1998; Patterson et al., 2006; Selvamurugan et al., 2007; Yan et al., 2015; Wang et al., 2019], TGF-β [Lohmann et al., 2000; Patterson et al., 2006; Selvamurugan et al., 2017], and Wnt [Lin et al., 2015; Zhou et al., 2015; Zhai et al.,

2016] signaling are modulated in osteoblasts by PEMFs.

It has been long known that cell membrane appears at the center of the effects of PEMFs because of their action on ion channels, most noticeably calcium channels, and the release of bioactive factors and membrane trafficking. Most recently, primary cilia have been reported to play a role in transducing PEMF signaling to cells [Yan et al., 2015; Xie et al., 2016; Wang et al., 2018] and could provide a unifying theory to explain differences in cell responsiveness depending on their differentiation stage and the involvement of signaling pathways that could all be regulated at the receptor level by an effect on membrane trafficking. Besides biochemical signaling, therefore, a closer attention to morphology is probably needed in any new study on osteoblasts and PEMFs. Reports of morphological effects of PEMFs on cells are sporadic but consistent [Noriega-Luna et al., 2011; Wang et al., 2018], and they might be central to a more correct interpretation of the latest data to better understand the cellular targets of PEMFs and therefore improve their clinical use.

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Radiofrequency Electromagnetic Field Exposure and the Resting EEG: Exploring the Thermal Mechanism Hypothesis

Loughran SP, Verrender A, Dalecki A, Burdon CA, Tagami K, Park J, Taylor NAS, Croft RJ. Radiofrequency Electromagnetic Field Exposure and the Resting EEG: Exploring the Thermal Mechanism Hypothesis. Int J Environ Res Public Health. 2019 Apr 28;16(9). pii: E1505. doi: 10.3390/ijerph16091505.

Abstract

There is now strong evidence that radiofrequency electromagnetic field (RF-EMF) exposure influences the human electroencephalogram (EEG). While effects on the alpha band of the resting EEG have been repeatedly shown, the mechanisms underlying that effect have not been established. The current study used well-controlled methods to assess the RF-EMF exposure effect on the EEG and determine whether that effect might be thermally mediated. Thirty-six healthy adults participated in a randomized, double-blind, counterbalanced provocation study. A water-perfusion suit (34 C) was worn throughout the study to negate environmental influences and stabilize skin temperature. Participants attended the laboratory on four occasions, the first being a calibration session and the three subsequent ones being exposure sessions. During each exposure session, EEG and skin temperature (8 sites) were recorded continuously during a baseline phase, and then during a 30 min exposure to a 920 MHz GSM-like signal (Sham, Low RF-EMF (1 W/kg) and High RF-EMF (2 W/kg)). Consistent with previous research, alpha EEG activity increased during the High exposure condition compared to the Sham condition. As a measure of thermoregulatory activation, finger temperature was found to be higher during both exposure conditions compared to the Sham condition, indicating for the first time that the effect on the EEG is accompanied by thermoregulatory changes and suggesting that the effect of RF-EMF on the EEG is consistent with a thermal mechanism.

Open access paper: https://www.mdpi.com/1660-4601/16/9/1505

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ION cyclotron resonance: Geomagnetic strategy for living systems?

Liboff AR. ION cyclotron resonance: Geomagnetic strategy for living systems? Electromagn Biol Med. 2019 Apr 27:1-6. doi: 10.1080/15368378.2019.1608234.

Abstract

Except for relatively few polarity reversals the magnitude of the magnetic dipole moment of the earth has remained constant since life first began, allowing evolutionary processes to integrate the geomagnetic field (GMF) into several biological functions. One of these, bearing the classical signature of an ion cyclotron

resonance (ICR)-like interaction, results in biological change associated with enhanced proton transport. The wide range of cation masses over which this effect is found suggest a fundamental biological dependence on the GMF, one that functions equally well for electric as well as magnetic fields. Such generalization of ICR requires two things: transparency of tissues to the GMF and suitably tuned ELF resonant magnetic or electric fields. To complement the widely reported ICR responses to applied AC magnetic fields, we hypothesize the existence of weak endogenous ICR electric field oscillations within the cell. This equivalence implies that even in the absence of applied AC magnetic fields, biological systems will exhibit intrinsic GMF-dependent ion cyclotron resonance intracellular interactions. Many ICR effects that have been reported appear as antagonist pairs suggesting that the characteristics of the GMF have not only been incorporated into the genome but also appear to function in an endocrine-like manner.

https://www.ncbi.nlm.nih.gov/pubmed/31017814

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Cardiovascular response as a marker of environmental stress caused by variations in geomagnetic field and local weather

Pishchalnikova RY, Gurfinkel YI, Sarimov RM, Vasin AL, Sasonko ML, Matveeva TA, Binhi VN, Baranov MB. Cardiovascular response as a marker of environmental stress caused by variations in geomagnetic field and local weather. Biomedical Signal Processing and Control . 51:401-410. May 2019.
https://doi.org/10.1016/j.bspc.2019.03.005

Highlights

• A Helmholtz-like magnetic field exposure system adapted for long-term experiments.
• Three modes of magnetic field exposure including geomagnetic storm have been used.
• Correlations of heart rate with magnetic field are criterion of cardiovascular response.
• Maximum cardiovascular response has been detected for the storm mode of exposure.
• Time-frequency representation of heart rate for each subject has individual character.

Abstract

We report the results of a physiological study that include ECG analysis, capillary blood velocity (CBV) data, and blood pressure (BP) measurements obtained under conditions of modified external magnetic field (MF). Each of eight volunteers was sequentially exposed to MFs of three different types for 22 h. A Helmholtz-like MF exposure system was used. The system was specially designed for long-term exposures of human beings to static and low frequency MFs. The MF of the first type reproduced an initially recorded geomagnetic storm (GS). The MF inductions of the other two types were about 55 and 49 μT, which corresponded to the natural local magnetic background and a slightly decreased MF, respectively. In all three cases, the environmental magnetic fluctuations were suppressed by the active Helmholtz system. The variability of RR intervals[the time elapsed between two successive R-waves of the QRS signal on the electrocardiogram] was considered as a key indicator of cardiovascular response to the MFs and weather conditions. A time-frequency representation (TFR) and a frequency-frequency representation (FFR) were used for processing of the time series of RR intervals. It turned out that the transformation to TFR makes it possible to obtain the characteristic matrix of RR intervals; such a matrix can be used as a subject identifier. FFR was used to calculate correlations of RR intervals with the components of the MFs. The averaged correlation coefficients of RR intervals with the Bx and By components appeared significantly higher ($p < 0.001$) during the Storm mode in comparison with control. Thus, it is shown that artificial geomagnetic storm can cause a detectable cardiovascular response.

https://www.sciencedirect.com/science/article/abs/pii/S1746809419300795

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Evaluation of in vivo exposure to ELF magnetic fields on plasma levels of pro-inflammatory cytokines in rats

Wyszkowska J, Jędrzejewski T, Piotrowski J, Wojciechowska A, Stankiewicz M, Kozak W. Evaluation of the influence of in vivo exposure to extremely low-frequency magnetic fields on the plasma levels of pro-inflammatory cytokines in rats. Int J Radiat Biol. 2018 Oct;94(10):909-917. doi: 10.1080/09553002.2018.1503428.

Abstract

PURPOSE: Epidemiological data suggest that there is a link between exposure to extremely low-frequency magnetic fields (ELF-MFs), immune response, and the occurrence of neurodegenerative diseases. The exact nature of this phenomenon remains speculative and requires detailed laboratory investigation. In the present study, we evaluate changes in plasma concentration of pro-inflammatory and regulatory cytokines as well as alternations of the hematological parameters in rats exposed to an ELF-MF.

MATERIALS AND METHODS: Male Wistar rats were repeatedly exposed for either 1 h/day for 7 days, or continuously for 24 h, to a sinusoidal ELF-MF (50 Hz, 7 mT). Control groups were sham exposed for either 1 h/day for 7 days, or continuously for 24 h, respectively. The levels of cytokines: interleukin (IL)-1β, IL-2, IL-6, and IL-10 in plasma obtained from blood samples were determined using enzyme-linked immunosorbent assay (ELISA). The changes in blood parameters were determined using an automatic hematology analyzer in whole blood samples immediately after collection.

RESULTS: We found that a single continuous (lasting 24 h) exposure provoked a significant increase of the plasma IL-1β, IL-6, and IL-2 levels, and caused an elevation in blood parameters, such as white blood cells, lymphocytes, hemoglobin, and hematocrit levels. In contrast, however, repetitive exposure of rats to an ELF-MF for 1 h/day for 7 days did not lead to any changes in plasma levels of cytokines and hematological counts.

CONCLUSIONS: Based on these data we conclude that exposure duration (dose-response) plays a significant role in the immune response, specifically at the cellular level. While single 24 h-lasting exposure provoked changes that indicate an immune alarm stimulation, under the conditions which are typical for therapeutic use of ELF-MFs (repeated short daily exposure) the immune potentially harmful response has not been observed.

https://www.ncbi.nlm.nih.gov/pubmed/30028649

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Effects of ELF EMF on c-Maf, STAT6, and RORα expressions in spleen and thymus of rat

Mahaki H, Jabarivasal N, Sardarian K, Zamani A. The effects of extremely low-frequency electromagnetic fields on c-Maf, STAT6, and RORα expressions in spleen and thymus of rat. Electromagn Biol Med. 2019 Apr 24:1-7. doi: 10.1080/15368378.2019.1608832.

Abstract

The study investigated the effect of extremely low-frequency electromagnetic fields (ELF-EMFs) exposure at different magnetic flux densities on genes expression of transcription factor Maf (c-Maf), signal transducer and activator of transcription 6 (STAT6), and retinoid-related orphan receptor alpha (RORα) in the spleen and thymus of rats. Eighty adult male rats were separated into four ELF-EMFs exposed and were exposed to magnetic flux densities of 1, 100, 500, and 2000 μT at a frequency of 50 Hz for 2 h daily for up to 60 d. All rats were intraperitoneally immunized on d 31, 44, and 58 of exposure. The experimental results showed that the expression levels of c-Maf, STAT6, and RORα in the thymus were not significantly changed at different magnetic flux densities. The expression levels of RORα and c-Maf were significantly downregulated at the

densities of 1 and 100 μT, while the expression of STAT6 was only significantly decreased at the density of 100 μT. In conclusion, low magnetic flux densities of ELF-EMFs may reduce the expression levels of c-Maf, STAT6, and RORα genes in the spleen.

https://www.ncbi.nlm.nih.gov/pubmed/31017814

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Effects of continuous exposure to power frequency electric fields on soybean Glycine max

Li X, Liu X, Wan B, Li X, Li M, Zhu H, Hua H. Effects of continuous exposure to power frequency electric fields on soybean Glycine max. J Environ Radioact. 2019 Apr 5;204:35-41. doi: 10.1016/j.jenvrad.2019.03.026.

Abstract

With the increasing density of high voltage transmission systems, the potential risks and hazards of environmental electric fields (EFs) generated by these systems to surrounding organisms is becoming a source of public concern. To evaluate the effect of environmental EFs on plants, we used soybean as a model and systematically evaluated the effect of continuous exposure to different intensities (0 kV/m, 2 kV/m, and 10 kV/m) of power frequency EFs on agronomic characters, yield, nutrient contents, protective enzyme activities, and gene transcription. We found that the effects on soybean were more pronounced when plants were exposed to EF during development (especially at the seedling stage) than when they were exposed at maturity. The functional leaf number, stem diameter, plant dry weight, and pod number were largely unaffected by EF, while the germination rate and protective enzyme activities increased with increasing EF intensity. In plants exposed to low-intensity EF (2 kV/m), some agronomic characters, including chlorophyll content, plant height, and bean dry weight, as well as the soluble sugar and total protein contents, were significantly higher than those of plants exposed to high-intensity EF (10 kV/m) and control plants (0 kV/m). Through transcriptome analysis, we found that 2,977 genes were significantly up-regulated and 1,462 genes were down-regulated when plants were exposed to EF. These differentially expressed genes mainly encode ribosome proteins and related enzymes involved in carbon metabolism pathway, providing a novel perspective for understanding molecular mechanisms underpinning the responses to EF stress in soybean.

https://www.ncbi.nlm.nih.gov/pubmed/30959328

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The "Moscow signal" epidemiological study, 40 years on

Martinez JA. The "Moscow signal" epidemiological study, 40 years on. Reviews on Environmental Research. 34(1):13-24. Mar 2019. d oi: 10.1515/reveh-2018-0061.

Abstract

Between 1953 and 1979, the USSR irradiated the United States embassy in Moscow with microwaves. This episode, a classic Cold War affair, has acquired enormous importance in the discussions on the effect of non-ionizing radiation on people's health. In 2011, the International Agency for Research on Cancer (IARC) classified radiofrequency electromagnetic fields as being a possible human carcinogen (Group 2B), but the results of recent laboratory and epidemiological studies have led some researchers to conclude that radiofrequency electromagnetic fields should be reclassified as a human carcinogen instead of merely a possible human carcinogen. In 1978, the "Moscow signal" case was officially closed after the publication of the epidemiological study of (Lilienfeld AM, Tonascia J, Tonascia S, Libauer CA, Cauthen GM. Foreign Service health status study. Evaluation of health status of foreign service and other employees from selected Eastern European posts. Report on Foreign Service Health Status Study, U.S. Department of State 6025-619073,

1978), showing no apparent evidence of increased mortality rates and limited evidence regarding general health status. However, several loose ends still remain with respect to this epidemiological study, as well as the affair as a whole. In this paper, we summarize the available evidence concerning this case, paying special attention to the epidemiological study of Lilienfeld et al. After reviewing the available literature (including declassified documents), and after some additional statistical analyses, we provide new insights which do not complete the puzzle, but which may help to better understand it.

https://www.ncbi.nlm.nih.gov/pubmed/30676008

Conclusions

This event was just one of many that took place during the Cold War, and must therefore be assessed in the context of manipulation, political interests and classified information typical of the time. With the data in hand, with what we have been able to gather and what we have shown in this article, we can approach the truth, possibly even guess it, but not reveal it in its total dimension. And we will probably never be able to do so.

Those who, in the published results we have mentioned, use this event to deny the harmful effects of microwave radiation do not have enough evidence to support their position. There are too many loose ends, unanalyzed information, methodological flaws, and debatable interpretations.

However, on the opposite side of the debate, those who take this case as incontestable evidence of the harmful effects of microwaves on humans at low intensities, must also admit that there is a lack of statistical consistency in the results. There is still too much imprecision.

A global vision of the whole event, including the nuances and details that we have explained in this article, show the latter to be closer to the truth than the former, even more so when we consider non-carcinogenic effects linked to what is now associated with electrohypersensitivity. However, it must be recognized that the methodology used by Lilienfeld et al. (1) also casts doubt on this claim, as the health status symptom questionnaires were filled in after the case was made public (nocebo effect). In addition, the results of our simulations are also partially dependent of the quality of data of Lilienfeld et al. (1), which were not complete, having a different degree of potential bias regarding mortality, cancer incidence and health status. Further research on the personnel of the Havana embassy who were recently subjected to a similar attack, could indirectly help to better understand what happened in Moscow more than 40 years ago.

Power densities measured at the Moscow embassy were higher than the average levels typically found nowadays in homes, schools and urban areas, and were of the same order of magnitude as the more extreme case of living just a few meters from a base station (see (19)). This means that exposure at the embassy could have been high in terms of today's typical levels of exposure. Nevertheless, the exposure was several orders of magnitude lower than those suggested by the ICNRIP guidelines, adopted by many countries as legal limits. As Hardell et al. (19) indicated, the BioInitiative Report (49) with updated references defined the scientific benchmark for possible health risks as 0.000003–0.000006 mW/cm^2. Consequently, the exposure at the Moscow embassy was from 3 to 4 orders of magnitude higher than this safety benchmark, but 3 orders of magnitude lower than the legal limits of many countries.

In any case, and as Frentzle-Beyme (50) stated, "*The level of proof required to justify action for health protection should be less than that required to constitute causality as a scientific principle*". The "Moscow signal" remains a "signal"; let us not reject it, but listen to it instead.

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Radio Frequency Electromagnetic Field Exposure Assessment for future 5G networks

Persia S, Carciofi C, Barbiroli M, Volta C, Bontempelli D, Anania G. Radio frequency electromagnetic field

exposure assessment for future 5G networks. IEEE 29th Annual International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC), 2018. IEEE, 2018. doi:10.1109/PIMRC.2018.8580919

Abstract

The fifth generation of mobile network (5G) will relay not only on the expansion of existing fourth (4G) Long Term Evolution (LTE) network, but thanks to the introduction of new radio access in the millimetre wave bands will allow to meet new requirements in terms of connectivity and capacity. Specifically, 5G network will be characterized by the use of new spectrum at higher frequencies with a very large number of antenna elements deployment. As a consequence, the RF EMF (Radio Frequency Electromagnetic Field) compliance assessments with the regulatory requirements for human exposure for the installation permission needs to be revised accordingly. In this work, a Country case (Italy), where a more restrictive regulatory framework than the ICNIRP Guidelines is applied, has been analysed to investigate the impact of the restrictive approach on the future 5G mobile networks roll-out.

Conclusions

The EMF evaluations of existing cellular networks has been analysed in this work in order to highlight how restrictive regulatory framework than International Guidelines can affect 5G and future network deployment. Italy case study is considered as an example, due to its restrictive regulation to verify if it can permit an efficient 5G roll-out. This consideration has been confirmed by evaluations of the trend of saturated sites from 2010 to 2017 in Italy. Simulations demonstrate that in Italy the strong development expected for the evolution of 4G networks and, in the perspective of 5G systems, can be threatened with the stringent constraints imposed by the current regulatory framework for exposure to electromagnetic fields.

https://ieeexplore.ieee.org/document/8580919

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Radio Frequency Electromagnetic Fields Exposure Assessment in Indoor Environments: A Review

Chiaramello E, Bonato M, Fiocchi S, Tognola G, Parazzini M, Ravazzani P, Wiart J. Radio Frequency Electromagnetic Fields Exposure Assessment in Indoor Environments: A Review. Int J Environ Res Public Health. 2019 Mar 17;16(6). pii: E955. doi: 10.3390/ijerph16060955.

Abstract

Exposure to radiofrequency (RF) electromagnetic fields (EMFs) in indoor environments depends on both outdoor sources such as radio, television and mobile phone antennas and indoor sources, such as mobile phones and wireless communications applications. Establishing the levels of exposure could be challenging due to differences in the approaches used in different studies. The goal of this study is to present an overview of the last ten years research efforts about RF EMF exposure in indoor environments, considering different RF-EMF sources found to cause exposure in indoor environments, different indoor environments and different approaches used to assess the exposure. The highest maximum mean levels of the exposure considering the whole RF-EMF frequency band was found in offices (1.14 V/m) and in public transports (0.97 V/m), while the lowest levels of exposure were observed in homes and apartments, with mean values in the range 0.13 - 0.43 V/m. The contribution of different RF-EMF sources to the total level of exposure was found to show slightly

different patterns among the indoor environments, but this finding has to be considered as a time-dependent picture of the continuous evolving exposure to RF-EMF.

Open access paper: https://www.mdpi.com/1660-4601/16/6/955

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Assessment of RF EMF exposure from personal measurements considering the body shadowing effect in Korean children and parents

Choi J, Hwang JH, Lim H, Joo H, Yang HS, Lee YH, Eeftens M, Struchen B, Röösli M, Lee AK, Choi HD, Kwon JH, Ha M. Assessment of radiofrequency electromagnetic field exposure from personal measurements considering the body shadowing effect in Korean children and parents. Sci Total Environ. 2018 Jun 15;627:1544-1551. doi: 10.1016/j.scitotenv.2018.01.318. Epub 2018 Feb 9.

Abstract

We aimed to assess the personal radiofrequency electromagnetic field (RF-EMF) exposure levels of children and adults through their activities, with consideration to the body shadowing effect. We recruited 50 child-adult pairs, living in Seoul, Cheonan, and Ulsan, South Korea. RF-EMF measurements were performed between September and December 2016, using a portable exposure meter tailored to capture 14 Korean radiofrequency (RF) bands ranging from 87.5 to 5875MHz. The participants carried the device for 48h and kept a time-activity diary using a smartphone application in flight mode. To enhance accuracy of the exposure assessment, the body shadowing effect was compensated during the statistical analysis with the measured RF-EMF exposure. The compensation was conducted using the hybrid model that represents the decrease of the exposure level due to the body shadowing effect. A generalized linear mixed model was used to compare the RF-EMF exposure levels by subjects and activities. The arithmetic (geometric) means of the total power density were 174.9 (36.6) μW/m2 for all participants, 226.9 (44.6) for fathers, 245.4 (44.8) for mothers, and 116.2 (30.1) for children. By compensating for the body shadowing effect, the total RF-EMF exposure increased marginally, approximately 1.4 times. Each frequency band contribution to total RF-EMF exposure consisted of 76.7%, 2.4%, 9.9%, 5.0%, 3.3%, and 2.6% for downlink, uplink, WiFi, FM Radio, TV, and WiBro bands, respectively. Among the three regions, total RF-EMF exposure was highest in Seoul, and among the activities, it was highest in the metro, followed by foot/bicycle, bus/car, and outside. The contribution of base-station exposure to total RF-EMF exposure was the highest both in parents and children. Total and base-station RF-EMF exposure levels in Korea were higher than those reported in European countries.

https://www.ncbi.nlm.nih.gov/pubmed/30857115

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Emissions from smart meters and other residential radiofrequency sources

Aerts S, Verloock L, Van den Bossche M, Martens L, Vergara X, Joseph W. Emissions from smart meters and other residential radiofrequency sources. Health Phys. 2019 Mar 15. doi: 10.1097/HP.0000000000001032.

Abstract

The advent of the Internet of things comes with a huge increase in wirelessly communicating devices in our environment. For example, smart energy-consumption meters are being widely deployed in residences from which they communicate their state using radiofrequency networks. Accurate characterization of the

radiofrequency emissions from emerging residential wireless solutions is important to inform the public about the potential impact on their exposure to radiofrequency electromagnetic fields. A new measurement procedure to determine the exposure from residential radiofrequency devices is proposed by assessing the peak emitted fields at various distances and the proportion of time they transmit (duty cycle). Radiofrequency emissions from 55 residential devices were measured in 10 residences (Belgium and France) and compared to environmental levels, emissions from 41 mobile phones, and international standards. Overall, residential levels of radiofrequency electromagnetic field exposure are low. In addition to the continuous environmental exposure, wireless access points (due to frequent use) and especially mobile phones and other personal communication devices (due to their use close to the body) continue to represent the bulk of the radiofrequency electromagnetic field exposure in the smart home. However, some residential devices can significantly increase the exposure if their duty cycles are high enough (>10%), especially when held or used close to the body. Individual smart meters, on the other hand, will contribute only little in general, despite emissions of up to 20 V per m at 50 cm, due to their low duty cycles (maximum 1%) and locations.

https://www.ncbi.nlm.nih.gov/pubmed/30883437

Conclusion

Overall, low to very low emissions were measured for nearly all of the devices, and it is concluded that, in addition to the continuous exposure due to environmental sources, when used, wireless access points and especially mobile phones and other personal communication devices (e.g., DECT cordless phones, walkie-talkies) will continue to represent the bulk of our exposure to radiofrequency electromagnetic fields in the smart home, due to their typically high emissions and use close to the body. However, RF-emitting devices with high duty cycles (e.g., in this sample, motion sensor, baby monitor, and an IoT toothbrush) may significantly increase the potential for exposure, especially when used or located close to the body. The potential impact on the exposure due to individual smart meters, on the other hand, and in particular due to the communications modules wirelessly linked to a utility company's central network, is small, regardless of their emissions of up to 20 volts per meter at 0.2 m, given their rare transmissions and usual deployment away from the residents.

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Not in My Neighborhood: A User Equipment Perspective of Cellular Planning Under Restrictive EMF Limits

Chiaraviglio L, Galán-Jiménez J, Fiore M, Blefari-Melazzi N. Not in my neighborhood: A user equipment perspective of cellular planning under restrictive EMF limits. IEEE Access. 7:6161-6185. 20 December 2018. Updated 16 January 2019. DOI: 10.1109/ACCESS.2018.2888916

Abstract

The installation of base station (BS) sites is regulated by a variety of laws at international, national, and local levels. While international regulations are already severe, the national and local laws applied in many countries and regions follow precautionary principles and enforce electromagnetic field (EMF) constraints that are even more restrictive. This legal environment results in substantial constraints affecting the planning of cellular networks, as requests for new BS site installation are easily denied by national or local authorities. In this paper, we consider the problem of cellular planning under restrictive EMF limits from the user equipment (UE) viewpoint. We focus on outdoor urban areas and first evaluate the impact of the current, non-optimal network

planning at the UE side through a quantitative measurement-driven analysis of the quality of service (QoS) observed by users in heterogeneous, large-scale urban scenarios. We then perform a qualitative assessment of the perceived QoS and generated EMF levels at one UE transferring data from/to a BS based on its position with respect to the serving BS. Finally, we run a what-if analysis by comparing the existing planning with the one where new BS sites can be installed, thanks to a relaxation of the restrictive EMF constraints. Our results clearly show that a cellular planning driven by restrictive EMF constraints forces UE to experience large distances from the serving BS, frequent non-line-of-sight conditions, and poor received signal. In turn, this entails a very negative combination of high electric field activity (EFA) levels generated by the UE and low QoS perceived by the user. We show that, by relaxing the restrictive EMF constraints, the problem could be sensibly mitigated with a positive impact on the UE channel conditions and consequently on the perceived QoS and the UE EFA.

Open access paper: https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=8584448

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Becoming electro-hypersensitive: A replication study

Dieudonné M. Becoming electro-hypersensitive: A replication study. Bioelectromagnetics. 2019 Apr;40(3):188-200. doi: 10.1002/bem.22180.

Abstract

Idiopathic Environmental Intolerance attributed to Electromagnetic Fields (IEI-EMF) is an emerging environmental illness that is characterized by the attribution of various symptoms to electromagnetic fields (EMF). To date, research has not succeeded in objectifying the illness' semiology or etiology. IEI-EMF remains impossible to define other than in terms of the attributions of the persons affected. Yet, the genesis of these attributions is still not well understood. This study's objective is to replicate previous results relating to them, while correcting their limitations. Sixteen electro-hypersensitive (EHS) subjects lent themselves to both a sociological interview and a medical interview, and completed a set of standardized questionnaires. Three distinct types of biographical trajectories leading to persons becoming convinced of their hypersensitivity were identified, which were called the Reticent Attribution model, the Prior Attribution model, and the By Proxy Attribution model. These three models of EHS attribution process do not appear to lead to clinically distinct forms of IEI-EMF. What distinguishes them is the way in which the initial suspicion of the electromagnetic environment emerges. They demonstrate a diversification of the pathways to IEI-EMF. Nonetheless, in each model, the learning process that enables the EHS attribution to be materialized and operationalized is identical. The ability to establish causation between the electromagnetic environment and their condition is therefore the result of EHS subjects' trajectories, rather than their starting point. This observation is not congruent with models attributing IEI-EMF to nocebo reactions, which raises the question of these models' ecological validity.

https://www.ncbi.nlm.nih.gov/pubmed/30920673

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A critical review on wireless charging for electric vehicles

Machura P, Li Q. A critical review on wireless charging for electric vehicles. Renewable and Sustainable Energy Reviews. 104:209-234. Apr 2019. https://doi.org/10.1016/j.rser.2019.01.027.

Highlights
• The paper timely presents a thorough review on wireless charging technology for electric vehicles.
• Following the previous review papers, the paper includes the most recent developments.
• The paper shows future directions for wireless charging from both commercial and research perspective.
• The paper has reviewed the health and safety aspect of wireless charging technology, as well as relevant standards published recently.
• The paper covers the economic aspect of wireless charging systems, and presents a detailed comparison on cost.

Abstract

Electric vehicles (EVs) have recently been significantly developed in terms of both performance and drive range. There already are various models commercially available, and the number of EVs on road increases rapidly. Although most existing EVs are charged by electric cables, companies like Tesla, BMW and Nissan have started to develop wireless charged EVs that don't require bulky cables. Rather than physical cable connection, the wireless (inductive) link effectively avoids sparking over plugging/unplugging. Furthermore, wireless charging opens new possibilities for dynamic charging – charging while driving. Once realised, EVs will no longer be limited by their electric drive range and the requirement for battery capacity will be greatly reduced. This has been prioritised and promoted worldwide, particularly in UK, Germany and Korea. This paper presents a thorough literature review on the wireless charging technology for EVs. The key technical components of wireless charging are summarised and compared, such as compensation topologies, coil design and communication. To enhance the charging power, an innovative approach towards the use of superconducting material in coil designs is investigated and their potential impact on wireless charging is discussed. In addition, health and safety concerns about wireless charging are addressed, as well as their relevant standards. Economically, the costs of a wide range of wireless charging systems has also been summarised and compared.

https://www.sciencedirect.com/science/article/pii/S1364032119300383

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Effects of a brain tumor in a human head on SAR and temperature rise due to RF sources at 4G and 5G frequencies

Kaburcuk F. Effects of a brain tumor in a dispersive human head on SAR and temperature rise distributions due to RF sources at 4G and 5G frequencies. Electromagn Biol Med. 2019 Mar 20:1-9. doi: 10.1080/15368378.2019.1591441.

Abstract

In this paper, effects of a brain tumor located in a dispersive human head model on specific absorption rate (SAR) and temperature rise distributions due to different types of RF sources at 4G and 5G cellular frequencies are investigated with the use of a multiphysics model. This multiphysics model analyzes the dispersive human head with the brain tumor and provides the SAR and temperature rise distributions in the head due to the RF source operated at 4G and 5G cellular frequencies in a single finite-difference time-domain simulation. An adjacent antenna operated at 4G and 5G cellular frequencies to the human head is considered as the RF source for near-field exposure, while a plane wave field radiated by base stations operated at 4G and 5G cellular frequencies is considered as the RF source for far-field exposure. Numerical results show that

the brain tumor in the head slightly affects the SAR and temperature rise distributions due to different RF sources at 4G and 5G cellular frequencies.

https://www.ncbi.nlm.nih.gov/pubmed/30889978

Conclusion

The effects of the brain tumor in the dispersive human head on the SAR1g and temperature rise distributions due to the near-field and far-field exposures are investigated at 4G and 5G cellular frequencies with the aid of multiphysics model. In the multiphysics model, these distributions in the head are calculated at 2.1 and 3.6 GHz in a single simulation. Numerical results show that the SAR1g and temperature rise distributions are slightly affected by the presence of the brain tumor in the head. The calculated SAR1g values and temperature rise in the area of the brain tumor are higher than those calculated in the same area of the healthy head because the EM and thermal parameters of the brain tumor are different from those of the healthy tissues in the same area of the head. Moreover, it has been realized that the distributions are affected by the frequencies and type of the RF sources.

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Comparing DNA Damage Induced by Mobile Telephony and Other Types of Man-Made Electromagnetic Fields

Panagopoulos DJ. Comparing DNA damage induced by mobile telephony and other types of man-made electromagnetic fields. Mutation Research/Reviews in Mutation Research. Published online Mar 11, 2019. https://doi.org/10.1016/j.mrrev.2019.03.003.

Abstract

The number of studies showing adverse effects on living organisms induced by different types of man-made Electromagnetic Fields (EMFs) has increased tremendously. Hundreds of peer reviewed published studies show a variety of effects, the most important being DNA damage which is linked to cancer, neurodegenerative diseases, reproductive declines etc. Those studies that are far more effective in showing effects employ real-life Mobile Telephony (MT) exposures emitted by commercially available mobile phones. The present review - of results published by my group from 2006 until 2016 - compares DNA fragmentation induced by six different EMFs on the same biological system - the oogenesis of Drosophila melanogaster - under identical conditions and procedures. Such a direct comparison between different EMFs - especially those employed in daily life - on the same biological endpoint, is very useful for drawing conclusions on their bioactivity, and novel. It shows that real MT EMFs are far more damaging than 50 Hz alternating magnetic field (MF) - similar or much stronger to those of power lines - or a pulsed electric field (PEF) found before to increase fertility. The MT EMFs were significantly more bioactive even for much shorter exposure durations than the other EMFs. Moreover, they were more damaging than previously tested cytotoxic agents like certain chemicals, starvation, dehydration. Individual parameters of the real MT EMFs like intensity, frequency, exposure duration, polarization, pulsing, modulation, are discussed in terms of their role in bioactivity. The crucial parameter for the intense bioactivity seems to be the extreme variability of the polarized MT signals, mainly due to the large unpredictable intensity changes.

Excerpts

Thus, the present study makes the point that once a specific EMF is polarized (and coherent), includes ELFs, and has adequate intensity, then variability in its parameters (especially in its intensity) is of decisive importance in terms of its bioactivity. In the present study this was shown, a) by the direct comparison between six different EMFs in terms of their ability to induce DNA fragmentation in my studies, b) by indirect comparison between the effects of real MT EMFs in my studies and simulated MT EMFs in other studies, both directly compared with corresponding effects of a 50 Hz alternating MF, and c) by the large difference in bioactivity between simulated MT signals with invariable parameters and real MT (highly variable) ones from a great number of reviewed studies. This important point in terms of biological activity and public health protection should be further confirmed experimentally by direct comparison of effects between simulated and real MT EMFs of the same average parameters.

The importance of exposure variability shown in the present study implies the need to define EMF-exposures not only by frequency components and average intensity values, but by reporting maximum and minimum intensity as well, frequency variations, pulsing or continuous wave, modulation, and - of course - polarization. Moreover, in published reviews of experimental studies employing MT and other types of microwave telecommunication EMFs such as DECT phones, Wi-Fi etc, it must be explicitly reported whether the exposures were real from commercially available devices or simulated from generators, test phones, etc.

The present study further confirms my previous results and conclusions that experiments should employ real-life and not simulated EMFs, and human/animal exposure to microwave telecommunication EMFs should be drastically reduced by prudent use, and establishment of much stringer exposure limits by the responsible health authorities.

https://www.sciencedirect.com/science/article/pii/S1383574218300991

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Radiofrequency electromagnetic field exposure and risk perception: A pilot experimental study

Berihun M.Zeleke BM, Bhatt CR, Brzozek C, Abramson MJ, Freudenstein F, Croft RJ, Wiedemann P, Benke G. Radiofrequency electromagnetic field exposure and risk perception: A pilot experimental study. Environmental Research. 170:493-499. March 2019. https://doi.org/10.1016/j.envres.2018.12.058

Highlights
• People may get concerned about radiofrequency electromagnetic fields exposures.
• We examined people's risk perceptions to RF-EMF from mobile phone base stations.
• Personal RF-EMF exposure measurement and provision did not affect risk perception.
• Personal exposure knowledge improves confidence in self-protection from RF-EMF.

Abstract

Background Exposure to far-field radiofrequency electromagnetic fields (RF-EMF) has raised public concerns in recent decades. However, it is not known if individuals' perception towards the health risks of RF-EMF is dependent on their knowledge of the objectively measured personal RF-EMF exposure levels.

Objectives This pilot study aimed to demonstrate the feasibility of objectively measuring personal RF-EMF exposure from mobile phone base stations (MPBS) and to determine if the risk perception of people to the potential health risk of exposure to RF-EMF from MPBS is dependent on their knowledge of personal RF-EMF exposure levels.

Design An experimental study was conducted in 383 adults, recruited in Melbourne, Australia. Participants were randomized to one of the three groups: 1) basic information group who were provided with basic information about RF-EMF to read prior to completing a risk perception assessment questionnaire; 2) precautionary group who were provided with an information pack which included precautionary messages; and 3) personal exposure measurement group who were provided with a summary of their quantitative RF-EMF exposure from MPBS. The same basic information about RF-EMF was also given to the precautionary and personal exposure measurement groups.

Results Participants had a mean (± SD) age of 36.9 ± 12.5 years; 66.7% were women. Overall, 44.1% had noticed an MPBS in their neighbourhood. The mean (SD) values (from 1 to 7) for risk perceptions to RF-EMF from MPBS were 4.02 (1.67) for basic information, 3.82 (1.62) for precautionary messages, and 3.97 (1.72) for the personal exposure measurement groups. These differences were not statistically significant. Nevertheless, the personal exposure measurement group were more confident that they could protect themselves from RF-EMF than the precautionary or basic information groups.

Conclusion Our findings suggest that providing people with personal RF-EMF exposure measurements may not affect their perceived risk from MPBS, but increase their confidence in protecting themselves.

Conclusions

In conclusion, our study demonstrated that, compared to those provided with precautionary messages and basic information, people provided with personal RF-EMF exposure data did not have significantly different scores for their exposure or risk perception towards RF-EMF in general or that from MPBS, but had greater confidence in being able to protecting themselves from RF-EMF. As a strategy, providing software apps on mobile phones that measure actual exposure could be implemented with the intention of providing realistic exposure information. This may 'demystify' the relatively abstract notion of personal RF-EMF exposure, and ultimately boost confidence in protection. Future research, preferably from a larger and more diverse sample, should aim to investigate the impact of provision of objectively measured exposure information and the knowledge of personal, as well as environmental RF-EMF exposures from both near-field and far-field sources on peoples` risk perception and risk communication vis-a-vis telecommunication technologies.

https://www.sciencedirect.com/science/article/pii/S001393511830255X

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Effects of Exposure to 5.8 GHz EMF on Micronucleus Formation, DNA strand breaks & Heat Shock Protein Expressions in Human Eye Cells

Miyakoshi J, Tonomura H, Koyama S, Narita E, Shinohara N. Effects of Exposure to 5.8 GHz Electromagnetic Field on Micronucleus Formation, DNA strand breaks, and Heat Shock Protein Expressions in Cells Derived from Human Eye. IEEE Trans Nanobioscience. 2019 Mar 15. doi: 10.1109/TNB.2019.2905491.

Abstract

In the near future, electrification will be introduced to heavy-duty vehicles and passenger cars. However, wireless power transfer (WPT) requires high energy levels, and the suitability of various types of WPT systems must be assessed. This paper describes a method for solving technical and safety issues associated with this technology. We exposed human corneal epithelial (HCE-T) cells derived from the human eye to 5.8-GHz

electromagnetic fields for 24 h. We observed no statistically significant increase in micronucleus (MN) frequency in cells exposed to a 5.8-GHz field at 1 mW/cm2(the general public level in ICNIRP) relative to sham-exposed or incubator controls. Similarly, DNA strand breaks, and expression of heat shock protein (Hsp) Hsp27, Hsp70, and Hsp90α exhibited no statistically significant effects as a result of exposure. These results indicate that exposure to 5.8-GHz electromagnetic fields at 1 mW/cm2 for 24 h has little or no effect on micronucleus formation, DNA strand breaks, and Hsp expression in human eye cells.

https://www.ncbi.nlm.nih.gov/pubmed/30892224

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The carcinogenic potential of non-ionizing radiations: The cases of S-50 Hz MF and 1.8 GHz GSM radiofrequency radiation

Soffritti M, Giuliani L. The carcinogenic potential of non-ionizing radiations: The cases of S-50 Hz MF and 1.8 GHz GSM radiofrequency radiation. Basic Clin Pharmacol Toxicol. 2019 Feb 24. doi: 10.1111/bcpt.13215.

Abstract

Epidemiological studies have suggested that human exposure to extremely low-frequency electromagnetic fields from the electric power and to mobile phone radiofrequency electromagnetic fields induce an increased risk of developing malignant tumours. However, no adequate laboratory data, in particular long-term carcinogenicity bioassays to support the epidemiological evidence, have yet been available. This motivated the Ramazzini Institute to embark on a first project of four large life-span carcinogenic bioassays conducted on over 7000 Sprague Dawley rats exposed from prenatal life until natural death to S-50 Hz MF alone or combined with gamma radiation or formaldehyde or aflatoxin B1. Results now available from these studies, which started concurrently, have shown that exposure to Sinusoidal-50 Hz Magnetic Field (S-50 Hz MF) combined with acute exposure to gamma radiation or to chronic administration of formaldehyde in drinking water induces a significantly increased incidence of malignant tumours in males and females. A second project of two large life-span carcinogenic bioassays was conducted on over 3000 Sprague Dawley rats exposed from prenatal life until natural death to 1.8 GHz GSM of mobile phone radio base station, alone or combined with acute exposure to gamma radiation. Early results from the experiment on 1.8 GHz GSM alone show a statistically significant increase in the incidence of heart malignant schwannoma among males exposed at the highest dose.

https://www.ncbi.nlm.nih.gov/pubmed/30801980

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Monitoring of mice health, investigation of behavior, hematological parameters under the effect of an electromagnetic field

Zymantiene, J, Zelvyte, R, Juozaitiene, V, Oberauskas, V, Noreika, A, Juodziukyniene, N, Aniuliene, A. Monitoring of BALB/C strain mice health, investigation of behavior, hematological parameters under the effect of an electromagnetic field. Weterynary JNA-Veterinary Medicine-Science and Practice. 75(3):158-163. Mar 2019.

Abstract

The aim of this study was to investigate the effect of electromagnetic fields on BALB/c strain mice on their

health, body weight, behavior characteristics, hematological parameters and histopathological findings in the brain. The mice of the experimental groups were exposed to electromagnetic waves by using Nokia 230 and Samsung 19300 Galaxy S III mobile phones situated at 2 cm from the cages. In the present study, it can be concluded that the exposure of mice to mobile phone radiation had an effect on the structure of the brain, behavior and body weight. The waves of mobile phones increased activity characteristics and changed some behavioral categories of mice and also decreased their body weight. Histopathological examination revealed mild edema of neutrophils and degeneration of some neurons and glial cells in the brains of experimental mice. The results of the present study showed that a using mobile phone had an influence on in vivo systems.

Open access paper: http://www.medycynawet.edu.pl/images/stories/pdf/pdf2019/032019/2019036194.pdf

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Oxidative stress-mediated alterations on sperm parameters in male Wistar rats exposed to 3G mobile phone radiation

Gautam R, Singh KV, Nirala J, Murmu NN, Meena R, Rajamani P. Oxidative stress-mediated alterations on sperm parameters in male Wistar rats exposed to 3G mobile phone radiation. Andrologia. 2019 Apr;51(3):e13201. doi: 10.1111/and.13201.

Abstract

In recent years, there has been significant increase in mobile phone users. With this, health concerns associated with the exposure to electromagnetic radiation are also increasing. Continuous exposure to electromagnetic (EM) radiation generated from mobile phone is one of the probable reasons behind increasing male infertility. EM radiations induce oxidative stress that leads to numerous changes in reproductive parameters. With this hypothesis, we studied the effect of 3G mobile phone radiations on the reproductive system of male Wistar rats. Adult rats were divided into two groups: control and radio frequency-exposed. The animals were exposed to 3G mobile phone radiation for 45 days (2 hr/day) in specially designed exposure setup under standard conditions. Various biochemical and physiological parameters such as sperm count, sperm morphology, mitochondrial activity, lipid peroxidation, reactive oxygen species level and histopathological analysis were studied. Histopathological examination revealed a reduction in spermatogenic cells and alterations in sperm membrane. Significant increase in ROS and lipid peroxidation level with simultaneously decrease in sperm count, alterations in sperm tail morphology were observed in the exposed group. In conclusion, exposure to mobile phone radiations induces oxidative stress in male Wistar rats which may lead to alteration in sperm parameters and affects their fertility.

https://www.ncbi.nlm.nih.gov/pubmed/30461041

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Exposure to non-ionizing electromagnetic radiation of public risk prevention instruments threatens the quality of spermatozoids

Tirpak F, Slanina T, Tomka M, Zidek R, Halo M Jr, Ivanic P, Gren A, Formicki G, Stachanczyk K, Lukac N, Massanyi P. Exposure to non-ionizing electromagnetic radiation of public risk prevention instruments threatens the quality of spermatozoids. Reprod Domest Anim. 2019 Feb;54(2):150-159. doi: 10.1111/rda.13338.

Abstract

The use of artificial insemination in cattle breeding has evolved to global extent, and insemination doses are often shipped via air transport which requires strict radiation-based examinations. For the determination of effect of non-ionizing radiation (NIR), to which are beings frequently exposed due to protection of airport or cultural event security, freshly ejaculated and cryopreserved bovine spermatozoa were used as experimental model. Following radiation with hand-held metal detector in various exposition times (0, 10 s, 15, 30 and 60 min-groups FR, FR10, FR15, FR30 and FR60) the spermatozoa underwent motility and DNA fragmentation analyses. Study on cryoconserved semen treated with NIR was performed in time intervals 0, 10 s, 1 and 5 min (insemination doses radiated before cryoconservation-CB, CB10, CB1, CB5; samples radiated after freezing-CA, CA10, CA1 and CA5). Fresh semen and insemination doses radiated after cryoconservation showed significantly lower total and progressive motility. No effect on motility parameters was detected in semen extended with cryopreservative medium and radiated prior to freezing. Surprisingly, NIR showed a potential to stimulate spermatozoa velocity; however, the effect was modulated throughout the post-thawing incubation. Based on the DNA fragmentation assay, sperm DNA stayed intact. Present study underlines the potential harm of NIR, which is frequently used in everyday life, with overall adverse impact on human and animal reproduction. Current study also points out on interesting short-term spermatozoa stimulation induced by NIR.

https://www.ncbi.nlm.nih.gov/pubmed/30192989

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Effect of 1800-2100 MHz Electromagnetic Radiation on Learning-Memory and Hippocampal Morphology in Swiss Albino Mice

Kishore, GK, Venkateshu, KV, Sridevi, NS. Effect of 1800-2100 MHz electromagnetic radiation on learning-memory and hippocampal morphology in Swiss albino mice. J Clinical and Diagnostic Research. 13(2); Feb 2019. DOI: 10.7860/JCDR/2019/39681.12630

Abstract

Introduction: With advancing technology the mobile phone with multiple features is used as a multipurpose device and attract people of all age groups. Increased usage of mobile phone raises the question of possible adverse effects on health.

Aim: To assess the 1800-2100 MHz radiation effect on learning-memory and microscopic anatomy of hippocampal Cornu Ammonis (CA3) neurons in mice.

Materials and Methods: A total of 18 albino mice were divided into 3 groups (6 Mice per group). Group-I: Control Group, Group-II: Exposed to Radio frequency-Electromagnetic radiation (RF-EMR) for 30 minutes/day for 3 months, Group-III: Exposed to RF-EMR for 60 minutes/day for 3 months. Followed by the exposure, learning memory was assessed by using Hebb-Williams maze in all the groups. The mice were then sacrificed, brains were dissected out and sections were taken at the level of hippocampus and then stained with Haematoxylin and Eosin The results were expressed in Mean +/- SD and analysed by using one-way (analysis of variance) ANOVA followed by LSD (Least Square Difference) test for paired wise data. The p-value<0.05 was considered as statistically significant.

Results: The time taken by the animal to reach the target chamber was significantly increased in Group-III (exposed 60 minutes/day for 3 months), whereas group-II (exposed 30 minutes/day for 3 months) showed no significant changes when compared to Group-I (control group). Microscopic anatomy of hippocampal CA3 neurons in exposed group shows less number of pyramidal cells with darkened nuclei, cytoplasm was vacuolated and cells were scattered.

Conclusion: Exposure to 1800-2100 MHz radiation leads to damage and decrease of neurons in hippocampal region, which alters the learning and memory.

Open access paper:
https://www.jcdr.net/articles/PDF/12630/39681_CE[Ra1]_F(AC)_PF1(PC_SL)_PFA(PC_KM)_PN(SL).pdf

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Cell Phone Radiation Effect on Bone-to-Implant Osseointegration: A Preliminary Histologic Evaluation in Rabbits

Kavyashree M, Harish PV, Mishra SK, Chowdhary R. Cell phone radiation wffect on bone-to-implant osseointegration: A preliminary histologic evaluation in rabbits. Int J Oral Maxillofac Implants. 2019 Feb 19. doi: 10.11607/jomi.7024.

Abstract

BACKGROUND AND PURPOSE: The increased use of cell phones has raised many questions as to whether their use is safe for patients with dental implants. This study aimed to assess the consequences of cell phone-emitted radiation on bone-to-implant osseointegration during the healing phase.

MATERIALS AND METHODS: Twelve rabbits were grouped into three groups of four. Group 1 (control) was not exposed to electromagnetic radiation; group 2 (test) was exposed for 8 hours/day in speech mode and 16 hours/day in standby mode; and group 3 (test) was exposed for 24 hours continuously in standby mode for 3 months. Forty-eight implants were placed in tibia and femur bone of rabbits, and after 90 days the rabbits were sacrificed and bone surrounding the implant was retrieved. Histopathologic evaluations of the specimens were done using transmitted light microscope. The differences among the three groups were statistically analyzed with analysis of variance (ANOVA) and pairwise comparisons via Fisher's exact test.

RESULTS: Significantly less bone-to-implant contact and bone area surrounding implant threads were found in the test groups compared to the control group. There was a significant difference in regular bone formation ($P < .001$) among the three groups.

CONCLUSION: Implants exposed to cell phone radiation showed more inflammatory reaction when compared to the nonexposed implants, thus indicating that cellular phone overuse could affect the maturation of bone and thus delay osseointegration.

https://www.ncbi.nlm.nih.gov/pubmed/30892289

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Effect of Mobile Tower Radiation on Microbial Diversity in Soil and Antibiotic Resistance

Sharma AB, Lamba OS; Sharma L, Sharma A. Effect of mobile tower radiation on microbial diversity in soil and antibiotic resistance. 2018 International Conference on Power Energy, Environment and Intelligent Control (PEEIC). April 13-14, 2018. DOI: 10.1109/PEEIC.2018.8665432

Abstract

A substantial increase in the number of mobile phone base stations (MPBS) has been demonstrated in the world. This development has raised concerns with biological systems due to electromagnetic field and radiations. Antibiotic resistance is referred as "the silent tsunami facing modern medicine". The aim of this in vitro study was to demonstrate the impact of these radiations transmitted by Mobile tower stations on microbial diversity in soil and antibiotic resistance pattern. Soil samples were taken from near four different base stations located in Dausa city, while control samples were taken far from stations. Isolation and identification of microorganisms was done using biochemical reactions and antibiotic resistance was observed. Chi-square test with Yates correction was applied to compare the pattern of antibiotic resistance. Stenotrophomonas maltophilia, Chryseobacterium Gleum, Kocuria Rosea were isolated and identified in soil samples collected near radiation exposed zone. Greater antibiotic resistance was observed in microbes present in soil near base stations compared to control. A statistical significant difference in pattern of antibiotic resistance was found with Nalidixic acid, and cefixime when used as antimicrobial agents. (P-value less than 0.05). Our findings suggest that mobile tower radiations can significantly alter the vital systems in microbes and turn them multidrug resistant (MDR) which is most important current threat to public health.

https://ieeexplore.ieee.org/document/8665432

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Effects of ELF EMF on B16F10 cancer cells

Tang JY, Yeh TW, Huang YT, Wang MH, Jang LS. Effects of extremely low-frequency electromagnetic fields on B16F10 cancer cells. Electromagn Biol Med. 2019 Mar 20:1-9. doi: 10.1080/15368378.2019.1591438.

Abstract

This paper presents a method to inhibit B16F10 cancer cells using extremely low-frequency electromagnetic fields (ELF-EMFs) and to evaluate cell viability using MTT (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl tetrazolium bromide) assay. The study examined the effect of a natural EMF resonance frequency (7.83 Hz) and a power line frequency (60 Hz) on B16F10 cancer cells for 24 and 48 h. The B16F10 cancer cells were also exposed to sweep frequencies in several sweep intervals to quantitatively analyze the viability of cancer cells. The results yielded a 17% inhibition rate under 7.83 Hz compared with that of the control group. Moreover, sweep frequencies in narrow intervals (7.83 ± 0.1 Hz for the step 0.05 Hz) caused an inhibition rate of 26.4%, and inhibitory effects decreased as frequency sweep intervals increased. These results indicate that a Schumann resonance frequency of 7.83 Hz can inhibit the growth of cancer cells and that using a specific frequency type can lead to more effective growth inhibition.

https://www.ncbi.nlm.nih.gov/pubmed/30889982

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Low frequency pulsed EMF promotes differentiation of oligodendrocyte precursor cells through upregulation of miR-219-5p in vitro

Yao F, Li Z, Cheng L, Zhang L, Zha X, Jing J. Low frequency pulsed electromagnetic field promotes differentiation of oligodendrocyte precursor cells through upregulation of miR-219-5p in vitro. Life Sci. 2019 Mar 15. pii: S0024-3205(19)30189-4. doi: 10.1016/j.lfs.2019.03.031.

Abstract

AIM: Spinal cord injury (SCI) is a common demyelinating disorder of the central nervous system. The differentiation of oligodendrocyte precursor cells (OPCs) into mature oligodendrocytes (OLs), which induce myelination, plays a critical role in the functional recovery following SCI. In this study, the effect of low frequency pulsed electromagnetic field (PEMF) on the differentiation of OPCs and the potential underlying mechanisms were investigated.

MAIN METHODS: OPCs were randomly divided into the PEMF and non-PEMF (NPEMF) groups. qRT-PCR and western blot assays were performed to assess the expression levels of OLs stage-specific markers after 3, 7, 14, and 21 days of PEMF exposure. qRT-PCR was used to further assess the expression levels of miR-219-5p, miR-338, miR-138, and miR-9, which are associated with OPCs differentiation, and the expression levels of genes associated with miR-219-5p. Finally, following PEMF or NPEMF exposure, qRT-PCR and western blot assays were performed to explore the relationship between miR-219-5p and Lingo1 and between miR-219-5p and PEMF in promoting OPCs differentiation.

KEY FINDINGS: PEMF promoted the differentiation of OPCs. PEMF upregulated the expression level of miR-219-5p and downregulated the expression level of Lingo1 during the differentiation of OPCs. Under PEMF exposure, miR-219-5p targeted Lingo1 and reversed the inhibitory effect of miR-219-5p inhibitor on OPCs differentiation. In addition, PEMF synergized with miR-219-5p to promote OPCs differentiation.

SIGNIFICANCE: Our results, for the first time, indicated that PEMF promoted OPCs differentiation by regulating miR-219-5p activity in vitro.

https://www.ncbi.nlm.nih.gov/pubmed/30885522

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Effects of pulsed EMF on learning and memory abilities of STZ-induced dementia rats

Li Y, Zhang Y, Wang W, Zhang Y, Yu Y, Cheing GL, Pan W. Effects of pulsed electromagnetic fields on learning and memory abilities of STZ-induced dementia rats. Electromagn Biol Med. 2019 Mar 17:1-8. doi: 10.1080/15368378.2019.1591437.

Abstract

INTRODUCTION: Recent studies have shown that pulsed electromagnetic field (EMF) has therapeutic potential for dementia, but the associated neurobiological effects are unclear. This study aimed to determine the effects of pulsed EMF on Streptozotocin (STZ)-induced dementia rats.

METHODS: Forty Sprague-Dawley rats were randomly allocated to one of the four groups: (i) control, (ii) normal saline injection (sham group), (iii) STZ injection (STZ group) and (iv) STZ injection with pulsed EMF exposure (PEMF, 10 mT at 20 Hz) (STZ + MF group). Morris water maze was used to assess the learning and memory abilities. Insulin growth factors 1 and 2 (IGF-1 and IGF-2) gene expression were determined by quantitative PCR.

RESULTS: The results showed that the mean escape latency in STZ-induced dementia rats was reduced by 66% under the exposure of pulsed EMF. Compared with the STZ group, the swimming distance and the time

for first crossing the platform decreased by 55 and 41.6% in STZ + MF group, respectively. Furthermore, the IGF-2 gene expression significantly increased compared to that of the STZ group.

CONCLUSIONS: Our findings indicate that the pulsed EMF exposure can improve the ability of learning and memory in STZ-induced dementia rats and this effect may be related to the process of IGF signal transduction, suggesting a potential role for the pulsed EMF for the amelioration of cognition impairment.

https://www.ncbi.nlm.nih.gov/pubmed/30880541

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Computational simulations of the penetration of 0.30 THz radiation into the human ear

Vilagosh Z, Lajevardipour A, Wood A. Computational simulations of the penetration of 0.30 THz radiation into the human ear. Biomed Opt Express. 2019 Feb 28;10(3):1462-1468. doi: 10.1364/BOE.10.001462.

Abstract

There is an increasing interest in industrial and security applications and the establishment of wireless communication operating at frequencies of up to 0.30 THz. Soft tissue has a high coefficient of absorption at 0.30 THz and this limits effective penetration of the energy to a depth of 0.2 to 0.4 mm. The capacity of 0.30 THz radiation to access the deeper parts of the ear by diffusing through the ear canal and exposing the tympanic membrane (ear drum) to the radiation has not been studied. Simulations show that, with excitation parallel to the ear canal, the average power flux density within the central tympanic membrane region is 97% of the incident excitation. The structures of the outer ear are highly protective; less than 0.4% of the power flux density is directed at 45° from the parallel reached the same region. Given the sensitivity of the tympanic membrane to mechanical change, in-vivo assessment of the penetration of 0.3 THz into the ear canal is warranted to assess the suitability of the present radiation safety limits and to inform 0.3 THz emitting device deign.

https://www.ncbi.nlm.nih.gov/pubmed/30891359

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Involvement of calcium in 50-Hz magnetic field-induced activation of sphingosine kinase 1 signaling pathway

Yang X, Ye A, Chen L, Xia Y, Jiang W, Sun. Involvement of calcium in 50-Hz magnetic field-induced activation of sphingosine kinase 1 signaling pathway. Bioelectromagnetics. 2019 Apr;40(3):180-187. doi: 10.1002/bem.22181.

Abstract

Previously, we found that exposure to a 50-Hz magnetic field (MF) could induce human amniotic epithelial (FL) cell proliferation and sphingosine kinase 1 (SK1) activation, but the mechanism was not clearly understood. In the present study, the possible signaling pathways which were involved in SK1 activation induced by 50-Hz MF exposure were investigated. Results showed that MF exposure increased intracellular Ca2+ which was dependent on the L-type calcium channel, and induced Ca2+ -dependent phosphorylation of extracellular

regulated protein kinase (ERK), SK1, and protein kinase C α (PKCα). Also, treatment with U0126, an inhibitor of ERK, could block MF-induced SK1 phosphorylation, but had no effect on PKCα phosphorylation. Also, the inhibitor of PKCα, Gö6976, had no effect on MF-induced SK1 activation in FL cells. In addition, the activation of ERK and PKCα could be abolished by SKI II, the inhibitor of SK1. In conclusion, the intracellular Ca2+ mediated the 50-Hz MF-induced SK1 activation which enhanced PKCα phosphorylation, and there might be a feedback mechanism between SK1 and ERK activation in responding to MF exposure in FL cells.

https://www.ncbi.nlm.nih.gov/pubmed/30920672

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Transduction of the Geomagnetic Field as Evidenced from Alpha-band Activity in the Human Brain

Wang CX, Hilburn IA, Wu D-A, Mizuhara Y, Cousté CP, Abrahams JNH, Bernstein SE, Matani A, Shimojo S. Kirschvink JL. Transduction of the Geomagnetic Field as Evidenced from Alpha-band Activity in the Human Brain. eNeuro 18 March 2019, ENEURO.0483-18.2019; DOI: https://doi.org/10.1523/ENEURO.0483-18.2019

Abstract

Magnetoreception, the perception of the geomagnetic field, is a sensory modality well-established across all major groups of vertebrates and some invertebrates, but its presence in humans has been tested rarely, yielding inconclusive results. We report here a strong, specific human brain response to ecologically-relevant rotations of Earth-strength magnetic fields. Following geomagnetic stimulation, a drop in amplitude of EEG alpha oscillations (8-13 Hz) occurred in a repeatable manner. Termed alpha event-related desynchronization (alpha-ERD), such a response has been associated previously with sensory and cognitive processing of external stimuli including vision, auditory and somatosensory cues. Alpha-ERD in response to the geomagnetic field was triggered only by horizontal rotations when the static vertical magnetic field was directed downwards, as it is in the Northern Hemisphere; no brain responses were elicited by the same horizontal rotations when the static vertical component was directed upwards. This implicates a biological response tuned to the ecology of the local human population, rather than a generic physical effect.

Biophysical tests showed that the neural response was sensitive to static components of the magnetic field. This rules out all forms of electrical induction (including artifacts from the electrodes) which are determined solely on dynamic components of the field. The neural response was also sensitive to the polarity of the magnetic field. This rules out free-radical 'quantum compass' mechanisms like the cryptochrome hypothesis, which can detect only axial alignment. Ferromagnetism remains a viable biophysical mechanism for sensory transduction and provides a basis to start the behavioral exploration of human magnetoreception.

Significance Statement

Although many migrating and homing animals are sensitive to Earth's magnetic field, most humans are not consciously aware of the geomagnetic stimuli that we encounter in everyday life. Either we have lost a shared, ancestral magnetosensory system, or the system lacks a conscious component with detectable neural activity but no apparent perceptual awareness by us. We found two classes of ecologically-relevant rotations of Earth-strength magnetic fields that produce strong, specific and repeatable effects on human brainwave activity in the EEG alpha band (8-13 Hz); EEG discriminates in response to different geomagnetic field stimuli. Biophysical tests rule out all except the presence of a ferromagnetic transduction element, such as biologically-precipitated crystals of magnetite (Fe_3O_4).

Conclusion

Our results indicate that at least some modern humans transduce changes in Earth-strength magnetic fields into an active neural response. We hope that this study provides a road-map for future studies aiming to replicate and extend research into human magnetoreception. Given the known presence of highly-evolved

geomagnetic navigation systems in species across the animal kingdom, it is perhaps not surprising that we might retain at least some functioning neural components especially given the nomadic hunter/gatherer lifestyle of our not-too-distant ancestors. The full extent of this inheritance remains to be discovered.

Open access paper: http://www.eneuro.org/content/early/2019/03/18/ENEURO.0483-18.2019

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Geomagnetic storm under laboratory conditions: randomized experiment

Oleg Grigoriev, Chairman of the Russian National Committee on Non-Ionizing Radiation Protection, sent me the following paper after I disseminated the study above:

Gurfinkel YI, Vasin AL, Pishchalnikov RY, Sarimov RM, Sasonko ML, Matveeva TA. Geomagnetic storm under laboratory conditions: randomized experiment. Int J Biometeorol. 2018 Apr;62(4):501-512. doi: 10.1007/s00484-017-1460-8.

Abstract

The influence of the previously recorded geomagnetic storm (GS) on human cardiovascular system and microcirculation has been studied under laboratory conditions. Healthy volunteers in lying position were exposed under two artificially created conditions: quiet (Q) and storm (S). The Q regime playbacks a noise-free magnetic field (MF) which is closed to the natural geomagnetic conditions on Moscow's latitude. The S regime playbacks the initially recorded 6-h geomagnetic storm which is repeated four times sequentially. The cardiovascular response to the GS impact was assessed by measuring capillary blood velocity (CBV) and blood pressure (BP) and by the analysis of the 24-h ECG recording. A storm-to-quiet ratio for the cardio intervals (CI) and the heart rate variability (HRV) was introduced in order to reveal the average over group significant differences of HRV. An individual sensitivity to the GS was estimated using the autocorrelation function analysis of the high-frequency (HF) part of the CI spectrum. The autocorrelation analysis allowed for detection a group of subjects of study which autocorrelation functions (ACF) react differently in the Q and S regimes of exposure.

https://www.ncbi.nlm.nih.gov/pubmed/29030697

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Real-world cell phone radiofrequency electromagnetic field exposures

Wall S, Wang ZM, Kendig T, Dobraca D, Lipsett M. Real-world cell phone radiofrequency electromagnetic field exposures. Environ Res. 2019 Apr;171:581-592. doi: 10.1016/j.envres.2018.09.015.

"Based in part on the results of this study, the California Department of Public Health published the following safety guidelines: “How to Reduce Exposure to Radiofrequency Energy from Cell Phones” (CDPH, 2017)."

Highlights

• Factors decreasing cell phone RF EMF exposures were strong signal strength, greater distance from phones, and Bluetooth use.
• Cell phone RF EMF exposures were one to four orders of magnitude higher in weak vs strong signal reception environments.
• At a typical texting distance, RF EMF exposures from phones with weak signal strength decreased by 90% over near-ear distance.
• Exposures from Bluetooth headsets were 10 to 400 times lower than direct near-ear exposures from the attached cell phones.

Abstract

In 2011 the International Agency for Research on Cancer classified radiofrequency electromagnetic fields (RF EMF) from cell phones as possibly carcinogenic to humans. The National Toxicology Program and the Ramazzini Institute have both reported that RF EMF exposures significantly increase gliomas and Schwannomas of the heart in rodent studies. Recent studies indicate that RF EMF exposures from cell phones have negative impacts on animal cells and cognitive and/or behavioral development in children. Case-control epidemiological studies have found evidence for cell phone use and increased risk for glioma and localization of the glioma associated with the consistent exposure site of regular cell phone use. Understanding the exposure level, or power density, from RF EMF emitted by cell phones under real-world usage and signal reception conditions, as distinct from the published measurements of maximum Specific Absorption Rate values, may help cell phone users decide whether to take behavioral steps to reduce RF EMF exposure.

Exposure measurements were conducted on phone models from four major mobile network operators (MNOs) in the USA for calls received under strong and weak reception signal conditions, near the phone face and at several distances up to 48 cm. RF EMF exposure from all phones was found to be greater under weak (1-2 display bars) than under strong (4-5 display bars) reception signal conditions by up to four orders of magnitude. Notably, RF EMF exposure levels under weak reception signal conditions at a distance of 48 cm from the phone were similar to or greater than those detected under strong reception signal conditions at a distance of 4 cm. Under weak reception signal conditions, power density reductions of up to 90% occurred at 16 cm typical for speaker phone or texting over the 4 cm near-ear exposure.

The results of this investigation of second-generation (2G) technology suggest that reduced and precautionary use of cell phones under weak signal conditions could lower a user's RF EMF exposure by up to several orders of magnitude. Bluetooth headset power density exposures were 10-400 times lower than those of the cell phones to which they were connected and dependent on the headset rather than the connected phone. The results of this study informed the development of public health guidance regarding cell phone use.

https://www.ncbi.nlm.nih.gov/pubmed/30448205

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Mother's Exposure to EMF before and during Pregnancy is Associated with Risk of Speech Problems in Offspring

Zarei S, Vahab M, Oryadi-Zanjani MM, Alighanbari N, Mortazavi SM. Mother's Exposure to Electromagnetic Fields before and during Pregnancy is Associated with Risk of Speech Problems in Offspring. J Biomed Phys Eng. 2019 Feb 1;9(1):61-68.

Abstract

Background: Rapid advances in technology, especially in the field of telecommunication, have led to extraordinary levels of mothers' exposures to radiofrequency electromagnetic fields (RF-EMFs) prior to or during pregnancy.

Objective: The main goal of this study was to answer this question whether exposure of women to common sources of RF-EMFs either prior to or during pregnancy is related to speech problems in the offspring.

Materials and Methods: In this study, mothers of 110 three-to-seven-year-old children with speech problems and 75 healthy children (control group) were interviewed. These mothers were asked whether they had exposure to different sources of EMFs such as mobile phones, mobile base stations, Wi-Fi, cordless phones, laptops and power lines. Chi square test was used to analyze the differences observed between the control and exposed groups.

Results: Statistically significant associations were found between the use of cordless phone and offspring speech problems for both before pregnancy and during pregnancy maternal exposures (P=0.005 and P=0.014, respectively). However, due to high rate of mobile phone use in both groups, this study failed to show any link between mobile phone use and speech problems in offspring. Furthermore, significant associations were observed between living in the vicinity of power lines and speech problems again for both before pregnancy and during pregnancy maternal exposures (P=0.003 and P=0.002, respectively). However, exposure to other sources of non-ionizing radiation was not linked to speech problems. Moreover, exposure to ionizing radiation (e.g. radiography before and during pregnancy) was not associated with the occurrence of speech problems.

Conclusion: Although this study has some limitations, it leads us to this conclusion that higher-than-ever levels of maternal exposure to electromagnetic fields could be linked to offspring speech problems.

https://www.ncbi.nlm.nih.gov/pubmed/30881935

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Impact of Adolescents' Screen Time & Nocturnal Mobile Phone-Related Awakenings on Sleep & Health Symptoms

Foerster M, Henneke A, Chetty-Mhlanga S, Röösli M. Impact of adolescents' screen time and nocturnal mobile phone-related awakenings on sleep and general health symptoms: A prospective cohort study.Int J Environ Res Public Health. 2019 Feb 12;16(3). pii: E518. doi: 10.3390/ijerph16030518.

Abstract

Nocturnal media use has been linked to adolescents' sleeping problems in cross-sectional studies which do not address reverse causality. To prospectively assess the new occurrence of sleep problems or health symptoms in relation to electronic media use and nocturnal mobile phone use, we used data from the longitudinal Swiss HERMES (Health Effects Related to Mobile phone usE in adolescentS) cohort on 843 children from 7th to 9th grade. Logistic regression models were fitted and adjusted for relevant confounders. Adolescents reporting at baseline and follow-up at least one nocturnal awakenings from their own mobile phone per month were more likely to have developed restless sleep (Odds Ratio (OR): 5.66, 95% Confidence Interval: 2.24–14.26) and problems falling asleep (3.51, 1.05–11.74) within one year compared to adolescents without nocturnal awakenings. A similar pattern was observed for developing symptoms, although somewhat less pronounced in terms of the magnitude of the odds ratios. With respect to high screen time at baseline and follow-up, associations were observed for falling asleep (2.41, 1.41–4.13), exhaustibility (1.76, 1.02–3.03), lack of energy (1.76, 1.04–2.96) and lack of concentration (2.90, 1.55–5.42). Our results suggest a detrimental effect of screen time and mobile phone-related awakenings on sleep problems and related health symptoms. However, the results should be interpreted cautiously with respect to adolescents' natural changes in circadian rhythm, which may coincidence with an increase in mobile phone and media use.

Open access paper: https://www.mdpi.com/1660-4601/16/3/518

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Memory Function and Cell Phone Microwave Exposure in Youngsters

Lin JC. Memory Function and Cell Phone Microwave Exposure in Youngsters [Health Matters]. IEEE Microwave Magazine. 20(2):16-20. Feb 2019.

Abstract

Cell phones, especially smartphones, have become such a popular phenomenon that marketing cell phones to youngsters is no longer the forbidden practice it once was. As a result of the increase of cell phone use among youngsters, France and other countries have banned the use of such phones in primary, junior, and middle schools, both inside classrooms and even outside on school playgrounds [1], [2].

Looking at the Data

The question of whether RF/microwave radiation emitted by cell phones during use could disturb brain activity in children and lead to impaired learning ability or behavioral problems has persisted for some time. To date, there remains a paucity of existing scientific data and relevant knowledge, including data on cognitive functions of adolescents. As a result, the question cannot be easily answered based on existing scientific evidence. Reported results may lead to the conclusion that RF/microwave radiation emitted from GSM cell phones does not produce acute effects on an adolescent's cognitive or memory function. But available data suggest that significant decreases in figural memory were found to be consistently associated with cumulative exposure of the brain of adolescents to 1,000–4,000 mJ/kg per day over one year. Therefore, a cautious approach to risk management, especially in relation to children and adolescents, is warranted.

https://ieeexplore.ieee.org/document/8608029

Note: James C. Lin is the Editor of the journal, Bioelectromagnetics, published on behalf of the Bioelectromagnetics Society. He was also one of the three EMF experts selected for the peer review of the cell phone radiation study conducted last year by the U.S. National Toxicology Program.

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Shielding methods and products against man-made Electromagnetic Fields: Protection versus risk

Panagopoulos DJ, Chrousos GP. Shielding methods and products against man-made Electromagnetic Fields: Protection versus risk. Sci Total Environ. 2019 Feb 23;667:255-262. doi: 10.1016/j.scitotenv.2019.02.344.

Highlights

- Human exposure to man-made EMFs has increased with increasing health problems.
- Metal shielding is lately suggested by private companies/individuals as a way to reduce exposure.
- Metal shielding reduces both man-made and natural atmospheric EMFs.
- EHS symptom relapses and internal desynchronization are reported after shielding.
- An avoidance strategy of man-made EMFs should be preferable than metal shielding.

Abstract

Human exposure to man-made Electromagnetic Fields (EMFs) has increased to unprecedented levels, accompanied by increase in various health problems. A connection has been indicated by an increasing number of studies. Symptoms characterized as Electro-hyper-sensitivity (EHS) are frequently reported especially in urban environments. Lately, people are advised by private companies and individuals to protect themselves from man-made EMFs by metal shielding through various products, for which there are reasonable concerns about their protective efficacy and safety. Indeed, any metal shielding practice, even when correctly applied, attenuates not only man-made totally polarized EMFs accused for the health problems, but also the natural non-polarized EMFs responsible for the biological rhythmicity and well-being of all animals. Strong evidence on this was provided by pioneering experiments in the 1960's and 1970's, with volunteers staying in a shielded underground apartment. We analyze the physical principles of EMF-shielding, the importance of natural atmospheric EMFs, and examine available shielding methods and suggested products, relying on science-based evidence. We suggest that an avoidance strategy is safer than shielding, and provide specific protection tips. We do not reject shielding in general, but describe ways to keep it at a minimum by intermittent use, as this is theoretically safer than extensive permanent shielding. We explain why metallic patches or

"chips" or minerals claimed by sellers to be protective, do not seem to make sense and might even be risky. We finally suggest urgent research on the safety and efficacy of shielding methods combined with use of generators emitting weak pulses of similar frequency, intensity, and waveform with the natural atmospheric resonances.

https://www.ncbi.nlm.nih.gov/pubmed/30831365

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Short-term RF exposure from new generation mobile phones reduces EEG alpha power with no effects on cognitive performance

Vecsei Z, Knakker B, Juhász P, Thuróczy G, Trunk A, Hernádi I. Short-term radiofrequency exposure from new generation mobile phones reduces EEG alpha power with no effects on cognitive performance. Sci Rep. 2018 Dec 20;8(1):18010. doi: 10.1038/s41598-018-36353-9.

Abstract

Although mobile phone (MP) use has been steadily increasing in the last decades and similar positive trends are expected for the near future, systematic investigations on neurophysiological and cognitive effects caused by recently developed technological standards for MPs are scarcely available. Here, we investigated the effects of radiofrequency (RF) fields emitted by new-generation mobile technologies, specifically, Universal Mobile Telecommunications System (UMTS) and Long-Term Evolution (LTE), on intrinsic scalp EEG activity in the alpha band (8-12 Hz) and cognitive performance in the Stroop test. The study involved 60 healthy, young-adult university students (34 for UMTS and 26 for LTE) with double-blind administration of Real and Sham exposure in separate sessions. EEG was recorded before, during and after RF exposure, and Stroop performance was assessed before and after EEG recording. Both RF exposure types caused a notable decrease in the alpha power over the whole scalp that persisted even after the cessation of the exposure, whereas no effects were found on any aspects of performance in the Stroop test. The results imply that the brain networks underlying global alpha oscillations might require minor reconfiguration to adapt to the local biophysical changes caused by focal RF exposure mimicking MP use.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6301959/

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Towards predicting intracellular radiofrequency radiation effects

Nielsen C, Hui R, Lui WY, Solov'yov IA. Towards predicting intracellular radiofrequency radiation effects. PLoS One. 2019 Mar 14;14(3):e0213286. doi: 10.1371/journal.pone.0213286.

Abstract

Recent experiments have reported an effect of weak radiofrequency magnetic fields in the MHz-range on the concentrations of reactive oxygen species (ROS) in living cells. Since the energy that could possibly be deposited by the radiation is orders of magnitude smaller than the energy of molecular thermal motion, it was suggested that the effect was caused by the interaction of RF magnetic fields with transient radical pairs within the cells, affecting the ROS formation rates through the radical pair mechanism. It is, however, at present not entirely clear how to predict RF magnetic field effects at certain field frequency and intensity in nanoscale biomolecular systems. We suggest a possible recipe for interpreting the radiofrequency effects in cells by presenting a general workflow for calculation of the reactive perturbations inside a cell as a function of RF magnetic field strength and frequency. To justify the workflow, we discuss the effects of radiofrequency magnetic fields on generic spin systems to particularly illustrate how the reactive radicals could be affected by specific parameters of the experiment. We finally argue that the suggested workflow can be used to predict

effects of radiofrequency magnetic fields on radical pairs in biological cells, which is specially important for wireless recharging technologies where one has to know of any harmful effects that exposure to such radiation might cause.

Open access paper: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0213286

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Analysis of biological effects of cell phone radiation on human body using SAR

Rashid TB, Song HH. Analysis of biological effects of cell phone radiation on human body using specific absorption rate and thermoregulatory response. Microwave and Optical Technology Letters. First published: 15 March 2019.

Abstract

Health and science have reached a point of intersection which has never existed before. With the recent rapid increase in the use of cellular phones and long periods of usage of these devices near the human body, public concern regarding potential health hazards due to absorption of electromagnetic energy has been growing. To address these issues, this research evaluates the average Specific Absorption Rate in different human tissues by varying source to antenna distance and radiated power using the ANSYS 3D human body model. The Pennes bioheat transfer equation was solved analytically to calculate the longtime exposure effect and temperature rise. The results show that regardless of the frequency, if the antenna radiated power is low (less than 125 mW), temperature increase within the human tissues is low; however if the antenna operates at high radiated power (1 W), temperature tends to increase eight and a half times.

Excerpts

SAR values are lower than the FCC safety limit in all cases shown in Tables 1 and 2 in head tissues, when there is no distance between head and antenna, in a lower frequency (850 MHz, 900 MHz) and lower radiated power (125 mW). In the same cases, when antenna radiated power increases to 1 W, SAR values are higher than the FCC safety limit in all head tissues. The maximum SAR values are found in CSF [cerebrospinal fluid] and skin tissues.

In head tissues, at higher frequencies (2.1 GHz, 2.6 GHz, and 5.1 GHz) at 125 mW radiated and when there is no distance between head and antenna, average SAR values are higher in all tissues except fat tissues as shown in Table 3-5. Maximum average SAR values are found in CSF, dura, brain, skin, and bone tissues at 5.1 GHz frequency, which are 11.4 W/kg, 10.89 W/kg, 10.77 W/kg, 10.51 W/kg, and 9.3 W/kg, respectively, as shown in Table 4. Average SAR values are high at higher frequencies because tissues have relatively high conductively (sic). In high frequency at high radiated power of 1 W, average SAR values in all tissues are very high. The maximum average SAR value found in CSF tissue was 91.2 W/kg. This means if the antenna is operating at a high power level, there is a high chance of tissues being affected.

... increasing the distance between the source and the head model from 0 mm to 10 mm causes the SAR to decrease by approximately three times at lower frequency, and it decreases approximately five and a half times at higher frequency.

The research concludes, for the long time exposure, and even for the worst possible radiated power level, the temperature rise caused in the human tissues is not close to the dangerous limit.

https://onlinelibrary.wiley.com/doi/abs/10.1002/mop.31777

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Mobile phone EMR affects Amyloid Precursor Protein and α-synuclein metabolism in SH-SY5Y cells

Stefi AL, Margaritis LH, Skouroliakou AS, Vassilacopoulou D. Mobile phone electromagnetic radiation affects Amyloid Precursor Protein and α-synuclein metabolism in SH-SY5Y cells. Pathophysiology. Published online March 1, 2019. https://doi.org/10.1016/j.pathophys.2019.02.004.

Highlights

• GSM radiation applied to SH-SY5Y cells:
• Causes alternative APP metabolism.
• Shifts the equilibrium from multimeric to the monomeric form of α-synuclein.
• Induces oxidative stress and cytotoxicity.
• Contributes to the Alzheimer's and Parkinson's disease pathogenetic mechanisms.

Abstract

In this study, the effects of low-level, GSM emitted ElectroMagnetic Field (EMF) on Amyloid Precursor Protein (APP) and alpha-synuclein (α-syn) in human neuroblastoma cells was investigated. Our data indicated alterations on APP processing and cellular topology, following EMF exposure ($\mathcal{E}$ = 10.51 V/m, SAR = 0.23 W/kg, exposure time: 3 times, for 10 minutes, for 2 days). Furthermore, changes in monomeric α-syn accumulation and multimerization, as well as induction of oxidative stress and cell death, were documented. The results presented here require further investigation to determine potential links of EMF with the molecular pathogenic mechanisms in Alzheimer's and Parkinson's Diseases.

Conclusions

To the best of our knowledge, the work presented here, seems to be the first report linking exposure to EMF emitted by a transmitting mobile phone, to altered metabolism of APP and α-syn in SH-SY5Y cells. The observed increase in monomeric α-syn along with the generation of novel amyloidogenic fragments possessing alternative cellular topology, in addition to the induction of cellular toxicity and oxidative stress, should be taken into consideration in future research aiming towards the understanding of the molecular mechanisms linking EMR to human health. It is possible that wireless communications, may represent a new factor affecting human health while exposure to these devices could be involved in pathogenic mechanisms leading to neurodegeneration.

https://www.sciencedirect.com/science/article/pii/S0928468018303523

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Personal exposure to environmental RF EMF in Albacete (Spain) and risk perception

Ramirez-Vazquez R, Gonzalez-Rubio J, Arribas E, Najera A. Characterisation of personal exposure to environmental radiofrequency electromagnetic fields in Albacete (Spain) and assessment of risk perception. Environ Res. 2019 Feb 12;172:109-116. doi: 10.1016/j.envres.2019.02.015.

Abstract

In the last decades, exposure to radiofrequency electromagnetic fields (RF-EMF) has substantially increased as new wireless technologies have been introduced. Society has become more concerned about the possible effects of RF-EMF on human health in parallel to the increase in their exposure. The appearance of personal exposimeters opens up wide-ranging research possibilities. Despite studies having characterised personal exposure to RF-EMF, part of the population is still worried, to the extent that psychogenic diseases ("nocebo" effect) appear, and patients suffer. It could be interesting to share personal exposure results with the population to better understand and promote public health. The main objective was to characterise personal

exposure to environmental RF-EMF in Albacete (166,000 inhabitants, SE Spain), and assess the effect of sharing the results of the study on participants' risk perception. Measurements were taken by a personal Satimo EME SPY 140 exposimeter, which was programmed every 10 s for 24 h. To measure personal exposure to RF-EMF, we worked with 75 volunteers. Their personal exposure, 14 microenvironments in the city, e.g., home, outdoors, work, etc., and possible time differences were analysed. After participating in the study, 35 participants completed a questionnaire about their RF-EMF risk perception, which was also answered by a control sample to compare the results (N = 36). The total average exposure of 14 bands was 37.7 μW/m2, and individual ranges fell between 0.2 μW/m2, recorded in TV4&5, and a maximum of 264.7 μW/m2 in DECT. For Friday, we recorded a mean of 53.9 μW/m2 as opposed to 23.4 μW/m2 obtained on Saturday. The recorded night-time value was 27.5 μW/m2 versus 43.8 μW/m2 recorded in the daytime. The mean personal exposure value also showed differences between weekdays and weekend days, with 39.7 μW/m2 and 26.9 μW/m2, respectively. The main source that contributed to the mean total personal exposure was enhanced cordless telecommunications (DECT) with 50.2%, followed by mobile phones with 18.4% and mobile stations with 11.0% (GSM, DCS and UMTS), while WiFi signals gave 12.5%. In the analysed microenvironments, the mean exposure of homes and workplaces was 34.3 μW/m2 and 55.2 μW/m2, respectively. Outdoors, the mean value was 34.2 μW/m2 and the main sources were DECT, WiFi and mobile phone stations, depending on the place. The risk perception analysis found that 54% of the participants perceived that RF-EMF were less dangerous than before participating in the study, while 43% reported no change in their perceptions. Only 9% of the volunteers who received information about their measurements after the study assessed the possible RF-EMF risk with a value over or equal to 4 (on a scale from 1 to 5) versus 39% of the non-participant controls. We conclude that personal exposure to RF-EMF fell well below the limits recommended by ICNIRP and showed wide temporal and spatial variability. The main exposure sources were DECT, followed by mobile phones and WiFi. Sharing exposure results with participants lowered their risk perception.

https://www.ncbi.nlm.nih.gov/pubmed/30782530
My Note: The case-control studies of wireless phone use and brain tumor risk typically failed to account for DECT phone radiation exposure to the head. The above study found that DECT phones contributed 50% to the overall personal RF radiation exposure as compared to only 18% for mobile phones. Thus, except for Hardell's research, case-control studies likely underestimate the effect of wireless phone use on brain tumor risk.

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Simulation of incidence of malignant brain tumors in birth cohorts that started using mobile phones when they first became popular in Japan

Sato Y, Kojimahara N, Yamaguchi N. Simulation of the incidence of malignant brain tumors in birth cohorts that started using mobile phones when they first became popular in Japan. Bioelectromagnetics. 2019 Mar 15. doi: 10.1002/bem.22176.

Abstract

Over 20 years have passed since the initial spread of mobile phones in Japan. Epidemiological studies of mobile phone use are currently being conducted around the world, but scientific evidence is inconclusive. The present study aimed to simulate the incidence of malignant brain tumors in cohorts that began using mobile phones when they first became popular in Japan. Mobile phone ownership data were collected through an Internet-based questionnaire survey of subjects born between 1960 and 1989. The proportion of mobile phone ownership between 1990 and 2012 was calculated by birth cohort (1960s, 1970s, and 1980s). Subsequently, using the ownership proportion, the incidence of malignant brain tumors was calculated under simulated risk conditions. When the relative risk was set to 1.4 for 1,640 h or more of cumulative mobile phone use and the mean daily call duration was 15 min, the incidence of malignant brain tumors in 2020 was 5.48 per 100,000 population for the 1960s birth cohort, 3.16 for the 1970s birth cohort, and 2.29 for the 1980s birth cohort. Under the modeled scenarios, an increase in the incidence of malignant brain tumors was shown to be observed around 2020.

Conclusion

Epidemiological studies on mobile phone use have mainly focused on malignant brain tumors as a health outcome. The present study revealed that under the modeled scenarios, an increase in the incidence of malignant brain tumors was shown to be observed around 2020. In future epidemiological studies on mobile phone use, we believe that it will be necessary to investigate whether or not the incidence of malignant brain tumors is actually increased in 1960s, 1970s, and 1980s birth cohorts.

https://www.ncbi.nlm.nih.gov/pubmed/30875091

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No Evidence for Increased Brain Tumor Incidence in the Swedish National Cancer Register Between 1980-2012

Nilsson J, Järås J, Henriksson R, Holgersson G, Bergström S, Estenberg J, Augustsson T, Bergqvist M. No evidence for increased brain tumour incidence in the Swedish National Cancer Register between years 1980-2012. Anticancer Res. 2019 Feb;39(2):791-796. doi: 10.21873/anticanres.13176.

Abstract

BACKGROUND/AIM: The main objective of this study was to evaluate if there was an increased incidence of brain tumours between years 1980-2012, a time period when mobile phone usage has increased substantially.

MATERIALS AND METHODS: From the Swedish Cancer Registry, cases of meningiomas, low-grade gliomas (LGG) and high-grade gliomas (HGG) were identified in patients between 1980-2012. Direct age-standardised incidence rates were used to calculate incidence trends over time.

RESULTS: A total of 13,441 cases of meningiomas, 12,259 cases of high-grade gliomas and 4,555 cases of LGG were reported to the register during the study period. The results suggest that there may be a negative development in the trend for LGG of -0,016 cases per 100,000 and year, corresponding to a mean reduction of approximately 1% per year.

CONCLUSION: The present study was not able to demonstrate an increased incidence of glioma during the past 30 years in Sweden.

Excerpt:

" For HGG, there was a trend for slightly decreased incidence in the age group 0-39 years (incidence trend estimate=−0.004, 95% CI=−0.006-−0.001; p=0.005) and a trend for mildly increased incidence in the age group 60-74 years (incidence trend estimate=0.006, 95% CI=0.001-0.012; p=0.029)."

Open access paper: http://ar.iiarjournals.org/content/39/2/791.long

Note: The title of this paper is misleading as the authors found an increased incidence of high-grade gliomas from 1980 to 2012 in the age group 60-74. The authors did not provide a justification for performing a linear regression on the age-standardized incidence rates. How likely is it that a linear model is appropriate to explain a 32-year trend? And even if a linear model were appropriate, since this is a time series where there is likely autocorrelation, the p-values from a linear regression are meaningless.

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Risk Communication Strategies for Possible Health Risks From RF-EMF Emission by Telecom Structures

Fernandez PR, Ng KH, Kaur S. Risk Communication Strategies for Possible Health Risks From Radio-Frequency Electromagnetic Fields (RF-EMF) Emission by Telecommunication Structures. Health Phys. 2019 Mar 4. doi: 10.1097/HP.0000000000001037.

Abstract

There is widespread anxiety and speculation about RF-EMF emissions by telecommunication base stations and structures, as it is perceived by some to be unsafe and a threat to public health. Scientists, medical experts, politicians, journalists, and mobile telecommunication company specialists are involved in an active debate on whether people are immune to RF or if we are gambling with our future. Interviews with 31 individuals from 7 stakeholder groups in Malaysia reveal that the residents' main concerns are that the telecommunication companies do not follow guidelines and as a result the telecommunication structures are constructed close to their homes, which they perceive as a threat to public health. Some residents also do not want these structures because of cultural reasons, while some are jealous over rental income received by the landlords. Meanwhile, the authorities entrusted with safe-guarding public health are involved in a blame game as there is no agency that is clearly in charge. The interviews also highlight that the current risk communication initiatives are more reactive rather than proactive, and that the authorities do not speak in one voice. Based on the outcome of the interviews, eleven recommendations are formulated to improve risk communication initiatives in Malaysia. The recommendations stress on repairing, building, and strengthening trust, because trust in agencies, along with credibility, determines risk communication initiatives' effectiveness. These strategies can also be effectively replicated across regions to deal with contestations over RF-EMF emissions and the impact on health.

https://www.ncbi.nlm.nih.gov/pubmed/30844902

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Evaluating extremely low frequency magnetic fields in the rear seats of the electric vehicles

Lin J, Lu M, Wu T, Yang L, Wu TN. Evaluating extremely low frequency magnetic fields in the rear seats of the electric vehicles. Radiation Protection Dosimetry. 182(2):190-199. Dec 2018.

Abstract

In the electric vehicles (EVs), children can sit on a safety seat installed in the rear seats. Owing to their smaller physical dimensions, their heads, generally, are closer to the underfloor electrical systems where the magnetic field (MF) exposure is the greatest. In this study, the magnetic flux density (B) was measured in the rear seats of 10 different EVs, for different driving sessions. We used the measurement results from different heights corresponding to the locations of the heads of an adult and an infant to calculate the induced electric field (E-field) strength using anatomical human models. The results revealed that measured B fields in the rear seats were far below the reference levels by the International Commission on Non-Ionizing Radiation Protection. Although small children may be exposed to higher MF strength, induced E-field strengths were much lower than that of adults due to their particular physical dimensions.

https://www.ncbi.nlm.nih.gov/pubmed/29584925\

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Aluminium foil dampened the adverse effect of 2100 MHz mobile phone-induced radiation on the blood parameters and myocardium in rats

Kalanjati VP, Purwantari KE, Prasetiowati L. Aluminium foil dampened the adverse effect of 2100 MHz mobile phone-induced radiation on the blood parameters and myocardium in rats. Environ Sci Pollut Res Int. 2019 Feb 26. doi: 10.1007/s11356-019-04601-8.

Abstract

Mobile phones emit a radiofrequency radiation (RFR) that might have adverse health effects. We aimed to investigate the possible protective effects of aluminium foil (AF) as a physical shield against the RFR from mobile phones on the blood parameters and the myocardium in rats. The effects of whole body 2100 MHz with 0.84-1.86 W/kg of SAR, 4 h/day for 30 days Global System for Mobile Communications (GSM)-RFR exposure for 4 h/day for 30 days on blood parameters (i.e. haemoglobin, leucocytes, thrombocytes, erythrocyte sedimentation rate, white blood cell differential count, corticosterone, CKMB), and the histology of myocardium were investigated. Three-month-old male rats ($n = 32$) were studied and randomised equally in the following four groups: K1 (non-AF non-RFR control), K2 (AF non-RFR control), P1 (non-AF RFR-exposed), P2 (AF RFR-exposed). Data were analysed with level of significance of $p < 0.05$. In P1, lower leucocytes and neutrophils counts with high corticosterone levels were found compared with the control groups, whilst a significantly higher CKMB was observed compared with P2 ($p = 0.034$). Lower cardiomyocyte counts congruent to the area fraction of the non-fibrotic myocardium were observed in P1 compared with the other groups ($p < 0.01$). AF might decrease the inflammatory-oxidative stress on rodent's blood cells and myocardium induced by the exposures of radiofrequency radiation of the mobile phones.

https://www.ncbi.nlm.nih.gov/pubmed/30806932

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Are MF and EMF of anthropogenic origin potential threats to early life stages of fish?

Fey DP, Jakubowska M, Greszkiewicz M, Andrulewicz E, Otremba Z, Urban-Malinga B. Are magnetic and electromagnetic fields of anthropogenic origin potential threats to early life stages of fish? Aquat Toxicol. 2019 Jan 30;209:150-158. doi: 10.1016/j.aquatox.2019.01.023.

Abstract

The number of underwater cables transferring electric current in sea and freshwater environments is constantly increasing. As a result, the risk of negative effects of magnetic fields generated in the vicinity of those cables on fish eggs and larvae is also growing. This is especially the case for species that settle on the bottom for certain periods of time during early development. To study those effects, eggs and larvae of rainbow trout, Oncorhynchus mykiss, were subjected under experimental conditions to a static magnetic field (MF) of 10 m T and a 50 Hz electromagnetic field (EMF) of 1 m T for a period of 36 days (i.e., from eyed egg stage to approximately 26 days post hatching, dph). Neither MF nor EMF had significant effect on embryonic or larval mortality, hatching time, larval growth, or the time of larvae swim-up from the bottom. However, both MF and EMF enhanced the yolk-sac absorption rate. Although it was not related directly to magnetic field effect, it was also shown that larvae with absorbed yolk-sacs by the time of swim-up were less efficient in taking advantage of available food at first feeding (i.e., obtained smaller weight at age). That indicates the importance of processes affecting yolk-sac absorption rate.

https://www.ncbi.nlm.nih.gov/pubmed/30780112

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The protective role of spermine against male reproductive aberrations induced by exposure to EMF - An experimental investigation in the rat

Shahin NN, El-Nabarawy NA, Gouda AS, Mégarbane B. The protective role of spermine against male reproductive aberrations induced by exposure to electromagnetic field - An experimental investigation in the rat. Toxicol Appl Pharmacol. 2019 Mar 13. pii: S0041-008X(19)30091-2. doi: 10.1016/j.taap.2019.03.009.

Abstract

The exponentially increasing use of electromagnetic field (EMF)-emitting devices imposes substantial health burden on modern societies with particular concerns of male infertility. Limited studies have addressed the modulation of this risk by protective agents. We investigated the hazardous effects of rat exposure to EMF (900 MHz, 2 h/day for 8 weeks) on male fertility and evaluated the possible protective effect of the polyamine, spermine, against EMF-induced alterations. Exposure to EMF significantly decreased sperm count, viability and motility, and increased sperm deformities. EMF-exposed rats exhibited significant reductions in serum inhibin B and testosterone along with elevated activin A, follicle-stimulating hormone, luteinizing hormone and estradiol concentrations. Testicular steroidogenic acute regulatory protein (StAR), c-kit mRNA expression and testicular activities of the key androgenic enzymes 3β- and 17β-hydroxysteroid dehydrogenases were significantly attenuated following exposure to EMF. Exposure led to testicular lipid peroxidation, decreased catalase and glutathione peroxidase activities and triggered nuclear factor-kappa B p65, inducible nitric oxide synthase, cyclooxygenase-2 and caspase-3 overexpression. EMF-exposed rats showed testicular DNA damage as indicated by elevated comet parameters. Spermine administration (2.5 mg/Kg/day intraperitoneally for 8 weeks) prevented EMF-induced alterations in the sperm and hormone profiles, StAR and c-kit expression and androgenic enzyme activities. Spermine hampered EMF-induced oxidative, inflammatory, apoptotic and DNA perturbations. Histological and histomorphometric analysis of the testes supported all biochemical findings. In conclusion, rat exposure to EMF disrupts sperm and hormone profiles with underlying impairment of steroidogenesis and spermatogenesis. Spermine confers protection against EMF-associated testicular and reproductive aberrations, at least in part, via antioxidant, anti-inflammatory and anti-apoptotic mechanisms.

https://www.ncbi.nlm.nih.gov/pubmed/30878504

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Carcinogenicity of intermediate frequency magnetic field in mice

Nishimura I, Doi Y, Imai N, Kawabe M, Mera Y, Shiina T. Carcinogenicity of intermediate frequency magnetic field in Tg.rasH2 mice. Bioelectromagnetics. 2019 Mar 15. doi: 10.1002/bem.22177.

Abstract

Although the likelihood of exposure to leaking intermediate frequency magnetic fields (MFs) from electronic devices, such as induction-heating and wireless power transfer systems, has increased, biological data assessing the health risks associated with human exposure remain insufficient. We examined the carcinogenicity of a 20 kHz MF, a typical frequency produced by induction-heating cookers, using a transgenic rasH2 mouse model. Twenty-five male and female CByB6F1-Tg(HRAS)2Jic mice were exposed to a 0.20 mT, 20 kHz MF (22 h/day) or sham-exposed for 26 weeks. As a positive control, 10 male and female rasH2 mice from the same batch were administered a single intraperitoneal injection of 75 mg/kg N-methyl-N-nitrosourea. A blinded histopathological evaluation was performed, and the same experiments were conducted twice, independently, to confirm the reproducibility of the results. Histopathological examination revealed that spontaneous neoplastic lesions, such as splenic hemangiosarcomas and gastric squamous cell papillomas, were less (1-3 per group) in the MF- and sham-exposed groups. The frequency of the neoplastic lesions was not significantly different between the groups. Eight to ten mice in each positive-control group exhibited malignant lymphoma. The outcomes were consistent between duplicated experiments, which indicates lack of carcinogenicity of 20 kHz MF in the rasH2 mouse model

https://www.ncbi.nlm.nih.gov/pubmed/30875092

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Upper bound on the biological effects of 50/60 Hz magnetic fields mediated by radical pairs

Hore PJ. Upper bound on the biological effects of 50/60 Hz magnetic fields mediated by radical pairs. Elife. 2019 Feb 25;8. pii: e44179. doi: 10.7554/eLife.44179.

Abstract

Prolonged exposure to weak (~1 μT) extremely-low-frequency (ELF, 50/60 Hz) magnetic fields has been associated with an increased risk of childhood leukemia. One of the few biophysical mechanisms that might account for this link involves short-lived chemical reaction intermediates known as radical pairs. In this report, we use spin dynamics simulations to derive an upper bound of 10 parts per million on the effect of a 1 μT ELF magnetic field on the yield of a radical pair reaction. By comparing this figure with the corresponding effects of changes in the strength of the Earth's magnetic field, we conclude that if exposure to such weak 50/60 Hz magnetic fields has any effect on human biology, and results from a radical pair mechanism, then the risk should be no greater than travelling a few kilometres towards or away from the geomagnetic north or south pole.

Open access paper: https://elifesciences.org/articles/44179

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Weak magnetic fields alter stem cell–mediated growth

Van Huizen AV, Morton JM, Kinsey LJ, Von Kannon DG, Saad MA, Birkholz TR, Czajka JM, Cyrus J, Barnes FS, Beane WS. Weak magnetic fields alter stem cell–mediated growth. Science Advances. 5(1). 30 Jan 2019. DOI: 10.1126/sciadv.aau7201.

Abstract

Biological systems are constantly exposed to electromagnetic fields (EMFs) in the form of natural geomagnetic fields and EMFs emitted from technology. While strong magnetic fields are known to change chemical reaction rates and free radical concentrations, the debate remains about whether static weak magnetic fields (WMFs; <1 mT) also produce biological effects. Using the planarian regeneration model, we show that WMFs altered stem cell proliferation and subsequent differentiation via changes in reactive oxygen species (ROS) accumulation and downstream heat shock protein 70 (Hsp70) expression. These data reveal that on the basis of field strength, WMF exposure can increase or decrease new tissue formation in vivo, suggesting WMFs as a potential therapeutic tool to manipulate mitotic activity.

Open access paper: http://advances.sciencemag.org/content/5/1/eaau7201

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Review of biological effects of EMF in intermediate frequency range (300 Hz to 1 MHz)

Bodewein L, Schmiedchen K, Dechent D, Stunder D, Graefrath D, Winter L, Kraus T, Driessen S. Systematic review on the biological effects of electric, magnetic and electromagnetic fields in the intermediate frequency range (300 Hz to 1 MHz). Environ Res. 2019 Jan 9;171:247-259. doi: 10.1016/j.envres.2019.01.015.

Highlights

- Biological effects of intermediate frequency fields were systematically analyzed.
- Fifty-six experimental studies were eligible.

• Weak field strengths and frequencies > 100 kHz have been hardly investigated.
• Low quality of evidence for adverse effects for most examined endpoints.
• Methodical limitations lowered credibility of the results.

Excerpt

"... a few studies that were of moderate quality, revealed some potentially adverse effects of MF in the IF range, such as an increased number of abnormal chicken embryos (Juutilainen and Saali, 1986), or an increase in inflammatory mediators and oxidative stress markers in the young mouse brain (Win-Shwe et al., 2015). Such studies should be replicated by independent laboratories."

Abstract

BACKGROUND: Many novel technologies, including induction cookers or wireless power transfer, produce electric fields (EF), magnetic fields (MF) or electromagnetic fields (EMF) in the intermediate frequency (IF) range. The effects of such fields on biological systems, however, have been poorly investigated. The aim of this systematic review was to provide an update of the state of research and to evaluate the potential for adverse effects of EF, MF and EMF in the IF range (300 Hz to 1 MHz) on biological systems.

METHODS: The review was prepared in accordance with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. Methodical limitations in individual studies were assessed using the Office of Health Assessment and Translation (OHAT) Risk of Bias Rating Tool for Human and Animal Studies.

RESULTS: Fifty-six studies exposing humans, animals or in vitro systems were eligible for this review. In these studies, many different endpoints were examined and most of the findings were obtained in studies with exposure to MF. For most endpoints, however, the reviewed studies yielded inconsistent results, with some studies indicating no effect and some linking IF exposure with adverse effects. In the majority of the included studies, the applied field strengths were above the International Commission on Non-Ionizing Radiation Protection (ICNIRP) reference levels for the general public and the applied frequencies were mainly below 100 kHz. Furthermore, many of the reviewed studies suffered from methodical limitations which lowered the credibility of the reported results.

CONCLUSION: Due to the large heterogeneity in study designs, endpoints and exposed systems, as well as the inconsistent results and methodical limitations in many studies, the quality of evidence for adverse effects remains inadequate for drawing a conclusion on investigated biological effects of IF fields for most endpoints. We recommend that in future studies, effects of EF, MF and EMF in the IF range should be investigated more systematically, i.e., studies should consider various frequencies to identify potential frequency-dependent effects and apply different field strengths, especially if threshold-dependent effects are expected. Priority should be given to the investigation of acute effects, like induction of phosphenes, perception, excitation of nerves or muscles and thermal effects. This would be an important step towards the validation of the reference levels recommended by ICNIRP. Furthermore, we recommend that any new studies aim at implementing high quality dosimetry and minimizing sources of risk of bias.

https://www.ncbi.nlm.nih.gov/pubmed/30690271

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Trends and patterns of incidence of diffuse glioma in adults in the United States, 1973-2014

Li K, Lu D, Guo Y, Wang C, Liu X, Liu Y, Liu D. Trends and patterns of incidence of diffuse glioma in adults in the United States, 1973-2014. Cancer Med. 2018 Oct;7(10):5281-5290. doi: 10.1002/cam4.1757.

Abstract

INTRODUCTION: The objective of the study was to identify trends in incidence of adult diffuse gliomas in the United States and evaluate the contribution of age, period, and cohort effects to the trends.

METHODS: Using the Surveillance, Epidemiology, and End Results 9 database, primary diffuse glioma patients (≥20 years old) diagnosed from 1973 to 2014 were identified. Incidence trends were analyzed using joinpoint regression and age-period-cohort modeling.

RESULTS: Overall, the incidence for adult glioma decreased slowly from 1985 to 2014 (annual percent change [APC] = 0.5%, 95% confidence intervals [CI], 0.3%-0.6%). In histology subtype-stratified analysis, glioblastoma and nonglioblastoma exhibited opposite trends. The incidence for glioblastoma increased from 1978 to 2014 (APC for year 1978-1992 = 2.7%, 95% CI, 1.8%-3.6%; APC for 1992-2014 = 0.3%, 95% CI, 0%-0.6%), while the incidence for nonglioblastoma decreased significantly from 1982 to 2014 (APC = 2.2%, 95% CI, 2.0%-2.5%). Age-period-cohort modeling revealed significant period and cohort effects, with the patterns for glioblastoma and nonglioblastoma distinctive from each other. Compared with adults born 1890s, those born 1920s had approximately 4-fold the risk of glioblastoma after adjustment of age and period effects, while the risk of nonglioblastoma was reduced by half in individuals in the 1939 cohort as compared with those in the 1909 cohort.

CONCLUSIONS: The results support the hypothesis of etiological heterogeneity of diffuse gliomas by histology subtypes. The established risk factors cannot fully explain the distinct patterns by histology subtypes, which necessitate further epidemiological studies.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6198197/

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Effects of evening exposure to 3G mobile phone EMF on health and night sleep EEG architecture

Lowden A, Nagai R, Åkerstedt T, Hansson Mild K, Hillert L. Effects of evening exposure to electromagnetic fields emitted by 3G mobile phones on health and night sleep EEG architecture. J Sleep Res. 2019 Jan 15:e12813. doi: 10.1111/jsr.12813.

Abstract

Studies on sleep after exposure to radiofrequency electromagnetic fields have shown mixed results. We investigated the effects of double-blind radiofrequency exposure to 1,930-1,990 MHz, UMTS 3G signalling standard, time-averaged 10 g specific absorption rate of 1.6 W kg-1on self-evaluated sleepiness and objective electroencephalogram architecture during sleep. Eighteen subjects aged 18-19 years underwent 3.0 hr of controlled exposure on two consecutive days 19:45-23:00 hours (including 15-min break); active or sham prior to sleep, followed by full-night 7.5 hr polysomnographic recordings in a sleep laboratory. In a cross-over design, the procedure was repeated a week later with the second condition. The results for sleep electroencephalogram architecture showed no change after radiofrequency exposure in sleep stages compared with sham, but power spectrum analyses showed a reduction of activity within the slow spindle range (11.0-12.75 Hz). No differences were found for self-evaluated health symptoms, performance on the Stroop colour word test during exposure or for sleep quality. These results confirm previous findings that radiofrequency post-exposure in the evening has very little influence on electroencephalogram architecture but possible on spindle range activity.

https://www.ncbi.nlm.nih.gov/pubmed/30648318

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Telecommunication devices use, screen time and sleep in adolescents

Cabré-Riera A, Torrent M, Donaire-Gonzalez D, Vrijheid M, Cardis E, Guxens M. Telecommunication devices use, screen time and sleep in adolescents. Environ Res. 2018 Nov 1;171:341-347. doi: 10.1016/j.envres.2018.10.036.

Abstract

PURPOSE: To investigate the association between telecommunication and other screen devices use and subjective and objective sleep measures in adolescents at 17-18 years.

METHODS: Cross-sectional study on adolescents aged 17-18 years from a Spanish population-based birth cohort established in Menorca in 1997-1998. Information on devices use was collected using self-reported questionnaires. Mobile Phone Problematic Use Scale was used to assess mobile phone use dependency. Pittsburgh Sleep Quality Index was used to assess subjective sleep (n = 226). ActiGraph wGT3X-BT for 7 nights was used to assess objective sleep (n = 110).

RESULTS: One or more cordless phone calls/week was associated with a lower sleep quality [Prevalence Ratio (PR) 1.30 (95% Confidence Interval (CI) 1.04; 1.62)]. Habitual and frequent problematic mobile phone use was associated with a lower sleep quality [PR 1.55 (95%CI 1.03; 2.33) and PR 1.67 (95% CI 1.09; 2.56), respectively]. Higher tablet use was associated with decreased sleep efficiency and increased minutes of wake time after sleep onset [β-1.15 (95% CI -1.99; -0.31) and β 7.00 (95% CI 2.40; 11.60) per increase of 10 min/day of use, respectively]. No associations were found between other devices and sleep measures.

CONCLUSIONS: Frequency of cordless phone calls, mobile phone dependency, and tablet use were related to an increase of subjective and objective sleep problems in adolescents. These results seem to indicate that sleep displacement, mental arousal, and exposure to blue light screen emission might play a more important role on sleep than a high RF-EMF exposure to the brain. However, more studies are needed assessing personal RF-EMF levels to draw conclusions.

https://www.ncbi.nlm.nih.gov/pubmed/30716511

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Note: The increased cancer incidence observed in the cell phone radiation studies conducted by the National Toxicology Program (NTP) and the Ramazzini Institute was not likely due to heating, that is, it was not a thermal effect because hyperthermia alone is not carcinogenic according to this 2003 review paper. Dr. John Bucher pointed this out in the NTP's media teleconference about the study.

Carcinogenic effects of hyperthermia

Dewhirst MW, Lora-Michiels M, Viglianti BL, Dewey WC, Repacholi M. Carcinogenic effects of hyperthermia. Int J Hyperthermia. 2003 May-Jun;19(3):236-51.

Abstract

The purpose of this paper is to assess the evidence for and against the premise that hyperthermia is carcinogenic. The paper is one of several published in this issue of the International Journal of Hyperthermia on the subject of the health risks of hyperthermia. **The motivation for this issue of the journal was the result of a World Health Organization workshop that dealt with this issue, as it relates to exposure of the population to RF fields. Since hyperthermia can be a natural consequence of such exposures, the health risks of hyperthermia are relevant in this context.** Particularly in the case of carcinogenesis, it is necessary to provide a brief overview of the data that have been generated to examine the carcinogenic risks of RF exposure, so that these results can be compared with studies that have examined the carcinogenic risks of hyperthermia. For this reason, the paper is organized into three sections dealing with: (1) effects of heat on DNA damage/repair and mutations, (2) in vivo studies evaluating the carcinogenic potential of heat alone and

combined with other carcinogens, and (3) in vivo studies involving RF exposures. **The bulk of the data presented indicate that hyperthermia alone is not carcinogenic.** If hyperthermia occurs in the presence of exposure to known carcinogens, such as radiation or chemical carcinogens there is the potential for modulation of carcinogenic effects of those agents. In some circumstances, hyperthermia can actually protect against tumour formation. In other instances, hyperthermia clearly increases incidence of tumour formation, but this occurs following thermal exposures (several degrees C temperature rise for up to 1 h or more) and radiation (therapeutic levels as for treatment of cancer) or chemical carcinogen doses higher than would be encountered by the general population. **The extrapolation of these results to the general population, where radiation exposure levels would be at background and temperature rise from incidental RF exposure, such as cell phones (which are estimated to cause no more than 0.1 degrees C temperature rise) is not recommended. Current evidence indicates that the temperature elevations resulting from RF exposure are not carcinogenic.** Caution should be used in situations where exposure to known carcinogens is combined with thermal exposures high enough to cause tissue damage. A summary of thermal thresholds for tissue damage from hyperthermia is presented in another paper in this special issue (Dewhirst et al.). No data exist that examine the carcinogenic risks of chronic thermal exposures below the threshold for detectable tissue damage, either alone or in combination with known carcinogens. This is an important goal for future research.

https://www.ncbi.nlm.nih.gov/pubmed/12745970

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Significance of micronuclei in buccal smears of mobile phone users: A comparative study

Vanishree M, Manvikar V, Rudraraju A, Reddy KMP, Kumar NHP, Quadri SJM. Significance of micronuclei in buccal smears of mobile phone users: A comparative study. J Oral Maxillofac Pathol. 2018 Sep-Dec;22(3):448. doi: 10.4103/jomfp.JOMFP_201_18.

Abstract

AIMS AND OBJECTIVES: The present study was designed to evaluate the frequency of micronuclei (MN) in the buccal exfoliated cells of mobile phone users. In addition, comparison of MN frequency between high and low mobile phone users was also done.

MATERIALS AND METHODS: A total of 30 male and 30 female participants between the age group of 20-28 years were selected from the Outpatient Department of Navodaya Dental College and Hospital, Raichur, Karnataka. The participants were divided into two groups: Group A - low mobile phone users and Group B - high mobile phone users. Cell sampling and preparation was done on the slide. All the slides were observed for a total of 1000 cells for the presence and number of MN in each cell.

RESULTS: There was a significant increase in the mean MN count in Group B in comparison to the Group A. There was highly significant difference in the mean MN count of participants using (code division multiple access) CDMA than (global system for mobiles) GSM mobile phones. The MN mean count was found to be significantly increased in non-headphone users in comparison to headphone users. In Group B, the MN count on the side of mobile phone use was found to be statistically significantly elevated in comparison to the opposite side.

CONCLUSION: Mobile phone radiation even in the permissible range when used for longer duration can cause significant genotoxicity. The genotoxicity accentuates when mobile phones are frequently used on the same side which may be due to more amount of radiation and increase in the temperature. Headphone usage reduces the genotoxicity of mobile phone radiation to some extent.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6306606/

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Transdermal patches loaded with L-cysteine HCL as a strategy for protection from cell phone radiation

Omar SM, Nasr M, Rafla DA. Transdermal patches loaded with L-cysteine HCL as a strategy for protection from mobile phone-emitting electromagnetic radiation hazards. Saudi Pharm J. 2019 Jan;27(1):112-125. doi: 10.1016/j.jsps.2018.09.004.

Abstract

Mobile phone usage has been increased in the last few years emitting electromagnetic radiation (EMR), which disturbs normal cellular processes via oxidative stress. L-cysteine, a glutathione precursor, prevents oxidative damage.

Transdermal patches (TDPs) loaded with L-cysteine hydrochloride (L-CyS-HCL) were fabricated by dispersion of L-CyS-HCL 5% w/w and different concentrations of sorbitol as a plasticizer in room-temperature vulcanizable synthetic silicone matrices (RTV-Si). The effect of sorbitol on patch physicochemical parameters was assessed; in-vitro L-CyS-HCL release profiles and ex-vivo permeation were studied. Pharmacokinetic parameters of endogenous synthetized in-vivo glutathione, after receiving IV bolus dose of L-CyS-HCl and L-CyS-HCl-RTV-Si-TDPs were studied in rat model. The influence of L-CyS-HCL-RTV-Si-TDPs against damaging effects of mobile phone EMR on rats' blood and brain tissues was studied.

The results revealed that patch plasticity, intensity reflections, surface porosity, L-CyS-HCL release rate and skin permeation increased with increasing sorbitol concentration. Pharmacokinetic profile for IV dose and L-CyS-HCl-RTV-Si-TDPs revealed that the L-CyS-HCl-RTV-Si-TDPs provided a sustained glutathione plasma concentration-time profile over entire patch application. High significant differences in biological parameters (blood and brain samples) were observed for radiated rats using the patch in study compared with positive control rats.

Promising long-term strategy for protection against mobile phone hazards was obtained.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6323147/

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High ambient radiofrequency radiation in Stockholm city, Sweden

Carlberg M, Hedendahl L, Koppel T, Hardell L. High ambient radiofrequency radiation in Stockholm city, Sweden. Oncol Lett. 2019 Feb;17(2):1777-1783. doi: 10.3892/ol.2018.9789.

Abstract

We measured the radiofrequency (RF) radiation at central parts in Stockholm, Sweden in March and April 2017. The same measurement round tour was used each time. We used EME Spy 200 for the measurements as in our previous studies in Stockholm. The results were based on 11,482 entries, corresponding to more than 12 h measurements. The total mean level was 5,494 μW/m2 (median 3,346; range 36.6-205,155). The major contributions were down links from LTE 800 (4G), GSM + UMTS 900 (3G), GSM 1800 (2G), UMTS 2100 (3G) and LTE 2600 (4G). Regarding different places, the highest RF radiation was measured at the Hay Market with a mean level of 10,728 μW/m2 (median 8,578; range 335-68,815). This is a square used for shopping, and both retailers and visitors may spend considerable time at this place. Also, the Sergel Plaza had high radiation with a mean of 7,768 μW/m2. All measurements exceeded the target level of 30-60 μW/m2 based on non-thermal (no heating) effects, according to the BioInitiative Report. Based on short-term thermal effects, The International Commission on Non-Ionizing Radiation Protection established guideline 2 of 10 W/m2 (2,000,000-10,000,000 μW/m2) depending on frequency in 1998, and has not changed it despite solid evidence of non-

thermal biological effects at substantially lower exposure levels. These environmental RF radiation levels are expected to increase with the introduction of 5G for wireless communication.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6341832/

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Alternating Electric Fields (TTFields) Activate Cav1.2 Channels in Human Glioblastoma Cells

Neuhaus E, Zirjacks L, Ganser K, Klumpp L, Schüler U, Zips D, Eckert F, Huber SM. Alternating Electric Fields (TTFields) Activate Cav1.2 Channels in Human Glioblastoma Cells. Cancers (Basel). 2019 Jan 18;11(1). pii: E110. doi: 10.3390/cancers11010110.

Abstract

Tumor treating fields (TTFields) represent a novel FDA-approved treatment modality for patients with newly diagnosed or recurrent glioblastoma multiforme. This therapy applies intermediate frequency alternating electric fields with low intensity to the tumor volume by the use of non-invasive transducer electrode arrays. Mechanistically, TTFields have been proposed to impair formation of the mitotic spindle apparatus and cytokinesis. In order to identify further potential molecular targets, here the effects of TTFields on Ca2+-signaling, ion channel activity in the plasma membrane, cell cycle, cell death, and clonogenic survival were tested in two human glioblastoma cell lines in vitro by fura-2 Ca2+ imaging, patch-clamp cell-attached recordings, flow cytometry and pre-plated colony formation assay. In addition, the expression of voltage-gated Ca2+ (Cav) channels was determined by real-time RT-PCR and their significance for the cellular TTFields response defined by knock-down and pharmacological blockade. As a result, TTFields stimulated in a cell line-dependent manner a Cav1.2-mediated Ca2+entry, G_1 or S phase cell cycle arrest, breakdown of the inner mitochondrial membrane potential and DNA degradation, and/or decline of clonogenic survival suggesting a tumoricidal action of TTFields. Moreover, inhibition of Cav1.2 by benidipine aggravated in one glioblastoma line the TTFields effects suggesting that Cav1.2-triggered signaling contributes to cellular TTFields stress response. In conclusion, the present study identified Cav1.2 channels as TTFields target in the plasma membrane and provides the rationale to combine TTFields therapy with Ca2+ antagonists that are already in clinical use.

https://www.mdpi.com/2072-6694/11/1/110

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Complications of nonionizing radiofrequency on divided attention

Bamdad K, Adel Z, Esmaeili M. Complications of nonionizing radiofrequency on divided attention. J Cell Biochem. 2019 Feb 3. doi: 10.1002/jcb.28343.

Abstract

Exposure to electromagnetic fields is considered as a potential hazard for biological systems. The objective of our investigation is the study of probable consequences of radiofrequency electromagnetic fields from Wi-Fi router devices on the short-term memory, and attention's levels. A population consisting of 312 female college students (14 to 17 years old) was elected by cluster random sampling. Teenagers were divided into two groups of control group (Wi-Fi nonusers; n = 138), and experiment group (Wi-Fi users; n = 174). Both groups have been examined using short-term memory tests; selective attention, and also divided attention tests. According to the results, there was no significant difference between using Wi-Fi router devices on levels of selective attentions and short-term memory of the sample students with the control group. However, analyses revealed that there is a significant correlation between the use of Wi-Fi routers and declining levels of divided attentions. Our investigation has demonstrated the adverse consequences of 2.4-2.48 GHz radiofrequency

electromagnetic fields of Wi-Fi router devices on divided attention levels of female university students that should be mentioned as a technological risk factor and taken into account by healthcare organizations.

https://www.ncbi.nlm.nih.gov/pubmed/30714205

Note: This was an observational study, not a randomized trial. The observed difference on divided attention may be due to confounding.

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Effect of 900-, 1800-, and 2100-MHz radiofrequency radiation on DNA and oxidative stress in brain

Alkis ME, Bilgin HM, Akpolat V, Dasdag S, Yegin K, Yavas MC, Akdag MZ. Effect of 900-, 1800-, and 2100-MHz radiofrequency radiation on DNA and oxidative stress in brain. Electromagn Biol Med. 2019 Jan 22:1-16. doi: 10.1080/15368378.2019.1567526.

Abstract

Ubiquitous and ever increasing use of mobile phones led to the growing concern about the effects of radiofrequency radiation (RFR) emitted by cell phones on biological systems. The aim of this study is to explore whether long-term RFR exposure at different frequencies affects DNA damage and oxidant-antioxidant parameters in the blood and brain tissue of rats. 28 male Sprague Dawley rats were randomly divided into four equal groups (n = 7). They were identified as Group 1: sham-control, Group 2: 900 MHz, Group 3: 1800 MHz, and Group 4: 2100 MHz. Experimental groups of rats were exposed to RFR 2 h/day for 6 months. The sham-control group of rats was subjected to the same experimental condition but generator was turned off. Specific absorption rates (SARs) at brain with 1 g average were calculated as 0.0845 W/kg, 0.04563 W/kg, and 0.03957, at 900 MHz, 1800 MHz, and 2100 MHz, respectively. Additionally, malondialdehyde (MDA), 8-hydroxydeoxyguanosine (8-OHdG), total antioxidant status (TAS), and total oxidant status (TOS) analyses were conducted in the brain tissue samples. Results of the study showed that DNA damage and oxidative stress indicators were found higher in the RFR exposure groups than in the sham-control group. In conclusion, 900-, 1800-, and 2100-MHz RFR emitted from mobile phones may cause oxidative damage, induce increase in lipid peroxidation, and increase oxidative DNA damage formation in the frontal lobe of the rat brain tissues. Furthermore, 2100-MHz RFR may cause formation of DNA single-strand breaks.

https://www.ncbi.nlm.nih.gov/pubmed/30669883

Conclusion

RFR at different mobile phone frequencies seems to cause oxidative stress, lipid peroxidation, and DNA damage by changing oxidant and antioxidant levels in frontal lobe of the brain tissue. However, the increase in the frequency and the increase in the level of damage suggest that RFRs at higher frequencies may negatively affect brain tissue and may lead to the development of damage. Our study is consistent with many recent studies and supports the hypothesis that RFR causes damage to biological tissues. However, in order to reach solid conclusions, detailed long-term studies at molecular level are definitely needed.

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Effects of radiofrequency electromagnetic radiation (RF-EMF) on honey bee queen development and mating success

Odemer R, Odemer F. Effects of radiofrequency electromagnetic radiation (RF-EMF) on honey bee queen development and mating success. Science of The Total Environment. 661:553-562. April 15, 2019.

Highlights

• Chronic RF-EMF exposure significantly reduced hatching of honey bee queens.
• Mortalities occurred during pupation, not at the larval stages.
• Mating success was not adversely affected by the irradiation.
• After the exposure, surviving queens were able to establish intact colonies.

Abstract

Mobile phones can be found almost everywhere across the globe, upholding a direct point-to-point connection between the device and the broadcast tower. The emission of radiofrequency electromagnetic fields (RF-EMF) puts the surrounding environment inevitably into contact with this radiation. We have therefore exposed honey bee queen larvae to the radiation of a common mobile phone device (GSM band at 900 MHz) during all stages of their pre-adult development including pupation. After 14 days of exposure, hatching of adult queens was assessed and mating success after further 11 days, respectively. Moreover, full colonies were established of five of the untreated and four of the treated queens to contrast population dynamics. We found that mobile phone radiation had significantly reduced the hatching ratio but not the mating success. If treated queens had successfully mated, colony development was not adversely affected. We provide evidence that mobile phone radiation may alter pupal development, once succeeded this point, no further impairment has manifested in adulthood. Our results are discussed against the background of long-lasting consequences for colony performance and the possible implication on periodic colony losses.

Conclusions

Even though detrimental effects on ontogenetic queen development were revealed by the outcome of our study, caution is needed in interpreting these results. So far, there have been no serious records of colony losses associated with mobile phone radiation. Moreover, we have created by far a worst case operator scenario to which honey bee colonies would not be exposed under realistic beekeeping conditions. Duration and level were similar to average operator exposure by the use of a mobile phone, but not to those present at an apiary, neither in rural nor in urban areas. And yet, queens that survived the treatment were able to establish full functional colonies, demonstrating an immense recovering potential. Therefore we do not assume any acute negative effects on bee health in the mid-term. However,we do not rule out an influence through lower doses of permanent irradiation, in particular on a chronic sublethal level present in major city environments. Hence, we urgently suggest further research should be carried out in the long-term to ascertain what impacts are to be expected in the context of a suitable risk assessment for electromagnetic fields on bee health.

https://www.sciencedirect.com/science/article/pii/S0048969719301718

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Room temperature and selective triggering of supramolecular DNA assembly/ disassembly by non-ionizing radiation

Greschner AA, Ropagnol X, Kort M, Zuberi N, Perreault J, Razzari L, Ozaki T, Gauthier MA. Room temperature and selective triggering of supramolecular DNA assembly/disassembly by non-ionizing radiation. J Am Chem Soc. 2019 Feb 1. doi: 10.1021/jacs.8b10355.

Abstract

Recent observations have suggested that non-ionizing radiation in the microwave and terahertz (THz; far infrared) regimes could have an effect on double-stranded DNA (dsDNA). These observations are of significance owing to the omnipresence of microwave emitters in our daily lives (e.g., food preparation, telecommunication, wireless internet) and the increasing prevalence of THz emitters for imaging (e.g., concealed weapon detection in airports, screening skin cancer) and communication technologies. By

examining multiple DNA nanostructures as well as two plasmid DNA, microwaves were shown to promote the repair and assembly of DNA nanostructures and single-stranded regions of plasmid DNA, while intense THz pulses had the opposite effect (in particular for short dsDNA). Both effects occurred at room temperature within minutes, showed a DNA-length dependence, and did not affect the chemical integrity of the DNA. Intriguingly, the function of seven proteins (enzymes and antibodies) was not affected by exposure to either forms of radiation under the conditions examined. This particularity was exploited to assemble a fully-functional hybrid DNA-protein nanostructure in a bottom-up manner. This study therefore provides entirely new perspectives for the effects, on a molecular level, of non-ionizing radiation on biomolecules. Moreover, the proposed structure-activity relationships could be exploited in the field of DNA nanotechnology, which paves the way for designing a new range of functional DNA nanomaterials that are currently inaccessible to state-of-the-art assembly protocols.

https://www.ncbi.nlm.nih.gov/pubmed/30707028

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Exposure to EMF of High Voltage Overhead Power Lines and Female Infertility

Esmailzadeh S, Delavar MA, Aleyassin A, Gholamian SA, Ahmadi A. Exposure to Electromagnetic Fields of High Voltage Overhead Power Lines and Female Infertility. Int J Occup Environ Med. 2019 Jan;10(1):11-16. doi: 10.15171/ijoem.2019.1429.

Abstract

BACKGROUND: Living in the vicinity of high voltage power lines has brought about a range of health woes, but the effect of residential exposure to electromagnetic fields from the power lines on female fertility has not been explored yet.

OBJECTIVE: To test the hypothesis if residential proximity to high voltage power lines could be associated with the increased risk of female infertility.

METHODS: In a case-control study, 462 women with confirmed diagnosis of unexplained infertility or behavioral and environmental factors were assessed between February 2014 and December 2016. Control group comprised of 471 persons with no history of infertility selected using randomized-digit dialing from the numbers registered in a birth registry between 2014 and 2016. The nearest linear distance from high voltage power lines to the participants' residence of cases and controls was measured using a Geographical Information System (GIS) and Google Earth aerial evaluation for high voltage power lines (240-400 kV).

RESULTS: 112 (14.1%) houses were within 500 meters from a high voltage power line. Women living within 500 meters of the lines (OR 4.14, 95% CI 2.61 to 6.57) and 500-1000 meters of the line (OR 1.61, 95% CI 1.05 to 2.47) carried a significantly higher risk of infertility than those women living more than 1000 meters away from the power lines. After adjusting for confounding factors, women living within 500 meters of the lines carried a higher risk (aOR 4.44, 95% CI 2.77 to 7.11) of infertility compared with women living more than 1000 meters of the lines.

CONCLUSION: The current safety guidelines for electromagnetic fields exposure seems to be not adequate for protecting people from the hazardous effects of the field.

https://www.ncbi.nlm.nih.gov/pubmed/30685773

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Childhood leukemia risk in the California Power Line Study: magnetic fields versus distance from power lines

Catherine M.Crespi, JohnSwanson, Ximena P.Vergara, LeekaKheifets. Childhood leukemia risk in the California Power Line Study: magnetic fields versus distance from power lines.Environmental Research.January 11, 2019. https://doi.org/10.1016/j.envres.2019.01.022.

Highlights
• Magnetic field strength and power line proximity are related but distinguishable
• Childhood leukemia risk was higher only when highly exposed to both
• Factors other than magnetic fields may explain higher leukemia risk near lines

Abstract

Pooled analyses have suggested a small increased risk of childhood leukemia associated with distance and with exposure to high magnetic fields from power transmission lines. Because magnetic fields are correlated with distance from lines, the question of whether the risk is due to magnetic fields exposure or to some other factor associated with distance from lines is unresolved. We used data from a large records-based case-control study to examine several research questions formulated to disentangle the relationships among magnetic fields, distance from high voltage lines, and childhood leukemia risk. In models examining an interaction between distance and magnetic fields exposure, we found that neither close proximity to high voltage lines alone nor exposure to high calculated fields alone were associated with childhood leukemia risk. Rather, elevated risk was confined to the group that was both very close to high voltage lines (<50 m) and had high calculated fields (≥0.4 μT) (odds ratio 4.06, 95% CI 1.16, 14.3). Further, high calculated fields (≥0.4 μT) that were due solely to lower voltage lines (<200 kV) were not associated with elevated risk; rather, risk was confined to high fields attributable to high voltage lines. Whilst other explanations are possible, our findings argue against magnetic fields as a sole explanation for the association between distance and childhood leukemia and in favor of some other explanation linked to characteristics of power lines.

https://www.sciencedirect.com/science/article/pii/S0013935119300258

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Changes over time in the reported risk for childhood leukemia and magnetic fields

Swanson J, Kheifets LI, Vergara X. Changes over time in the reported risk for childhood leukaemia and magnetic fields.
J Radiol Prot. 2019 Feb 8. doi: 10.1088/1361-6498/ab0586.

Abstract

There have been many studies from 1979 to the present reporting raised risks for childhood leukaemia with exposure to power-frequency magnetic fields. There are also suggestions that the reported risk has been decreasing. We examine trends in the risk over time from all available studies. For 41 studies, we combine reported risks using inverse-variance weighting, drawing risk estimates from previous pooled analyses where possible for greater consistency. We examine the cumulative risk for studies published up to each successive calendar year for all studies and for various subsets, and test for a trend over the period. The cumulative relative risk has indeed declined, for our most rigorous analysis from a maximum 2.44 in 1997 to 1.58 in 2017, but not statistically significantly when tested as a linear trend. We find suggestions of higher risks in studies looking at higher exposures and in studies with better quality exposure assessment. We conclude that there is a decline in reported risk from the mid-1990s to now, which is unlikely to be solely explained by improving study quality but may be due to chance, and an elevated risk remains.

https://www.ncbi.nlm.nih.gov/pubmed/30736028

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Weak magnetic fields alter stem cell–mediated growth

Van Huizen AV, Morton JM, Kinsey LJ, Von Kannon DG, Saad MA, Birkholz TR, Czajka JM, Cyrus J, Barnes FS, Beane WS. Weak magnetic fields alter stem cell–mediated growth. Science Advances. 5(1). 30 Jan 2019. DOI: 10.1126/sciadv.aau7201.

Abstract

Biological systems are constantly exposed to electromagnetic fields (EMFs) in the form of natural geomagnetic fields and EMFs emitted from technology. While strong magnetic fields are known to change chemical reaction rates and free radical concentrations, the debate remains about whether static weak magnetic fields (WMFs; <1 mT) also produce biological effects. Using the planarian regeneration model, we show that WMFs altered stem cell proliferation and subsequent differentiation via changes in reactive oxygen species (ROS) accumulation and downstream heat shock protein 70 (Hsp70) expression. These data reveal that on the basis of field strength, WMF exposure can increase or decrease new tissue formation in vivo, suggesting WMFs as a potential therapeutic tool to manipulate mitotic activity.

Open access paper: http://advances.sciencemag.org/content/5/1/eaau7201

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Prenatal exposure to extremely low frequency magnetic field and its impact on fetal growth

Ren Y, Chen J, Miao M, Li DK, Liang H, Wang Z, Yang F, Sun X, Yuan W. Prenatal exposure to extremely low frequency magnetic field and its impact on fetal growth. Environ Health. 2019 Jan 11;18(1):6. doi: 10.1186/s12940-019-0447-9.

Abstract

OBJECTIVE: Studies on the effect of prenatal exposure to magnetic field (MF) on fetal growth is inconclusive and subject to some methodological limitations, particularly in measurement of MF exposure. The present study aimed to examine the association between maternal extremely low frequency MF (ELF-MF) exposure during pregnancy and fetal growth in offspring.

METHODS: A total of 128 pregnant women were recruited at their 3rd trimester and asked to wear an EMDEX Lite meter for 24 h to capture daily ELF-MF exposure. Time-weighted average (TWA), P50, and P75 of personal 24-h measurements were used to evaluate prenatal ELF-MF exposure. The medians of these measurements were used as cut-off points of high and low prenatal ELF-MF exposure. Fetal growth was measured by infant's birth weight, skinfold thickness of triceps, abdomen, and back, and circumference of head, upper arm, and abdomen. These measures were conducted within 24-h after birth. Generalized Linear Model was used to examine the association between maternal ELF-MF level and fetal growth indices after potential confounders were adjusted for.

RESULTS: Compared with girls with lower prenatal ELF-MF exposure, girls with higher exposure had a lower birth weight, thinner skinfold of triceps, abdomen and back, and smaller circumference of head, upper arm and abdomen in all three ELF-MF matrices. The differences were statistically significant for birth weight and most other growth measurements ($P < 0.05$). These measures had no significant difference between higher and lower prenatal ELF-MF exposure in boys except back skinfold thickness.

CONCLUSION: Prenatal exposure to higher ELF-MF levels was associated with decreased fetal growth in girls, but not in boys.

Open access paper: https://ehjournal.biomedcentral.com/articles/10.1186/s12940-019-0447-9

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The role of toxic stimuli combinations in determining safe exposure limits

Kostoff RN, Goumenou M, Tsatsakis A. The role of toxic stimuli combinations in determining safe exposure limits. Toxicol Rep. 2018 Nov 7;5:1169-1172. doi: 10.1016/j.toxrep.2018.10.010.

Abstract

This editorial addresses the effects of toxic stimuli combinations on determination of safe Exposure Limits. Examination of thousands of Medline abstracts showed typically that combinations of toxic stimuli can produce damage even when the exposure level of each member of the combination is less than the lowest exposure level of the member that produced damage when tested in isolation. The synergy of the toxic stimuli in combination means less of each component stimulus is required to cause damage compared to exposure levels when tested in isolation. This Editorial concludes there is no reason to believe today that the Exposure Limits on potentially toxic stimuli that have been set by the regulatory agencies are fully protective against serious adverse health effects in all real life exposure scenarios. The conclusion is applicable to essentially all potential contributing factors to disease amenable to Exposure Limits, including not only chemicals but other types of exposures such as radiofrequency radiation (RFR).

Open access paper: https://www.sciencedirect.com/science/article/pii/S221475001830622X?via%3Dihub

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Public health and the radio frequency radiation emitted by cellphone technology, smart meters and WiFi

Pockett S. Public health and the radio frequency radiation emitted by cellphone technology, smart meters and WiFi. New Zealand Medical Journal. 131(1487):97-107. Dec 14, 2018.

Abstract

This paper argues that the prevailing official narrative in New Zealand concerning the relationship between public health and the radio frequency emissions (RF) from cellphone technology, WiFi and electricity smart meters is scientifically and ethically flawed. The main regulatory document in the area, NZS2772.1:1999, is 20 years out of date and ignores existing laboratory evidence disproving its core assumption that the only biological effect of non-ionising radiation is tissue heating. This and further laboratory evidence for harmful effects of RF continues to be ignored, nominally on the contradictory grounds that (a) cellphone manufacturers say their products now emit less RF than early models, so early lab studies exposed tissue to RF levels higher than those now relevant (b) given the lack of actual data on population exposures either then or now, all laboratory evidence is unconvincing anyway. The offical narrative further opines that since there exist both laboratory and epidemiological studies concluding that RF is not biologically harmful, as well as studies concluding that RF is harmful, the appropriate response is to count up the number on each side, declare the "weight of evidence" to be such that "causation is not proven" and, pending unspecified further studies, continue exposing to unmonitored levels of RF the entire population of the country, none of whom has given informed consent to participate in the experiment. This approach is obviously unethical. It is also unacceptable

scientifically. First, the algebraic model is flawed: studies that do find a harmful effect of RF are not invalidated by differently constructed studies that fail to find an effect. Secondly, while causation is relatively easy to study in the laboratory, it is difficult if not impossible to prove epidemiologically, given that (1) the very narrative under discussion has ensured that there is now no unexposed control group and (2) interpretation of timeline correlation studies is hampered by changes in the way new cancer registrations have been recorded over the years and the perennial problem of multiple possible causal factors. The present paper concludes that a precautionary approach is justified, and ends with a number of specific suggestions on how to start implementing such an approach.

https://www.ncbi.nlm.nih.gov/pubmed/30543616

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Importance of Exposure Duration and Metrics on Correlation between RF Energy Absorption and Temperature Increase in a Human Model

Cavagnaro M, Lin J. Importance of exposure duration and metrics on correlation between RF energy absorption and temperature increase in a human model. IEEE Transactions on Biomedical Engineering. Dec 12, 2018. DOI: 10.1109/TBME.2018.2886475

Abstract

Objective: This study investigated the influence of absorption metrics and averaging schemes on correlation between RF/microwave energy and induced temperature elevation for plane wave exposures. Methods: A voxel-based, anatomically realistic model of the human body was considered. Correlation of electromagnetic fields and temperature increases were evaluated at several frequencies. Both Specific Absorption Rate (SAR) and Volume Absorption Rate (VAR) were considered. Results: The best correlation with temperature increase occurs for exposure durations between 1 and 2 min both for SAR and VAR for most of the 700- to 2700-MHz frequencies considered. In this case, a 1-g mass or 1-cm3 volume appears to be optimal. However, for VAR, as frequency increases to above 900 MHz, a better correlation is achieved at slightly increased exposure times and volumes. For longer exposures, the maximum correlation coefficient is reduced, and the correlation favors larger averaging mass or volume. At steady-state (30 min), correlation of temperature increase with SAR is maximum for a mass of 9 g for all frequencies considered, whereas the volume for VAR maximum correlation is 15 cm3 for higher frequencies and 20 cm3 for lower frequencies. Conclusions: In general, SAR provides a better correlation with temperature compared to VAR for short exposures, while VAR renders better correlations for higher frequencies and longer exposures. Significance: The correlation between electromagnetic absorption and temperature increases has implications in guidelines for limiting human exposure to electromagnetic fields and in biomedical applications such as imaging, sensing, and hyperthermia.

https://ieeexplore-ieee-org.libproxy.berkeley.edu/document/8573824

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Characterizing radiated power in near field of a phone operating in 3G+ and 4G+ communication standards

Sârbu A, Bechet A, Bălan T, Robu D, Bechet P, Simona Miclăuș S.Using CCDF statistics for characterizing the radiated power dynamics in the near field of a mobile phone operating in 3G+ and 4G+ communication standards. Measurement. 134:874-887. February, 2019. https://doi.org/10.1016/j.measurement.2018.12.018.

Highlights

• Near field radiated power density measured by both E and H field probes.
• Real life operating situations considered for correct exposure assessment.
• Highest exposure expected at using 4G+ as compared to 3G+.
• CCDF measurements provide realistic representation of user exposure profiles.

Abstract

In this article, an original method to assess the radiated power density of the near field in the immediate vicinity of mobile terminals using both electric and magnetic field strengths determination is proposed. The complementary cumulative distribution function (CCDF) is used for the first time to assess exposure. A demonstration of the CCDF's capabilities for providing a realistic representation of different wireless communication usage profiles is provided. Following the methodology description, an experimental setup was designed and a measurement campaign was conducted on a mobile terminal. The exposure assessment was performed for real life operating situations by selecting seven common application services used by mobile subscribers.

For 4G+ communication technologies the near field power density is the highest during file upload, followed by VoIP, video call, file download, streaming services and browsing. For 3G+ networks the higher to lower power density values were associated with: file upload, file download, streaming, VoIP, video call and browsing services. The total near field radiated power density was found to be on average 34 times higher for the tested applications running in the 4G+ as compared to the 3G+, with values ranging from 180 times - during file upload, down to 1.2 times - during video streaming. Significantly higher radiated power densities were emitted while using VoIP and video call on 4G+ network as compared to 3G+ network. Present results strongly suggest that higher exposure is expected for the same application running under 4G+ rather than under 3G+.

By applying an original procedure, it has been experimentally highlighted that different generations of communication technologies will lead to different exposure shapes in amplitude and in time, suggesting a future need for introducing the dose rate quantification.

http://www.sciencedirect.com/science/article/pii/S0263224118311631

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SAR and temperature elevation in human head due to overexposure to mobile phone radiation with different usage patterns

Bhargava D, Leeprechanon N, Rattanadecho P, Wessapan T. Specific absorption rate and temperature elevation in the human head due to overexposure to mobile phone radiation with different usage patterns. International Journal of Heat and Mass Transfer. 130:1178-1188. March, 2019.
https://doi.org/10.1016/j.ijheatmasstransfer.2018.11.031

Highlights
• The distribution parameters in tissues are significantly influenced by the considered cases.
• The temperature increase in the head tissues are lower to cause any thermal damage.
• The resultant SAR values in head models for some cases exceed the ICNIRP 2 W/kg exposure limit.

Abstract

Accidental overexposure to non-standard mobile phone radiation can occur in many situations. The overpower limit of mobile phone radiation interacts with the human body which could result in an adverse effect on human health. It is envisaged that the severity of the physiological effect can take place with small temperature increase in the delicate organs or tissues such as eyes, brain, skin, etc. However, the resulting thermo-physiological response of the body tissues to overpower limit of mobile phone radiation is still not well implemented. The aim of this study is to analyze the effect of overexposure of mobile phone radiation on the

specific absorption rate (SAR) and temperature increase in three-dimensional heterogeneous human head models. The study focuses attention on the differences in the electromagnetic (EM) absorption characteristics with higher power level among different usage pattern. The effect of three different usage patterns - voice calling, video calling, and texting- on SAR and temperature distributions in different types of head tissues is systematically investigated. This paper also investigates the effects of different user ages, radiated powers, and gap distances between mobile phone and human heads, on SAR and temperature distributions. Results obtained from this analysis considering the safety guidelines show a high impact of mobile phone radiation in the voice calling position. Hence, comparisons of the absorption of mobile phone radiation are calculated between an adult and a 7-year-old child head model, for the voice calling position at different gap distances. In addition, the results indicate that child head always has a higher absorption rate of mobile phone radiation than the adult head. The rate of absorption in tissue increases as the distance between mobile phone and head decreases and the radiated power increases, depending on their dielectric and thermal properties. The obtained results can be helpful in determining exposure limits for the power output of the mobile phone, and the distance a user should maintain from the mobile phone in thermo-physiological aspects.

Conclusion

The paper investigates the increase in SAR and temperature in anatomical human head models of child and adult in overexposure situations. The comparison of the three different mobile phone usage patterns is studied when the head models are exposed to mobile phone radiation at 900 MHz frequency and 5 W radiating power. The study also includes a comparison of the distribution parameters in child and adult heads, effect of different gap distances and radiated powers. The results show that among all the cases, the SAR and temperature increase are found to be highest in the voice calling case for 0.5 cm gap distance and 5 W radiated power. Also, it is evident from the results that the SAR and temperature increase in the tissues do not directly correspond to each other but are related to the physical parameters of biological tissues such as thermal conductivity, dielectric properties, blood perfusion rate, etc. This shows the importance of performing transient thermal analysis along with the dosimetry analysis to clearly understand the interaction between mobile phone radiation and human tissues. Comparing to the ICNIRP exposure limit, the resulting SAR values in skin layer, in voice and video calling cases, are found to exceed the exposure limit. But, comparing the temperature increase in the brain, it does not approach the possible physiological damage.

This study shows the concern regarding the non-standard mobile phone devices which may be harmful to human health from excessive radiation power. Moreover, the obtained results from the study also show that the children are more exposed and have a greater possibility of a serious adverse effect than the adult when exposed to mobile phone radiation.

http://www.phadungsak.me.engr.tu.ac.th/downloads/2019-01%20%20inter%20J%20heat&mass%20transfer.pdf

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Mobile phone users and its effect of hearing in terms of distortion product otoacoustic emission

Kumar G, Gupa N, Sinha NK. Mobile phone users and its effect of hearing in terms of distortion product otoacoustic emission (DPOAE). Journal of Evolution of Medical and Dental Sciences. 7(52):5520-5523. Dec. 24, 2018. DOI:10.14260/jemds/2018/1222.

Abstract

BACKGROUND Cellular phones/ mobile phones are the new addiction in today's society. They can do pretty much everything from making calls to controlling remotely located devices/cameras. Mobile phones, owing to their user-friendly interface and reasonable prices are being used by people from every socioeconomic section and almost all the age groups. Such a rampant use of these devices makes them potentially powerful tools. The convenience, that these devices offer, easily overlooks the cost our health has to pay because of their

continuous and prolonged use. The main technology that these devices use nowadays is Global System for Mobile Communications (GSM). Mobile phones emit a pulsed high-frequency electromagnetic (EM) field that may have adverse effects. The disturbances of the mechanoelectrical transduction during cellular phone use, especially because there is a close proximity of the cellular phone to the cochlea resulting in a fairly high absorption rate of the incident electromagnetic field (EM).
Aim - To assess hearing loss in mobile phone users.

MATERIALS AND METHODS This is a descriptive study conducted among mobile phone users in the Department of ENT at T.S. Misra Medical College and Hospital from January 2017 to June 2018 consisting of 190 healthy volunteers between the age of 21 and 50 years.

RESULTS Mostly in Rt. handed mobile user had shown Refer/Fail OAE 21%, out of which, higher frequency 6 KHz is affected more in comparison of all four frequency of (2, 3, 4 & 6 KHz).

CONCLUSION The study concludes that the use of mobile phones can cause damage to the Outer Hair Cells (OHCs) in the Cochlea especially in the basal turn which may impair hearing in long term use. Oto Acoustic Emissions from the cochlea can reliably detect this damage and thus has proven to be an excellent diagnostic tool.

https://jemds.com/abstract.php?at_id=16414

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Post-normal science and the management of uncertainty in bioelectromagnetic controversies

Wood AW. Letter: Post-normal science and the management of uncertainty in bioelectromagnetic controversies. Bioelectromagnetics. January 7, 2019.

No abstract.

https://www.ncbi.nlm.nih.gov/pubmed/30615800

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Cell phone radiation changes corticotrophin hormone levels & histology of brain and adrenal glands in male rats

Shahabi S, Hassanzadeh Taji I, Hoseinnezhaddarzi M, Mousavi F, Shirchi S, Nazari A, Zarei H, Pourabdolhossein F. Exposure to cell phone radiofrequency changes corticotrophin hormone levels and histology of the brain and adrenal glands in male Wistar rat. Iran J Basic Med Sci. 2018 Dec;21(12):1269-1274. doi: 10.22038/ijbms.2018.29567.7133.

Abstract

Objectives: Nowadays, the electromagnetic field-emitting devices are used routinely in our lives. Controversial reports exist concerning the effects of mobile radiofrequency (RF) on different parts of the body, especially stress hormones. The main goal of the present work was to study the long-term effects of mobile RF900 MHz exposure with special focus on the adrenal gland pathophysiology and function.

Materials and Methods: Adult male Wistar rats were exposed to mobile RF 6 hr daily for 4-8 weeks. Intact and switched-off exposed animals were considered as controls. Plasma ACTH and cortisol levels were measured by the ELISA method. At the end of the experiment, a histological study was done on adrenal gland and brain tissues by hematoxylin and eosin staining. The thickness of the fasciculate layer of the adrenal gland, and its cell count and perimeter were measured using the Fiji software.

Results: Enhanced plasma ACTH and cortisol levels were found after prolonged exposure to mobile RF. The fasciculata layer of adrenal cortex eventually thickened following mobile RF radiation. While the number of cells in zona fasciculata remained constant, the cell size and perimeter increased during RF exposure. Finally, we found that vacuolization in brain tissue and the number and size of vacuoles considerably increased during two months of RF exposure.

Conclusion: Cell phone RF exposure induced significant hormonal and structural changes in adrenal gland and brain tissues. Therefore, the public should be aware and limit their exposure as much as possible.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6312682/

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Role of Mitochondria in the Oxidative Stress Induced by EMF: Focus on Reproductive Systems

Santini SJ, Cordone V, Falone S, Mijit M, Tatone C, Amicarelli F, Di Emidio G. Role of mitochondria in the oxidative stress induced by electromagnetic fields: Focus on reproductive systems. Oxid Med Cell Longev. 2018 Nov 8;2018:5076271. doi: 10.1155/2018/5076271.

Abstract

Modern technologies relying on wireless communication systems have brought increasing levels of electromagnetic field (EMF) exposure. This increased research interest in the effects of these radiations on human health. There is compelling evidence that EMFs affect cellphysiology by altering redox-related processes. Considering the importance of redox milieu in the biological competence of oocyte and sperm, we reviewed the existing literature regarding the effects of EMFs on reproductive systems. Given the role of mitochondria as the main source of reactive oxygen species (ROS), we focused on the hypothesis of a mitochondrial basis of EMF-induced reproductive toxicity. MEDLINE, Web of Science, and Scopus database were examined for peer-reviewed original articles by searching for the following keywords: "extremely low frequency electromagnetic fields (ELF-EMFs)," "radiofrequency (RF)," "microwaves," "Wi-Fi," "mobile phone," "oxidative stress," "mitochondria," "fertility," "sperm," "testis," "oocyte," "ovarian follicle," and "embryo." These keywords were combined with other search phrases relevant to the topic. Although we reported contradictory data due to lack of uniformity in the experimental designs, a growing body of evidence suggests that EMF exposure during spermatogenesis induces increased ROS production associated with decreased ROS scavenging activity. Numerous studies revealed the detrimental effects of EMFs from mobile phones, laptops, and other electric devices on sperm quality and provide evidence for extensive electron leakage from the mitochondrial electron transport chain as the main cause of EMF damage. In female reproductive systems, the contribution of oxidative stress to EMF-induced damages and the evidence of mitochondrial origin of ROS overproduction are reported, as well. In conclusion, mitochondria seem to play an important role as source of ROS in both male and female reproductive systems under EMF exposure. Future and more standardized studies are required for a better understanding of molecular mechanisms underlying EMF potential challenge to our reproductive system in order to improve preventive strategies.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6250044/

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Electric field distribution and SAR inside a human eye exposed to Virtual Reality glasses

Cvetkovic N, Krstic, D, Stankovic V, Jovanovic D. Electric field distribution and SAR inside a human eye exposed to VR glasses. IET Microwaves Antennas & Propagation. 12(14):2234-2240. DOI: 10.1049/iet-map.2018.5227. Nov 28, 2018

Abstract

The aim of this study is a numerical analysis of the electric field and the specific absorption rate (SAR) distribution within a realistic 3D-human eye model exposed to electromagnetic (EM) wave of virtual reality (VR) glasses at the frequency of third generation, long-term evolution-4G, and the frequency of the latest generation of mobile networks - 5G. To obtain the values of the electric field and SAR, the numerical solution of equations of EM waves propagation has been used. A new realistic 3D-human head and human eye model has been created. The obtained results are shown for different biological tissues of the eye exposed to EM radiation from VR glasses at different frequencies. The maximum absorption of EM energy will be discussed for the following frequencies: 900MHz, 2.6GHz, and 28GHz. The maximum values of electric field strength in the human eye tissue at the frequencies 28GHz and 900MHz are 94.43 and 137.3V/m, respectively (higher than referent values), whereas for 2.6GHz amounts 8.62V/m (lower than referent limits). The obtained SAR peaks do not overcome prescribed safety values.

https://digital-library.theiet.org/content/journals/10.1049/iet-map.2018.5227

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A novel mobile phone antenna for effectively reducing specific absorption rate

He Y, Liang K, Li J, Abbasi QH. A novel mobile phone antenna for effectively reducing specific absorption rate. 12th European Conference on Antennas and Propagation (EuCAP 2018). 9-13 April 2018. Added to IEEE Xplore: 10 December 2018. DOI: 10.1049/cp.2018.1234.

Abstract

In this paper, a novel mobile phone antenna that can effectively reduce the harm of electromagnetic radiation to the human body is proposed. An inverted F-shaped antenna (IFA) is designed to reduce specific absorption rate (SAR) and all the measurements are done in over the air (OTA) test system. Measured results show that the proposed mobile phone antenna has excellent electrical characteristics such as reflection coefficient (700–870 MHz and 1710–2450 MHz), radiation pattern, total radiation power (TRP >17.5 dBm), hot spot map and low SAR values (< 1.4 W/kg). Due to these advantages, the proposed antenna is used to reduce SAR in the future mobile phone.

Excerpts

With the significant development of the mobile communication system, mobile phones have become indispensable tools for human daily life. Meanwhile, the number of the mobile phone has increased with an unprecedented rate around the globe including China. Since the three operators fully started 4G business in 2014, more and more users began to pay attention to and select 4G mobile phones with the reduction of 4G fees in 2015. When we make phone calls, the antenna is close to the human's face, and its microwave radiation directly affects the human's head. It will have a negative effect on the human body when the microwave signal power absorbed by the body exceeds the limiting value [1], [2]. Since its damage to human health is long and chronic, many domestic and foreign companies and institutions at present are studying how to keep mobile phones at a suitable level for human radiation [3].

A novel mobile phone antenna with lower SAR values is presented in this paper. By changing the routing of antenna on a mobile phone, it can increase the new amplitude wave to disperse the current peak, so that a new band (LTE band 30) can be obtained. Measured results show that the proposed antenna is simple and effective with wide bandwidths (700-870 MHz and 1710-2450 MHz), stable TRP (17.5-19.4 dBm) and lower SAR values (0.4-1.38 W/kg). In addition, the proposed antenna has lots of advantages, including low cost, compact structure, good stability, as well as easiness for fabrication. The proposed antenna can be a new solution in reducing mobile phone SAR values for modern mobile communication systems.

https://ieeexplore.ieee.org/document/8568912

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Mobile Phone Base Station Tower Settings Adjacent to School Buildings: Impact on Students' Cognitive Health.

Meo SA, Almahmoud M, Alsultan Q, Alotaibi N, Alnajashi I, Hajjar WM. Mobile phone base station tower settings adjacent to school buildings: Impact on students' cognitive health. Am J Mens Health. 2018 Dec 7:1557988318816914. doi: 10.1177/1557988318816914.

Abstract

The use of mobile phones has remarkably increased and become a basic need of daily life. Increasing subscriptions of mobile phones boost the installation of mobile phone base station towers (MPBSTs) in crowded commercial and residential areas including near school buildings. This study investigated the impact of exposure to radiofrequency electromagnetic field (RF-EMF) radiation generated by MPBSTs on cognitive functions. Two hundred and seventeen volunteer male students aged between 13 and 16 registered from two different intermediate schools: 124 students were from School 1 and 93 students were from School 2. The MPBSTs were located within 200 m from the school buildings. In School 1, RF-EMF was 2.010 μW/cm2 with a frequency of 925 MHz and in School 2, RF-EMF was 10.021 μW/cm2 with a frequency of 925 MHz. Students were exposed to EMFR for 6 hr a day, 5 days a week for a total period of 2 years. The Narda Safety Test Solution device SRM-3006 was used to measure RF-EMF in both schools, and cognitive functions tasks were measured by the Cambridge Neuropsychological Test Automated Battery (CANTAB). Significant impairment in Motor Screening Task (MOT; p = .03) and Spatial Working Memory (SWM) task (p = .04) was identified among the group of students who were exposed to high RF-EMF produced by MPBSTs. High exposure to RF-EMF produced by MPBSTs was associated with delayed fine and gross motor skills, spatial working memory, and attention in school adolescents compared to students who were exposed to low RF-EMF.

https://www.ncbi.nlm.nih.gov/pubmed/30526242

Note: In this cross-sectional study, students in two schools that are exposed to different amounts of microwave radiation from nearby cell towers were compared at one time. In my opinion, the authors did not adequately control for confounding that may explain the observed differences between the two groups of students. Also, the statistical tests are problematic because the students within each school are not independent of each other which the tests assume. Hence, I would not cite this study as evidence of cell tower effects.

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Oxidative and mutagenic effects of low intensity GSM 1800 MHz microwave radiation

Yakymenko I, Burlaka A, Tsybulin I, Brieieval, Buchynska L, Tsehmistrenko I, Chekhun F. Oxidative and mutagenic effects of low intensity GSM 1800 MHz microwave radiation. Exp Oncol. 2018 Dec;40(4):282-287.

Abstract

AIM: Despite a significant number of epidemiological studies on potential carcinogenicity of microwave radiation (MWR) from wireless devices and a bulk of experimental studies on oxidative and mutagenic effects of low intensity MWR, the discussion on potential carcinogenicity of low intensity MWR is going on. This study aims to assess oxidative and mutagenic effects of low intensity MWR from a typical commercial model of a modern smartphone.

MATERIALS AND METHODS: The model of developing quail embryos has been used for the assessment of

oxidative and mutagenic effects of Global System for Mobile communication (GSM) 1800 MHz MWR from a commercial model of smartphone. The embryos were exposed in ovo to 0.32 μW/cm2, discontinuously - 48 s - On, 12 s - Off, during 5 days before and 14 days through the incubation period.

RESULTS: The exposure of quail embryos before and during the incubation period to low intensity GSM 1800 MHz has resulted in expressive statistically significant oxidative effects in embryonic cells, including a 2-fold increase in superoxide generation rate and 85% increase in nitrogen oxide generation rate, damages of DNA integrity and oxidative damages of DNA (up to twice increased levels of 8-oxo-dG in cells of 1-day old chicks from the exposed embryos). Finally, the exposure resulted in a significant, almost twice, increase of embryo mortality.

CONCLUSION: The exposure of model biological system to low intensity GSM 1800 MHz MWR resulted in significant oxidative and mutagenic effects in exposed cells, and thus should be recognized as a significant risk factor for living cells.

https://www.ncbi.nlm.nih.gov/pubmed/30593748

Excerpt

These findings are in line with our previous research data [8, 14, 24, 25] and data from the other laboratories over the world on expressive oxidative and mutagenic effects of low intensity MWR exposure [18, 26–28]. A huge pathogenic potential of oxidative stress in the cell, including its role in carcinogenesis [29, 30], allowed us to hypothesize that overproduction of free radical species, namely superoxide and nitrogen oxide, in MWR exposed living cells is one of the key mechanisms for the next pathological transformation of cells [24]. The persistent oxidative damages of DNA could be a first step of mutagenic and carcinogenic processes [30]. Thus oxidative damages of DNA resulted in alters of transcription rate, replication errors and genomic instability [31]. In turn these processes are associated with carcinogenesis. And in different cancer tissues, an increased level of oxidative damages of DNA were reported [30].

Recently we have demonstrated that oxidative effects of low intensity MWR significantly depend on the GSM modulation of the signal [25]. Thus, except of urgent necessity to reevaluate current out-of-date official safety limits on RFR/MWR intensity, additional biologically proven restrictions on different types of modulated signals should be elaborated and implemented by international and national regulatory bodies.

In conclusion, statistically significant persistent oxidative and mutagenic effects in model biological system, a developing quail embryo, as well as significantly increased embryo mortality have been detected under low intensity GSM 1800 MHz MWR from a typical modern commercial smartphone. Thus the data confirm that modulated MWR from modern wireless devices should be recognized as a significant risk factor for living cells, and out-of-date official safety limits should be urgently reevaluated in line with current biological research on the issue.

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Pathological Findings Observed in Kidneys of Postnatal Male Rats Exposed to 2100 MHz EMF

Bedir R, Tumkaya L, Mercantepe T, Yilmaz A. Pathological findings observed in the kidneys of postnatal male rats exposed to the 2100 MHz electromagnetic field. Arch Med Res. 2018 Dec 29. pii: S0188-4409(18)30433-8. doi: 10.1016/j.arcmed.2018.12.010.

Abstract

BACKGROUND: The widespread use by young people of modern communication devices such as mobile phones means that they are particularly exposed to electromagnetic fields (EMF) and other problems. However, few studies have researched the effects of long-term exposure to EMF in the kidney. We therefore

investigated oxidative stress and apoptosis in long-term exposure to 2100 megahertz (MHz) in a rat model.

MATERIALS AND METHODS: Twenty-four Sprague Dawley rats were divided into a control group (n = 8, no EMF exposure), a group exposed to 2100 MHz for 6 h for 30 d (n = 8), and a group exposed to 2100 MHz for12 h for 30 d (n = 8). Immunohistochemical analysis was performed, using caspase-3 to evaluate apoptosis. Immediately after treatment, reduced glutathione (GSH), malondialdehyde (MDA) in kidney tissue and serum levels of various biochemical compounds were measured to detect oxidative stress.

RESULTS: Deterioration was observed in the brush border in renal tubules of the EMF groups. The results of the immunohistochemical analysis revealed a greater number of positively stained renal tubular epithelial cells in the EMF groups as compared with that in the control group. In the EMF groups, renal MDA levels increased, and renal GSH levels decreased compared with those in the control group, as shown by a biochemical examination (p = 0.00 and p = 0.00, respectively).

CONCLUSION: The findings showed that exposure to 2100 MHz for 6 and 12 h induced oxidative stress-mediated acute renal injury, depending on the length of exposure and dosage.

https://www.ncbi.nlm.nih.gov/pubmed/30600117

Excerpt

The EMF groups were continually exposed to electromagnetic waves produced by an EMF generator (Anritsu MG3670B, Kanagawa, Japan) for 30 d, 6 and 12 h per day. The generator had a signal power of 3.47 mW (5.4 dBm) at 2100 MHz, which is similar to the level experienced in mobile phone talk mode. The whole body specific absorption rate (SAR) was calculated to be 0.024 W/kg ....

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Electromagnetic Fields of Mobile Phone Jammer Exposure on Blood Factors in Rats

Shojaeifard MB, Jarideh S, Owjfard M, Nematollahii S, Talaei-Khozani T, Malekzadeh M. Electromagnetic fields of mobile phone jammer exposure on blood factors in rats. J Biomed Phys Eng. 2018 Dec 1;8(4):403-408.

Abstract

BACKGROUND: The increasing demand for using mobile phones has led to increasing mobile phone jammers as well. On the other hand, reports show that exposure to electromagnetic field causes an increase in the incidence of diseases such as leukemia, cancer, depression and failure in pregnancy outcomes; therefore, the aim of this study is to investigate the effects of exposure to electromagnetic fields of mobile phone jammers on blood factors.

MATERIALS AND METHODS: Thirty male Wistar immature and thirty mature rats were selected randomly and each one was divided into three groups of ten. The control group did not receive any radiation; the sham group was exposed to a switched-off jammer device and the experimental group was exposed to electromagnetic fields (EMF) radiated by Mobile Phone Jammer daily eight hours for five days a week during forty days. Blood sample was taken from heart and blood factors including PLT, MCHC and RDWCV were measured. The data were analyzed by ANOVA which was followed by Duncan's test.

RESULTS: The data from mature rats revealed that jammer usage led to a significant difference in blood factors including RBC, platelet, hemoglobin, hematocrit, MCV and RDWCV ($P \leq 0.05$); however, the number of lymphocytes, WBC and MCVH in the blood was the same in all groups. In immature rats, the exposure to jammer did not change RBC, lymphocyte and WBC count, hemoglobin and hematocrit; while, the platelet count along with MCHC, MVC and RDWCV changed by jammer radiation.

CONCLUSION: The results exhibited that mobile phone jammer caused frequent changes in blood cell factors.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6280113/

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Power frequency EMF exposure influences network connection pattern of local field potentials during working memory

[Article in Chinese]

Li S, Wen X, Sang H, Xu G. [Long term power frequency electromagnetic fields exposure influences the causal network connection pattern of local field potentials during working memory]. Sheng Wu Yi Xue Gong Cheng Xue Za Zhi. 2018 Jun 1;35(6):829-836. doi: 10.7507/1001-5515.201806004.

Abstract

The possible influence of electromagnetic field (EMF) on the function of neural systems has been widely concerned. In this article, we intend to investigate the effects of long term power frequency EMF exposure on brain cognitive functions and it's mechanism. The Sprague-Dawley (SD) rats were randomly divided into 3 groups: the rats in EMF Ⅰ group were placed in the 2 mT power frequency EMF for 24 days. The rats in EMF Ⅱ group were placed in the 2 mT power frequency EMF for 48 days. The rats in control group were not exposed to the EMF. Then, the 16 channel local field potentials (LFPs) were recorded from rats' prefrontal cortex (PFC) in each group during the working memory (WM) tasks. The causal networks of LFPs were also established by applying the directed transfer function (DTF). Based on that, the differences of behavior and the LFPs network connection patterns between different groups were compared in order to investigate the influence of long term power frequency EMF exposure on working memory. The results showed the rats in the EMF Ⅱ group needed more training to reach the task correction criterion (over 80%). Moreover, the causal network connection strength and the global efficiency of the rats in EMF Ⅰ and EMF Ⅱ groups were significantly lower than the corresponding values of the control group. Meanwhile, significant differences of causal density values were found between EMF Ⅱ group and the other two groups. These results indicate that long term exposure to 2 mT power frequency EMF will reduce the connection strength and the information transfer efficiency of the LFPs causal network in the PFC, as well as the behavior performance of the rats. These results may explain the effect of EMF exposure on working memory from the view of neural network connectivity and provide a support for further studies on the mechanism of the effect of EMF on cognition

https://www.ncbi.nlm.nih.gov/pubmed/30583305

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Effect of different intensities of static magnetic field on stress & reproduction in Zebrafish

Sedigh E, Heidari B, Roozati A, Valipour A. The effect of different intensities of static magnetic field on stress and selected reproductive indices of the Zebrafish (Danio rerio) during acute and subacute exposure. Bull Environ Contam Toxicol. 2019 Jan 9. doi: 10.1007/s00128-018-02538-1.

Abstract

The application of equipment and tools that produce a magnetic field is increasing in aquatic ecosystems. In the present study, the effects of acute (1 week) and subacute (3 weeks) exposures to different static magnetic fields (SMFs) of 2.5, 5, 7.5 mT on stress indices (cortisol and glucose), sex steroid hormones (17β-estradiol and 17-α hydroxy progesterone) and fecundity of the zebrafish (Danio rerio) were investigated. The obtained results showed a significant change in cortisol, glucose, 17β-estradiol (E2) and 17-α hydroxy progesterone (17-

OHP) levels by enhancing the intensity and time of exposure to SMFs. In conclusion, the SMFs, especially at higher levels of intensities, showed physiologically harmful effects on the reproductive biology of the zebrafish during acute and subacute exposure.

https://www.ncbi.nlm.nih.gov/pubmed/30627748

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Planetary electromagnetic pollution: it is time to assess its impact

Bandara P, Carpenter DO. Planetary electromagnetic pollution: it is time to assess its impact. The Lancet Planetary Health. 2(12):Pe512-e514, December 01, 2018. https://doi.org/10.1016/S2542-5196(18)30221-3

No abstract

Open access paper: https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(18)30221-3/fulltext

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Cancer epidemiology update, following the 2011 IARC evaluation of radiofrequency electromagnetic fields (Monograph 102)

Miller AB, Morgan LL, Udasin I, Davis DL. Cancer epidemiology update, following the 2011 IARC evaluation of radiofrequency electromagnetic fields (Monograph 102). Environmental Research. 167:673-683. Nov 2018. doi: 10.1016/j.envres.2018.06.043.

Highlights

• Increased risk of brain, vestibular nerve and salivary gland tumors are associated with mobile phone use.
• Nine studies (2011–2017) report increased risk of brain cancer from mobile phone use.
• Four case-control studies (3 in 2013, 1 in 2014) report increased risk of vestibular nerve tumors.
• Concern for other cancers: breast (male & female), testis, leukemia, and thyroid.
• Based on the evidence reviewed it is our opinion that IARC's current categorization of RFR as a possible human carcinogen (Group 2B) should be upgraded to Carcinogenic to Humans (Group 1).

Abstract

Epidemiology studies (case-control, cohort, time trend and case studies) published since the International Agency for Research on Cancer (IARC) 2011 categorization of radiofrequency radiation (RFR) from mobile phones and other wireless devices as a possible human carcinogen (Group 2B) are reviewed and summarized. Glioma is an important human cancer found to be associated with RFR in 9 case-control studies conducted in Sweden and France, as well as in some other countries. Increasing glioma incidence trends have been reported in the UK and other countries. Non-malignant endpoints linked include acoustic neuroma (vestibular Schwannoma) and meningioma. Because they allow more detailed consideration of exposure, case-control studies can be superior to cohort studies or other methods in evaluating potential risks for brain cancer. When considered with recent animal experimental evidence, the recent epidemiological studies strengthen and support the conclusion that RFR should be categorized as carcinogenic to humans (IARC Group 1). Opportunistic epidemiological studies are proposed that can be carried out through cross-sectional analyses of high, medium, and low mobile phone users with respect to hearing, vision, memory, reaction time, and other indicators that can easily be assessed through standardized computer-based tests. As exposure data are not uniformly available, billing records should be used whenever available to corroborate reported exposures.

Synthesis and conclusions

The Epidemiological studies reported since the 2011 IARC Working Group meeting are adequate to consider RFR as a probable human carcinogen (Group 2 A). However, they must be supplemented with the recently reported animal data as performed at the Ramazzini Institute and the US National Toxicology Program as well as by mechanistic studies. These experimental findings together with the epidemiology reviewed here are sufficient in our opinion, to upgrade the IARC categorization of RFR to Group 1, carcinogenic to humans.

It would be useful to know more about the association of additional tumor types such as parotid gland, testicular, breast, hematopoietic malignancies and multiple primaries with RFR. Case studies should continue to be conducted in the absence of a better exposure assessment system to increase awareness and understand the relationship between exposure to RFR and disease causation, as well as trial-error experiments and interventions.

In light of the evolving science concerning mobile phone and screen time exposures and the longer-term risk of cancer established by both epidemiological and toxicological studies, current evidence is strong enough to go from precaution concerning possible risk to prevention of known risks. Although the benefits of connectivity are extremely important, safety considerations demand reconciling use of information vs. risk of perceived rare outcomes. Thus, a concerted program of public and health professional education should be undertaken throughout society explaining current knowledge and devising policies to promote safer technology in partnership with designers of software and hardware. In addition, methods should be developed and validated to reduce exposures in schools, workplaces, hospitals and other workplaces. The precautionary principle should be applied now and suitable warning messages provided to adults and critically to children and their parents. Until technology has been devised that substantially lowers exposures, special efforts should be advanced to ensure that the exposures of children are limited to those deemed essential. Children should be encouraged to text to reduce their exposure to RFR, while every attempt should be made to reduce exposure to RFR in schools, as well as homes.

Research has so far been performed on technologies that have already been introduced, but is critically needed on new, untested technology prior to its use. Epidemiological studies necessarily confirm the impact of past exposures, while experimental studies provide indications of future risk. Thus, experimental evaluations and modeling are essential before distributing newer systems (e.g. 5 G) for which no safety data have been obtained. The absence of systematic testing of such technologies should not be confused with proof of safety. Better modeling through anatomically based systems, such as the Virtual Family, should be encouraged.

In the meantime, the evidence amassed thus far from epidemiology strengthens the case for instituting the precautionary principle with respect to exposures to RFR, especially to young children and men and women that wish to reproduce. The lack of detailed studies at this point reflects a myopic attitude toward the technology that may well prove to be wishful and dangerous thinking. Where studies have been carried out on human sperm quantity and quality there are increasing indications of serious human health impacts. To ignore those findings and subject humans to unevaluated novel RFR frequencies places current and future generations at risk.

https://www.ncbi.nlm.nih.gov/pubmed/30196934

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Modulation of brain functional connectivity by exposure to LTE (4G) cell phone radiation

Wei Y, Yang J, Chen Z, Wu T, Lv B. Modulation of resting-state brain functional connectivity by exposure to acute fourth-generation long-term evolution electromagnetic field: An fMRI study. Bioelectromagnetics. Published online 18 December 2018

Abstract

By now, the neurophysiological effect of electromagnetic field (EMF) exposure and its underlying regulating mechanisms are not well manifested. In this study, we aimed to investigate whether acute long-term evolution (LTE) EMF exposure could modulate brain functional connectivity using regional homogeneity (ReHo) method and seed-based analysis on resting-state functional magnetic resonance imaging (fMRI). We performed the LTE-EMF exposure experiment and acquired the resting-state brain activities before and after EMF exposure. Then we applied ReHo index to characterize the localized functional connectivity and seed-based method to evaluate the inter-regional functional connectivity. Statistical comparisons were conducted to identify the possible evidence of brain functional connectivity modulation induced by the acute LTE-EMF exposure. We found that the acute LTE-EMF exposure modulated localized intra-regional connectivity ($p < 0.05$, AlphaSim corrected, voxel size ≥ 18) and inter-regional connectivity in some brain regions ($p < 0.05$, AlphaSim corrected, voxel size ≥ 18). Our results may indicate that the approaches relying on network-level inferences could provide deeper insight into the acute effect on human functional activity induced by LTE-EMF exposure.

Excerpts

"To eliminate study biases, we employed a double-blind, crossover, randomized, and counterbalanced design. Each participant underwent two experimental sessions including real exposure and sham exposure, which were separated by 1 day….The time-division LTE signal (2.573 GHz) was produced by a signal generator (CMW500, R&S, Munich, Germany) using a standard formulation for LTE signals….The power delivered to the standard dipole of 2.6 GHz (D2600V2, Speag, Zurich, Switzerland) was 24 dBm (mean value), which was equivalent to a theoretical maximal emission by an LTE terminal. The experiments were conducted in a shielding room to avoid the influence of environmental EMF. Each exposure session lasted for 30 min."

"Numerical simulations that yielded spatial peak SAR averaging over 10 g tissues for the subjects was 0.98 ± 0.27 W/kg, with a maximal value of 1.52 W/kg, which was below the safety limits [ICNIRP, 1998]."

"In our previous studies, we found that LTE-EMF exposure depressed the amplitude of spontaneous low frequency fluctuations (ALFFs) in some brain regions [Lv et al., 2014], such as those surrounding the left superior temporal gyrus and middle temporal gyrus (STG_L and MTG_L), right superior temporal gyrus (STG_R), right medial frontal gyrus, and right paracentral lobule (MFG_R and PCL_R). In the present study, we found new evidence that acute LTE-EMF exposures lasting for 30 min modulated brain functional connectivity including not only localized intraregional connectivity, but also interregional connectivity."

"Conclusion. Our results may indicate that approaches relying on network-level inferences can provide deeper insights into the acute effects of LTE-EMF exposure with intensities below the current safety limits on human functional connectivity. In the future, we need to investigate the evolution of the effect over time."

https://onlinelibrary.wiley.com/doi/full/10.1002/bem.22165

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Mobile phone use and incidence of brain tumour histological types, grading or anatomical location: a population-based ecological study

Karipidis K, Elwood M, Benke G, Sanagou M, Tjong L, Croft RJ. Mobile phone use and incidence of brain tumour histological types, grading or anatomical location: a population-based ecological study. BMJ Open. 2018 Dec 9;8(12):e024489. doi: 10.1136/bmjopen-2018-024489.

Strengths and limitations of this study

- This study investigated incidence time trends for different brain tumour histological types, grading and anatomical location over different time periods.

- The study compared the observed brain tumour incidence rates with modelled predicted incidence rates assuming a causal association with mobile phone use.
- Mobile phone subscription data and information from surveys may not accurately represent mobile phone use patterns in adults.

Abstract

OBJECTIVE: Some studies have reported increasing trends in certain brain tumours and a possible link with mobile phone use has been suggested. We examined the incidence time trends of brain tumour in Australia for three distinct time periods to ascertain the influence of improved diagnostic technologies and increase in mobile phone use on the incidence of brain tumours.

DESIGN: In a population-based ecological study, we examined trends of brain tumour over the periods 1982-1992, 1993-2002 and 2003-2013. We further compared the observed incidence during the period of substantial mobile phone use (2003-2013) with predicted (modelled) incidence for the same period by applying various relative risks, latency periods and mobile phone use scenarios.

SETTING: National Australian incidence registration data on primary cancers of the brain diagnosed between 1982 and 2013.

POPULATION: 16 825 eligible brain cancer cases aged 20-59 from all of Australia (10 083 males and 6742 females).

MAIN OUTCOME MEASURES: Annual percentage change (APC) in brain tumour incidence based on Poisson regression analysis.

RESULTS: The overall brain tumour rates remained stable during all three periods. There was an increase in glioblastoma during 1993-2002 (APC 2.3, 95% CI 0.8 to 3.7) which was likely due to advances in the use of MRI during that period. There were no increases in any brain tumour types, including glioma (-0.6, -1.4 to 0.2) and glioblastoma (0.8, -0.4 to 2.0), during the period of substantial mobile phone use from 2003 to 2013. During that period, there was also no increase in glioma of the temporal lobe (0.5, -1.3 to 2.3), which is the location most exposed when using a mobile phone. Predicted incidence rates were higher than the observed rates for latency periods up to 15 years.

CONCLUSIONS: In Australia, there has been no increase in any brain tumour histological type or glioma location that can be attributed to mobile phones.

EXCERPT: In conclusion, we found no evidence that mobile phone use increased any brain tumour histological types or subtypes. There was an increase in the incidence of glioblastoma prior to the rapid increase in mobile phone use which was most likely due to improved diagnosis from MRI. Furthermore, there was no increase in gliomas of the temporal lobe, which is the most exposed location, during the period of substantial mobile phone use. The increase in gliomas of the temporal lobe and decrease in gliomas of unspecified location during the periods prior to substantial mobile phone use are in line with the theory of improved diagnosis from CT and MRI. Further, the predicted rates were higher than the observed rates for latency periods up to 15 years. These results do not support an association between mobile phone use and brain tumour, although the possibility of a small risk or a latency period of more than 15 years cannot be excluded. Future research should continue to investigate trends in brain tumour histological types, grading and anatomical location for a possible increase with a longer latency period.

Open access paper: https://bmjopen-bmj-com.libproxy.berkeley.edu/content/8/12/e024489.long

Note: This paper has significant methodological problems. Following are some of Alasdair Philips' comments about the paper:

Omitting the older age groups is not justifiable. Stopping at age 59 misses out the main age–group with the largest rise in glioblastomas. (See my paper: **https://www.hindawi.com/journals/jeph/2018/7910754/**) and especially the linked Letter to the Editor and the Supplementary file.) Few of the Interphone studies had people over 60 and those that did, did not have a representative number of people over 60, the population with the most people who have used cellphones for the longest cumulative time period

The tumor incidence data in this paper was age-standardized to the World Standard population which does not reasonably match the current age spectrum of higher income countries. The 65-74 age group population in Australia grew from 1.3 million in 2001 to 2.2 million in 2017, so even the Australian Standard Population (2001) is no longer appropriate.

Tables 2 and 3 use all topographical regions and all ages 20-59. This will greatly reduce any rise (see my paper) that occurs in the 50-59 year olds.

Better imaging for glioblastoma made little difference to diagnosing a glioblastoma as it an aggressive tumor; hardly anyone survives 3 years from initial diagnosis.

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Possible Effects of RF EMF Exposure on Central Nervous System

Kim JH, Lee JK, Kim HG, Kim KB, Kim HR. Possible effects of radiofrequency electromagnetic field exposure on central nerve system. Biomol Ther (Seoul). 2018 Nov 27. doi: 10.4062/biomolther.2018.152.

Abstract

Technological advances of mankind, through the development of electrical and communication technologies, have resulted in the exposure to artificial electromagnetic fields (EMF). Technological growth is expected to continue; as such, the amount of EMF exposure will continue to increase steadily. In particular, the use-time of smart phones, that have become a necessity for modern people, is steadily increasing. Social concerns and interest in the impact on the cranial nervous system are increased when considering the area where the mobile phone is used. However, before discussing possible effects of radiofrequency-electromagnetic field (RF-EMF) on the human body, several factors must be investigated about the influence of EMFs at the level of research using in vitro or animal models. Scientific studies on the mechanism of biological effects are also required. It has been found that RF-EMF can induce changes in central nervous system nerve cells, including neuronal cell apoptosis, changes in the function of the nerve myelin and ion channels; furthermore, RF-EMF act as a stress source in living creatures. The possible biological effects of RF-EMF exposure have not yet been proven, and there are insufficient data on biological hazards to provide a clear answer to possible health risks. Therefore, it is necessary to study the biological response to RF-EMF in consideration of the comprehensive exposure with regard to the use of various devices by individuals. In this review, we summarize the possible biological effects of RF-EMF exposure.

Open access paper: http://www.biomolther.org/journal/view.html?uid=1032&vmd=Full

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Cellular Phone Irradiation of the Head Affects Heart Rate Variability Depending on Inspiration/Expiration Ratio

Béres S, Németh Á, Ajtay Z, Kiss I, Németh B, Hejjel L. Cellular Phone Irradiation of the Head Affects Heart Rate Variability Depending on Inspiration/Expiration Ratio.

In Vivo. 2018 Sep-Oct;32(5):1145-1153. doi: 10.21873/invivo.11357.

Abstract

BACKGROUND: Mobile phones may have harmful health effects and clinical examinations report ambiguous results of exposure concerning neurophysiological and cardiovascular actions.

MATERIALS AND METHODS: This study investigated heart rate asymmetry (HRA) and heart rate variability (HRV) parameters with 1:2 and 1:1 metronome-paced inspiration/expiration ratios during short-term 1,800MHz GSM cellular phone exposure in 20 healthy volunteers.

RESULTS: Significant HRA changes by Porta and Guzik indices were not found on exposure compared to sham exposure. Time-domain HRV parameters on exposure showed significant differences at 1:1 paced, but not at 1:2 paced breathing compared to sham exposure. A mild post-exposure effect was observed regarding root mean square of successive RR-differences.

CONCLUSION: The findings reflect persisting acute effects of GSM handset emission on the autonomic nervous system. Exploring its influences on health status and survival needs further studies. Symmetrical breathing can be used as a sensitizing factor in other HRV/HRA analysis studies.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6199582/

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LiFi is a paradigm-shifting 5G technology

Haas H. LiFi is a paradigm-shifting 5G technology. Reviews in Physics. 3:26-31. Nov 2018. https://doi.org/10.1016/j.revip.2017.10.001

Abstract

In this paper we will first explain what Light-Fidelity (LiFi) is and argue that it is a 5th Generation (5G) technology. Peak transmission speeds of 8 Gbps from a single light source have been demonstrated, and complete cellular networks based on LiFi have been created. We will discuss numerous misconceptions and illustrate the potential impact this technology can have across a number of existing and emerging industries. We also discuss new applications which LiFi can unlock in the future.

Open access paper: https://www.sciencedirect.com/science/article/pii/S2405428317300151

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Shielding effects of myelin sheath on axolemma depolarization under transverse electric field stimulation

Ye H, Ng J. Shielding effects of myelin sheath on axolemma depolarization under transverse electric field stimulation. PeerJ. 2018 Dec 3;6:e6020. doi: 10.7717/peerj.6020.

Abstract

Axonal stimulation with electric currents is an effective method for controlling neural activity. An electric field parallel to the axon is widely accepted as the predominant component in the activation of an axon. However,

recent studies indicate that the transverse component to the axolemma is also effective in depolarizing the axon. To quantitatively investigate the amount of axolemma polarization induced by a transverse electric field, we computed the transmembrane potential (Vm) for a conductive body that represents an unmyelinated axon (or the bare axon between the myelin sheath in a myelinated axon). We also computed the transmembrane potential of the sheath-covered axonal segment in a myelinated axon. We then systematically analyzed the biophysical factors that affect axonal polarization under transverse electric stimulation for both the bare and sheath-covered axons. Geometrical patterns of polarization of both axon types were dependent on field properties (magnitude and field orientation to the axon). Polarization of both axons was also dependent on their axolemma radii and electrical conductivities. The myelin provided a significant "shielding effect" against the transverse electric fields, preventing excessive axolemma depolarization. Demyelination could allow for prominent axolemma depolarization in the transverse electric field, via a significant increase in myelin conductivity. This shifts the voltage drop of the myelin sheath to the axolemma. Pathological changes at a cellular level should be considered when electric fields are used for the treatment of demyelination diseases. The calculated term for membrane polarization (Vm) could be used to modify the current cable equation that describes axon excitation by an external electric field to account for the activating effects of both parallel and transverse fields surrounding the target axon.

Open access paper: https://peerj.com/articles/6020/

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Effect of antenna polarization & body morphology on measurement uncertainty of wearable multi-band distributed exposure meter

Aminzadeh R, Thielens A, Agneessens S, et al. The effect of antenna polarization and body morphology on the measurement uncertainty of a wearable multi-band distributed exposure meter. Ann. Telecommun. Dec 2018.

Abstract

This paper studies the effect of antenna polarization on measurement uncertainty of a multi-band body-worn distributed exposure meter (BWDM). The BWDM is a device for assessing electromagnetic fields in real environments accurately. The BWDM consists of 8 nodes and is calibrated on the body for simultaneous measurement of the incident power density in four frequency bands. Each node contains an antenna that can have two potential antenna polarizations.The BWDM is calibrated on four human subjects in an anechoic chamber to determine its measurement uncertainty in terms of 68% confidence interval (CI68) of the on-body antenna aperture. The results show that using a fixed polarization of the antennas on body can lead to a different CI68 up to maximum 4.9 dB when worn by another person which is still 9.6 dB lower than the measurement uncertainty of commercial exposure meters.

Excerpt

The outdoor measurements of both BWDM and ExpoM are in good agreement. Considering the detection limits of both devices, the detection limit of the ExpoM is a factor of 1.85 lower than that of the on-body detection limit of the BWDM worn by sb1. However, a single ExpoM has a larger measurement uncertainty (7.5 dB larger) in this paper. Factors larger than 2 have been reported in the literature [4, 6] for the underestimation of the PEMs.

Conclusions

For the first time, the polarization dependency of a multi-band body-worn distributed exposure meter (BWDM) and the effect of body morphology on this dependency are assessed. The BDWM consists of 8 nodes measuring at four frequency band including downlink (DL) and uplink bands of 900 MHz, WiFi 2 GHz, and DL

band of 2600 MHz. The BDWM is calibrated on four male subjects with different body mass indexes (BMIs). For each subject, the on-body antenna aperture and the uncertainty of the BWDM are determined for vertical and horizontal polarizations of the nodes in each of the above frequency bands. The obtained antenna apertures do not show an evident relationship with the BMI. Moreover, the results show that optimizing the polarization of the nodes on one subject could result in higher confidence interval values of the on-body antenna aperture for the subjects with different body morphologies. This is less than 0.5 dB and up to 2.62 dB for subjects with the same height and subjects with different height, respectively. From the results, we conclude that the location of the nodes on the body has a higher influence up to 3.7 dB on the directive gain of the antennas and consequently the measurement uncertainty of the BWDM rather than the height or BMI of the subjects. This could increase up to 4.9 dB if the locations of the nodes are not optimized on the body. The authors suggest to use antennas with dual polarization which register the orthogonal components of the RF fields with one antenna. As an application, a median power density of 39 μW/m2 is registered by the BWDM in a suburban residential area in Ghent which is below the issued reference levels by ICNIRP.

https://link.springer.com/article/10.1007/s12243-018-0691-y

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Parental Occupational Exposures and Risk of Childhood Acute Leukemia

Kyriakopoulou A, Meimeti E, Moisoglou I, Psarrou A, Provatopoulou X, Dounias G. Parental Occupational Exposures and Risk of Childhood Acute Leukemia. Mater Sociomed. 2018 Oct;30(3):209-214. doi: 10.5455/msm.2018.30.209-214.

Abstract

INTRODUCTION: Acute leukemia, accounting for 20% of all cancers diagnosed in individuals younger than 19 years old, is the most prevalent childhood malignancy. Among environmental risk factors, parental occupational exposures have attracted scientific interest as potential predisposing factors for childhood leukemia. The role of parental occupational exposure to social contacts, harmful chemicals, electromagnetic fields and ionizing radiation has been investigated with conflicting and inconsistent results.

AIM: A case-control study aiming to assess the association between parental occupational exposures to social contacts, chemicals and electromagnetic fields and the risk of offspring acute leukemia.

MATERIAL AND METHODS: 108 children with acute leukemia and equal number of matched controls were included. Data on parental occupations before conception, during pregnancy, during breastfeeding and after birth, and on potential risk factors was recorded. Associations between parental exposure and risk of childhood leukemia were estimated.

RESULTS: Parental occupational exposure during the four periods of exposure was not associated with childhood leukemia. High birth weight and family history of cancer were associated with the development of childhood acute leukemia. A weak association of maternal medication use during pregnancy and leukemia risk emerged.

CONCLUSIONS: Since the causative factors of childhood leukemia remain unknown, further investigation is mandatory for the reduction of disease burden.

https://www.ncbi.nlm.nih.gov/pubmed/30515061

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Possible effects of radiofrequency EMF on in vivo C6 brain tumors in Wistar rats

Ouadah NS, Lecomte A, Robidel F, Olsson A, Deltour I, Schüz J, Blazy K, Villégier AS. Possible effects of radiofrequency electromagnetic fields on in vivo C6 brain tumors in Wistar rats. J Neurooncol. 2018 Dec;140(3):539-546. doi: 10.1007/s11060-018-03012-y.

Abstract

PURPOSE: Glioblastoma is a malignant brain tumor which has one of the poorest prognosis. It is not clear if toxic environmental factors can influence its aggressiveness. Recently, it was suggested that brain cancer patients with heavy cell phone use showed reduced survival. Here we aimed to assess the effect of controlled brain averaged specific absorption rate (BASAR) from heavy use of cell phone radiofrequency electromagnetic fields (RF-EMF) on in vivo C6 brain tumors in Wistar rats.

METHODS: C6 cells grafted male rats were exposed to GSM 900 MHz signal at environmental BASAR, 0 (sham), 0.25 or 0.5 W/kg (5 days a week, 45 min a day in restraint), or were cage controls (no restraint). At death, tumor volume and immunohistochemistry for CD31, cleaved caspase (CC) 3 and Ki67 were assessed to examine vascularization, apoptosis and cellular divisions, respectively. Moreover, immune cell invasion, necrosis and mitotic index were determined.

RESULTS: Results showed no BASAR effect on survival (31 days post-graft median), tumor volume, mitotic index, vascularization, infiltration, necrosis or cell division. However, results suggested a BASAR-dependent reduction of immune cell invasion and apoptosis.

CONCLUSIONS: Our data suggested an action of RF-EMF by reducing immune cell invasion and glioblastoma cell apoptosis, at probably too low amplitude to impact survival. Further replication studies are needed to confirm these observations.

https://www.ncbi.nlm.nih.gov/pubmed/30421158

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Effects of continuous 1-h a day 900-MHz EMF applied through early & mid-adolescence on hippocampus morphology & learning behavior in late adolescent male rats

Keleş A, Yıldırım M, Gedikli Ö, Çolakoğlu S, Kaya H, Baş O, Sönmez OF, Odacı E. The effects of a continuous 1-h a day 900-MHz electromagnetic field applied throughout early and mid-adolescence on hippocampus morphology and learning behavior in late adolescent male rats. J Chem Neuroanat. 2018 Dec;94:46-53. doi: 10.1016/j.jchemneu.2018.08.006.

Abstract

The purpose of this study was to investigate hippocampus morphology and changes in learning behavior in male rats in late adolescence exposed to the effect of a continuous 1-h a day 900-megahertz (MHz) electromagnetic field (EMF). Twenty-four male Sprague Dawley rats aged 3-weeks were divided equally into control, sham and EMF groups. EMF group rats were exposed to a 900-MHz EMF inside an EMF cage, while the sham group rats were placed in the same cage but were not exposed to such an effect. No procedure was performed on the control group. Following 25-day application of EMF, passive avoidance, 8-arm radial maze and Y-maze tests were applied to determine rats' learning and memory performances. Open field and rotarod tests were applied to assess locomotor activity. At the end of the tests, the animals' brains were removed. Sections were taken and stained with toluidine blue. The regions of the hippocampus were subjected to histopathological evaluation. At histopathological examination, impairments of pyramidal and granular cell

structures were observed in the EMF group hippocampus. No significant change was observed in learning, memory or locomotor behavior in any group. In conclusion, 900-MHz EMF applied in early and mid-adolescence causes no changes in learning, memory or locomotor behavior.

https://www.ncbi.nlm.nih.gov/pubmed/30189239

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Exposure to 18 GHz EMF triggers uptake of large nanosphere clusters by pheochromocytoma cells

Perera PGT, Nguyen THP, Dekiwadia C, Wandiyanto JV, Sbarski I, Bazaka O, Bazaka K, Crawford RJ, Croft RJ, Ivanova EP. Exposure to high-frequency electromagnetic field triggers rapid uptake of large nanosphere clusters by pheochromocytoma cells. Intl J Nanomedicine. 2018(13):8429—8442. 10 December 2018. DOI: https://doi.org/10.2147/IJN.S183767

Abstract

Background: Effects of man-made electromagnetic fields (EMF) on living organisms potentially include transient and permanent changes in cell behaviour, physiology and morphology. At present, these EMF-induced effects are poorly defined, yet their understanding may provide important insights into consequences of uncontrolled (*e.g.*, environmental) as well as intentional (*e.g.*, therapeutic or diagnostic) exposure of biota to EMFs. In this work, for the first time, we study mechanisms by which a high frequency (18 GHz) EMF radiation affects the physiology of membrane transport in pheochromocytoma PC 12, a convenient model system for neurotoxicological and membrane transport studies.

Methods and results: Suspensions of the PC 12 cells were subjected to three consecutive cycles of 30s EMF treatment with a specific absorption rate (SAR) of 1.17 kW kg^{-1}, with cells cooled between exposures to reduce bulk dielectric heating. The EMF exposure resulted in a transient increase in membrane permeability for 9 min in up to 90 % of the treated cells, as demonstrated by rapid internalisation of silica nanospheres (diameter $d \approx$ 23.5 nm) and their clusters ($d \approx 63$ nm). In contrast, the PC 12 cells that received an equivalent bulk heat treatment behaved similar to the untreated controls, showing lack to minimal nanosphere uptake of approximately 1–2 %. Morphology and growth of the EMF treated cells were not altered, indicating that the PC 12 cells were able to remain viable after the EMF exposure. The metabolic activity of EMF treated PC 12 cells was similar to that of the heat treated and control samples, with no difference in the total protein concentration and lactate dehydrogenase (LDH) release between these groups.

Conclusion: These results provide new insights into the mechanisms of EMF-induced biological activity in mammalian cells, suggesting a possible use of EMFs to facilitate efficient transport of biomolecules, dyes and tracers, and genetic material across cell membrane in drug delivery and gene therapy, where permanent permeabilisation or cell death is undesirable.

Open access paper: https://www.dovepress.com/exposure-to-high-frequency-electromagnetic-field-triggers-rapid-uptake-peer-reviewed-article-IJN

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Two Forms of Electrical Transmission Between Neurons

Faber DS, Pereda AE. Two Forms of Electrical Transmission Between Neurons. Front Mol Neurosci. 2018 Nov 21;11:427. doi: 10.3389/fnmol.2018.00427.

Abstract

Electrical signaling is a cardinal feature of the nervous system and endows it with the capability of quickly reacting to changes in the environment. Although synaptic communication between nerve cells is perceived to be mainly chemically mediated, electrical synaptic interactions also occur. Two different strategies are responsible for electrical communication between neurons. One is the consequence of low resistance intercellular pathways, called "gap junctions", for the spread of electrical currents between the interior of two cells. The second occurs in the absence of cell-to-cell contacts and is a consequence of the extracellular electrical fields generated by the electrical activity of neurons. Here, we place present notions about electrical transmission in a historical perspective and contrast the contributions of the two different forms of electrical communication to brain function.

Open access paper: https://www.frontiersin.org/articles/10.3389/fnmol.2018.00427/full

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The effect of chronic exposure to extremely low-frequency electromagnetic fields on sleep quality, stress, depression and anxiety

Bagheri Hosseinabadi M, Khanjani N, Ebrahimi MH, Haji B, Abdolahfard M. The effect of chronic exposure to extremely low-frequency electromagnetic fields on sleep quality, stress, depression and anxiety. Electromagn Biol Med. 2018 Dec 14:1-6. doi: 10.1080/15368378.2018.1545665.

Abstract

Exposure to extremely low-frequency electromagnetic fields (ELF-EMF) is inevitable in some industries. There are concerns about the possible effects of this exposure. The present study aimed to investigate the effect of chronic exposure to extremely low-frequency electromagnetic fields on sleep quality, stress, depression and anxiety among power plant workers. In this cross-sectional study, 132 power plant workers were included as the exposed group and 143 other workers were included as the unexposed group. The intensity of ELF-EMF at work stations was measured by using the IEEE Std C95.3.1 standard and then the time weighted average was calculated. Sleep quality, stress, depression and anxiety were measured by using the Pittsburgh Sleep Quality Index Questionnaire; and the Depression, Anxiety and Stress Scale. The workers in the exposed group experienced significantly poorer sleep quality than the unexposed group. Depression was also more severe in the exposed group than the unexposed group (P = 0.039). Increased exposure to ELF-EMF had a direct and significant relation with increased stress, depression, and anxiety. Sleep quality in technicians with the highest exposure was significantly lower than the other groups. This study suggests that long-term occupational exposure to ELF-EMF may lead to depression, stress, anxiety and poor sleep quality.

https://www.ncbi.nlm.nih.gov/pubmed/30547710

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A review on the effects of ELF-EMF on cytokines of innate and adaptive immunity

Mahaki H, Tanzadehpanah H, Jabarivasal N, Sardanian K, Zamani A. A review on the effects of extremely low frequency electromagnetic field (ELF-EMF) on cytokines of innate and adaptive immunity. Electromagn Biol Med. 2018 Dec 6:1-12. doi: 10.1080/15368378.2018.1545668

Abstract

Extremely low frequency electromagnetic field (ELF-EMF) is produced extensively in modern technologies. Numerous in vitro and in vivo studies have shown that ELF-EMF has both stimulatory and inhibitory effects on the immune system response. This review was conducted on effects of ELF-EMF on cytokines of innate and adaptive immunity. Mechanisms of ELF-EMF, which may modulate immune cell responses, were also studied.

Physical and biological parameters of ELF-EMF can interact with each other to create beneficial or harmful effect on the immune cell responses by interfering with the inflammatory or anti-inflammatory cytokines. According to the studies, it is supposed that short-term (2-24 h/d up to a week) exposure of ELF-EMF with strong density may increase innate immune response due to an increase of innate immunity cytokines. Furthermore, long-term (2-24 h/d up to 8 years) exposure to low-density ELF-EMF may cause a decrease in adaptive immune response, especially in Th1 subset.

https://www.ncbi.nlm.nih.gov/pubmed/30518268

Conclusion

In this review, we reported a summary of ELF-EMF effects on the expression and release of cytokines of innate and adaptive immunity, which have been described in many investigations. Stimulatory and inhibitory effects of ELF-EMF on cytokine expression can be observed as a complex process associated with physical and biological factors of ELF-EMF. Based on the results of reviewed studies, short-term (2 to 24 h/d up to a week) exposure of strong density ELF-EMF probably increases the innate immune response. Furthermore, adaptive immune response may be reduced at long-term (2 to 24 h/d up to 8 years) exposure of low density ELF-EMF, especially for the Th1 subset. Altogether, it is difficult to conclude the beneficial or hazard effects of ELF-EMF on immune cells response, due to the differences in physical (frequency, field density, field direction, and exposure duration) and biological parameters (stimulus, species, cell type, and tissue type) of ELF-EMF.

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Protective properties of myrtle extract against oxidative effects of ELF EMF on rat plasma and hemoglobin

Seif F, Bayatiani MR, Ansarihadipour H, Habibi G, Sadelaji S. Protective properties of Myrtus communis extract against oxidative effects of extremely low-frequency magnetic fields on rat plasma and hemoglobin. Int J Radiat Biol. 2018 Nov 29:1-22. doi: 10.1080/09553002.2019.1542182.

Abstract

PURPOSE: This study investigates the protective properties of Myrtus communis extract against oxidative effects of Extremely Low Frequency Magnetic Fields (ELFMF). Also this study is aimed to analyze the conformational changes of hemoglobin, oxidative damages to plasma proteins and antioxidant power of plasma following exposure to ELFMF.

MATERIALS AND METHODS: Adult male rats were divided into 3 groups: (1) control, (2) ELFMF exposure, and (3) ELFMF exposure after Myrtus communis extract administration. The magnetic field (0.7 mT, 50 Hz) was produced by a Helmholtz coil for one month, 2 hours a day. The Myrtus communis extract was injected intraperitoneally at a dose of 0.5 mg/kg before exposure to ELFMF. The oxidative effects of ELFMF were studied by evaluating the hemoglobin, methemoglobin (metHb) and hemichrome levels, absorption spectrum of hemoglobin (200 to 700 nm), oxidative damage to plasma proteins by measuring protein carbonyl (PCO) levels and plasma antioxidant power according to ferric reducing ability of plasma (FRAP). The mean and standard errors of mean were determined for each group. One-way ANOVA analysis was used to compare the means of groups. The significance level was considered to be $P < 0.05$. Moreover, artificial neural network (ANN) analysis was used to identify the predictive parameters for estimating the oxyhemoglobin (oxyHb) concentration.

RESULTS: Exposure to ELFMF decreased the FRAP which was in concomitant with a significant increase in plasma PCO, metHb and hemichrome concentrations ($p < 0.001$). Oxidative modifications of Hb were shown by reduction in optical density at 340nm (globin-heme interaction) and 420 nm (heme-heme interaction). Administration of Myrtus communis extract increased FRAP values and decreased plasma POC, metHb and hemichrome concentrations. Also a significant increase in Hb absorbance at 340, 420, 542 and 577 nm

showed the protective properties of Myrtus communis extract against ELFMF-induced oxidative stress in erythrocytes. ANN analysis showed that optical absorption of hemoglobin at 520, 577, 542, and 630 nm and concentration of metHb and hemichrome were the most important parameters in predicting the oxyHb concentration.

CONCLUSIONS: Myrtus communis extract enhances the ability of erythrocytes and plasma to deal with oxidative conditions during exposure to ELFMF. Also ANN analysis can predict the most important parameters in relation to Hb structure during oxidative stress.

https://www.ncbi.nlm.nih.gov/pubmed/30496018

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Do subterranean mammals use the Earth's magnetic field as a heading indicator to dig straight tunnels?

Malewski S, Begall S, Schleich CE, Antenucci CD, Burda H. Do subterranean mammals use the Earth's magnetic field as a heading indicator to dig straight tunnels? PeerJ. 2018 Oct 31;6:e5819. doi: 10.7717/peerj.5819.

Abstract

Subterranean rodents are able to dig long straight tunnels. Keeping the course of such "runways" is important in the context of optimal foraging strategies and natal or mating dispersal. These tunnels are built in the course of a long time, and in social species, by several animals. Although the ability to keep the course of digging has already been described in the 1950s, its proximate mechanism could still not be satisfactorily explained. Here, we analyzed the directional orientation of 68 burrow systems in five subterranean rodent species (Fukomys anselli, F. mechowii, Heliophobius argenteocinereus, Spalax galili, and Ctenomys talarum) on the base of detailed maps of burrow systems charted within the framework of other studies and provided to us. The directional orientation of the vast majority of all evaluated burrow systems on the individual level (94%) showed a significant deviation from a random distribution. The second order statistics (averaging mean vectors of all the studied burrow systems of a respective species) revealed significant deviations from random distribution with a prevalence of north-south (H. argenteocinereus), NNW-SSE (C. talarum), and NE-SW (Fukomys mole-rats) oriented tunnels. Burrow systems of S. galiliwere randomly oriented. We suggest that the Earth's magnetic field acts as a common heading indicator, facilitating to keep the course of digging. This study provides a field test and further evidence for magnetoreception and its biological meaning in subterranean mammals. Furthermore, it lays the foundation for future field experiments.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6215444/

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Maternal cell phone use during pregnancy and child cognition at age 5 years in 3 birth cohorts

Sudan M, Birks LE, Aurrekoetxea JJ, Ferrero A, Gallastegi M, Guxens M, Ha M, Lim H, Olsen J, González-Safont L, Vrijheid M, Kheifets L. Maternal cell phone use during pregnancy and child cognition at age 5 years in 3 birth cohorts.Environ Int. 2018 Nov;120:155-162. doi: 10.1016/j.envint.2018.07.043.

Highlights

• Prenatal maternal cell phone use may be related to child cognition.

• Cognition scores are slightly lower in relation to higher frequency use, although imprecise.
• The causal mechanisms are unknown at this time.
• The association is likely affected by social and behavioral factors.

Abstract

BACKGROUND: There have been few studies of children's cognitive development in relation to mothers' cell phone use, and most were limited to outcomes at age 3 years or younger. We examined the relationship between maternal cell phone use during pregnancy and cognitive performance in 5-year old children.

METHODS: This study included data from 3 birth cohorts: the Danish National Birth Cohort (DNBC) (n = 1209), Spanish Environment and Childhood Project (INMA) (n = 1383), and Korean Mothers and Children's Environment Health Study (MOCEH) (n = 497). All cohorts collected information about maternal cell phone use during pregnancy and cognitive performance in children at age 5. We performed linear regression to compute mean differences (MD) and 95% confidence intervals (CI) in children's general, verbal, and non-verbal cognition scores comparing frequency of maternal prenatal cell phone use with adjustments for numerous potential confounding factors. Models were computed separately for each cohort and using pooled data in meta-analysis.

RESULTS: No associations were detected between frequency of prenatal cell phone use and children's cognition scores. Scores tended to be lower in the highest frequency of use category; MD (95% CI) in general cognition scores were 0.78 (-0.76, 2.33) for none, 0.11 (-0.81, 1.03) for medium, and -0.41 (-1.54, 0.73) for high compared to low frequency of use. This pattern was seen across all cognitive dimensions, but the results were imprecise overall.

CONCLUSION: We observed patterns of lower mean cognition scores among children in relation to high frequency maternal prenatal cell phone use. The causal nature and mechanism of this relationship remain unknown.

https://www.ncbi.nlm.nih.gov/pubmed/30096609

Excerpt

In this investigation of maternal cell phone use during pregnancy and cognition in children, we observed a pattern of slightly lower mean cognition scores among children at age 5 years in relation to high frequency maternal prenatal cell phone use in pooled data from three different birth cohorts. Patterns were consistent across cognitive dimensions, but the results were imprecise. We cannot conclude that our results reflect an effect of RF from cell phones, nor do our results indicate that maternal cell phone use directly influences child cognition as we still lack a known mechanism for how cell phone exposure may impact cognitive function. Although the magnitude of the mean differences in cognition scores that we observed were slight, and 1- or 2-point differences in scores are unlikely to have a considerable impact on individuals, there may be considerable costs to society associated with a negative shift of population IQ, especially if it is due to a very common exposure (Trasande et al., 2005). Thus, with the ubiquity of cell phone use among parents and children alike, it is clearly important to continue investigations into the possible health and cognitive effects of this exposure, with more studies examining associations related to frequency and duration of cell phone use and additional specific exposure parameters.

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Radiation and male fertility

Kesari KK, Agarwal A, Henkel R. Radiations and male fertility. Reprod Biol Endocrinol. 2018 Dec 9;16(1):118. doi: 10.1186/s12958-018-0431-1.

Abstract

During recent years, an increasing percentage of male infertility has to be attributed to an array of environmental, health and lifestyle factors. Male infertility is likely to be affected by the intense exposure to heat and extreme exposure to pesticides, radiations, radioactivity and other hazardous substances. We are surrounded by several types of ionizing and non-ionizing radiations and both have recognized causative effects on spermatogenesis. Since it is impossible to cover all types of radiation sources and their biological effects under a single title, this review is focusing on radiation deriving from cell phones, laptops, Wi-Fi and microwave ovens, as these are the most common sources of non-ionizing radiations, which may contribute to the cause of infertility by exploring the effect of exposure to radiofrequency radiations on the male fertility pattern. From currently available studies it is clear that radiofrequency electromagnetic fields (RF-EMF) have deleterious effects on sperm parameters (like sperm count, morphology, motility), affects the role of kinases in cellular metabolism and the endocrine system, and produces genotoxicity, genomic instability and oxidative stress. This is followed with protective measures for these radiations and future recommendations. The study concludes that the RF-EMF may induce oxidative stress with an increased level of reactive oxygen species, which may lead to infertility. This has been concluded based on available evidences from in vitro and in vivo studies suggesting that RF-EMF exposure negatively affects sperm quality.

Open access paper: https://rbej.biomedcentral.com/articles/10.1186/s12958-018-0431-1

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Survival of glioma patients in relation to mobile phone use in Denmark, Finland and Sweden

Olsson A, Bouaoun L, Auvinen A, Feychting M, Johansen C, Mathiesen T, Melin B, Lahkola A, Larjavaara S, Villegier AS, Byrnes G, Deltour I, Schüz J. Survival of glioma patients in relation to mobile phone use in Denmark, Finland and Sweden. J Neurooncol. 2018 Nov 12. doi: 10.1007/s11060-018-03019-5.

Abstract

PURPOSE: Gliomas are the most common cancer of the brain, with a poor prognosis in particular for glioblastoma. In 2014, a study suggested reduced survival in relation to latency of mobile phone use among glioblastoma patients. A joint epidemiological/experimental project to study effects of RF-EMF on tumor development and progression was established. The current analysis relates to the epidemiological part and addresses whether pre-diagnostic mobile phone use was associated with survival among glioma patients.

METHODS: Glioma cases (n = 806) previously enrolled in a collaborative population-based case-control study in Denmark, Finland and Sweden were followed up for survival. Vital status, date of death, date of emigration, or date last known to be alive was obtained based on registry linkages with a unique personal ID in each country. Cox regression models were used to calculate hazard ratios (HR) and 95% confidence intervals (CI) stratified by country. Covariates investigated were sex, age, education, histology, treatment, anatomic location and marital status.

RESULTS: No indication of reduced survival among glioblastoma patients was observed for various measures of mobile phone use (ever regular use, time since start of regular use, cumulative call time overall or in the last 12 months) relative to no or non-regular use. All significant associations suggested better survival for mobile phone users. Results were similar for high-grade and low-grade gliomas.

CONCLUSIONS: We found no evidence of reduced survival among glioma patients in relation to previous mobile phone use.

https://www.ncbi.nlm.nih.gov/pubmed/30421160

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Thermal effects of mobile phones on human auricle region

Bauer J, O'Mahony C, Drahomir Chovan, John Mulcahy, Christophe Silien and Syed A.M. Tofail. Thermal effects of mobile phones on human auricle region. Journal of Thermal Biology. https://doi.org/10.1016/j.jtherbio.2018.11.008

Highlights

• An in silico model of thermal heating of human auricle region due to mobile phone has been developed from first principle and using a COMSOL Multiphysics
• The model allowed determination of the impact of battery discharge rate, battery capacity, battery cathode material, biological tissue distance, antenna radio-wave frequency and intensity.
• Mobile phone heating during a typical call has been simulated and compared with experimental infrared thermographic imaging.
• 1800MHz frequency of data transmission showed the highest temperature increase in the fat/water phantom
• Heating process is generally dominated by the CPU heat although antenna heat can penetrate deeper and can still be a cause of concern.
• The proposed model can be used for the understanding of negative mobile phones impact on human health, including prediction and comprehension of eventual long and short-term side effects
• This new model will aid designing of mobile phones to prevent causing potential negative thermal effect.

Abstract

Mobile phones have become an indispensable utility to modern society, with international use increasing dramatically each year. The GSM signal operates at 900 MHz, 1800MHz and 2250 MHz, may potentially cause harm to human tissue. Yet there is no in silico model to aid design these devices to protect from causing potential thermal effect. Here we present a model of sources of heating in a mobile phone device with experimental verification during the phone call. We have developed this mobile phone thermal model using first principles on COMSOL® Multiphysics modelling platform to simulate heating effect in human auricle region due to mobile phone use. In particular, our model considered both radiative and non-radiative heating from components such as the lithium ion battery, CPU circuitry and the antenna. The model showed the distribution and effect of the heating effect due to mobile phone use and considered impact of battery discharge rate, battery capacity, battery cathode material, biological tissue distance, antenna radio-wave frequency and intensity. Furthermore, the lithium ion battery heating was validated during experiments using temperature sensors with an excellent agreement between simulated and experimental data (<1% variation). Mobile phone heating during a typical call has also been simulated and compared with experimental infrared thermographic imaging. Importantly, we found that 1800MHz frequency of data transmission showed the highest temperature increase in the fat/water phantom used in this simulation. We also successfully compared heating distribution in human auricle region during mobile phone use with clinical thermographic images with reasonable qualitative and quantitative agreements. In summary, our model provides a foundation to conceive thermal and other physical effects caused by mobile phone use and allow for the understanding of potential negative health effects thus supporting and promoting personalized and preventive medicine using thermography.

Excerpt

For the frequencies active in mobile phones, 900MHz, 1800MHz and 2250MHz, 1800MHz showed the highest temperature increase in the fat/water phantom used in this simulation. 900MHz and 2250MHz showed similar heating, but below 1 degree C. Varying the distance of the complete mobile phone model from the phantom cube, the temperature increased by a factor of 10 from contact with the phantom compared to 50 mm away. The model shows that the temperature was dominated by the CPU heat, conduction from and exceeded the contributions to the heating from the antenna and the battery. The antenna heat, however, has more penetrative properties. This allowed for temperature changes to travel deeper and cause much serious temperature effect on soft tissues and brain.

https://www.sciencedirect.com/science/article/pii/S0306456518304431

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Environmental RF exposure in Stockholm Old Town compared with tumour risks in rats in the Ramazzini Study

Hardell L, Carlberg M. Hedendahl L, Koppel T, Ahonen M. (2018) Environmental radiofrequency radiation at the Järntorget Square in Stockholm Old Town, Sweden in May, 2018 compared with results on brain and heart tumour risks in rats exposed to 1.8 GHz base station environmental emissions. World Academy of Sciences Journal. January-February 2019. DOI: 10.3892/wasj.2018.5

Abstract

Radiofrequency (RF) radiation in the frequency range 30 kHz to 300 GHz was evaluated in 2011 by the International Agency for Research on Cancer (IARC) at WHO to be a 'possible human carcinogen' Group 2B. The conclusion was based on human epidemiological studies on an increased risk of glioma and acoustic neuroma.

In previous measurement studies, we found high environmental RF radiation levels at certain public places and also in an apartment in Stockholm, Sweden. One such place was the Järntorget square in the Stockholm Old Town. The EME Spy exposimeter was used for these studies.

We have now conducted a field spatial distribution measurement with a radiofrequency broadband analyser. The maximum E-field topped at 11.6 V/m at the centre of the square, where the antenna was focused. Järntorget's mean value was 5.2 V/m, median 5.0 V/m, range 1.2-11.6 V/m.

Of interest is that this level can be compared to a lifespan carcinogenicity study on rats exposed to 1.8 GHz GSM environmental radiation performed at the Ramazzini Institute (RI) in Italy. A statistically significant increase in the incidence of malignant schwannoma in the heart was found in male rats at the highest dose, 50 V/m. In treated female rats at the highest dose, the incidence of malignant glial tumours was increased, although this was not statistically significant.

On the whole, the findings of this study showed that RF radiation levels at one square, Järntorget, in Sweden, were only one order of magnitude lower than those showing an increased incidence of tumours in the RI animal study. An increased cancer risk cannot be excluded for those working in the proximity of Järntorget for longer time periods.

PDF: http://worldacademyofsciences.com/journal/WASJ-104_HARDELL.pdf

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Analysis of relationship between EMR characteristics and urban functions in highly populated urban areas

Tang C, Yang C, Cai RS, Ye H, Duan L, Zhang Z, Shi Z, Lin K, Song J, Huang X, Zhang H, Yang J, Cai P. Analysis of the relationship between electromagnetic radiation characteristics and urban functions in highly populated urban areas. Sci Total Environ. 2018 Nov 10;654:535-540. doi: 10.1016/j.scitotenv.2018.11.143.

Abstract

The electromagnetic environment (EME) in cities is becoming increasingly complex, and the resulting potential health hazards have attracted widespread attention. Large-scale field observations and monitoring of electromagnetic fields were performed in Xiamen Island over the past six years. The results show that the integrated electric field intensity in Xiamen Island ranged from 0.32 V/m to 1.70 V/m, while the integrated magnetic flux density ranged from 0.11 μT to 0.50 μT; where more electric power facilities and electronic equipment are present in the island, the electric and magnetic field strengths are higher; the radiation power of 2nd Generation mobile communication (2G) is higher than that of 3rd Generation mobile communication (3G) and 4th Generation mobile communication (4G), the coverage of the 3G signal was more uniform than the others and the 4G communication signal's coverage is still developing. The relationship between the EME characteristics and urban functions has been analyzed in this study. Results showed that electric field intensity had no correlation with urban functional areas, magnetic flux density had a positive correlation with residential area (q = 0.29); 2G and 4G radiation power are positively related to the educational (Edu) function area (960 MHz q = 0.22, 1.8 GHz q = 0.47, 2.61 GHz q = 0.28); there was a positive relationship between 2G (1.8 GHz) radiation power and residential area (q = 0.2). We concluded that there is a strong link between the Xiamen Island's EME and the distribution of electromagnetic radiation (EMR) sources, the denser and wider distributed EMR sources lead to a more complicated urban EME.

https://www.ncbi.nlm.nih.gov/pubmed/30447592

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Exposure and health risks perception of ELF and RF EMF and the effect of providing information

Gallastegi M, Jiménez-Zabalaab A, Molinuevo A, Aurrekoetxea JJ, Santa-Marina L, Vozmediano L, Ibarluzea J .Exposure and health risks perception of extremely low frequency and radiofrequency electromagnetic fields and the effect of providing information. Environmental Research. Published online Nov 28, 2018. https://doi.org/10.1016/j.envres.2018.11.042.
Highlights

• Exposure and health risk perceptions of electromagnetic fields (EMF) were assessed.
• Mothers completed a survey before and after receiving information on EMF exposure.
• Levels of exposure and health-risk perception were very high.
• Information did not alter health-risk perceptions but perceived exposure decreased.
• Manual social class, younger age and fewer devices at home increased perception.
Abstract

Given that regardless of actual exposure levels, high-risk perceptions of electromagnetic fields of non-ionizing radiation (EMF-NIR) may cause health effects, it is important to understand the mechanisms behind perceptions in the general population. The aims of this study were to assess perceptions of both exposure and health-risk among mothers of the INMA (Environment and childhood)-Gipuzkoa child cohort; to explore possible determinants that explain such perceptions; and to evaluate whether providing information on exposure levels has any effect on perceptions. Overall, 387 mothers completed a questionnaire composed of four questions on perceived exposure and perceived health-risk of exposure to extremely low frequency (ELF) and radiofrequency (RF) fields answered on a Likert-type scale from 0 to 10. Later, measurements of ELF and RF fields were conducted in the houses of a subsample of 104 participants. All measured levels were far below the levels established by the European Council recommendation. This was explained in the individual reports sent to the families. After reading the results, mothers completed the aforementioned questionnaire a second time, plus two additional questions regarding the role of public health bodies in risk communication.

The association between perceived and measured levels as categorical variables was assessed with a chi-square test. Multiple linear regressions were conducted for each of the questions related to perceived exposure and health-risk perceptions. Wilcoxon signed-rank test was conducted to assess the effect of

receiving information.

Both exposure and health risk were perceived to be very high for both ELF and RF fields, with mean and medians of 7 on a 10-point scale. Reporting higher perception levels was not associated with higher levels of exposure measured at home. Variables that were repeatedly associated with higher perceptions included: manual social class, not having the feeling of living in a good neighborhood, difficulty getting by financially, not having a television antenna within 600 m, being younger and having fewer devices at home. Providing information on EMF-NIR exposure levels at home did not alter health-risk perceptions, but mean perceived RF exposure decreased significantly (by 0.7 points). Most of the participants claimed to have received no or insufficient information regarding exposure and health-risks of EMF-NIR from public bodies and considered it very important that they should.

https://www.sciencedirect.com/science/article/pii/S0013935118306236

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Can explicit suggestions about the harmfulness of EMF exposure exacerbate a nocebo response in healthy controls?

Adam Verrender A, Loughran SP, Dalecki A, Freudenstein F, Croft RJ. Can explicit suggestions about the harmfulness of EMF exposure exacerbate a nocebo response in healthy controls? Environmental Research,166:409-417. October 2018.

Highlights

• Results do not support a relationship between radiofrequency exposure and symptoms.
• Healthy participants exhibited a nocebo response during believed radiofrequency exposure.
• Awareness and belief are crucial in the presentation of symptoms.
• The nocebo response may be exacerbated by alarmist media reports.

Abstract

While there has been consistent evidence that symptoms reported by individuals who suffer from Idiopathic Environmental Intolerance attributed to Electromagnetic Fields (IEI-EMF) are not caused by EMF and are more closely associated with a nocebo effect, whether this response is specific to IEI-EMF sufferers and what triggers it, remains unclear. The present experiment tested whether perceived EMF exposure could elicit symptoms in healthy participants, and whether viewing an 'alarmist' video could exacerbate a nocebo response. Participants were randomly assigned to watch either an alarmist ($N = 22$) or control video ($N = 22$) before completing a series of sham and active radiofrequency (RF) EMF exposure provocation trials (2 open-label, followed by 12 randomized, double-blind, counterbalanced trials). Pre- and post-video state anxiety and risk perception, as well as belief of exposure and symptom ratings during the open-label and double-blind provocation trials, were assessed. Symptoms were higher in the open-label RF-ON than RF-OFF trial ($p < .001$). No difference in either symptoms ($p = .183$) or belief of exposure ($p = .144$) was observed in the double-blind trials. Participants who viewed the alarmist video had a significant increase in symptoms ($p = .041$), state anxiety ($p < .01$) and risk perception ($p < .001$) relative to the control group. These results reveal the crucial role of awareness and belief in the presentation of symptoms during perceived exposure to EMF, showing that healthy participants exhibit a nocebo response, and that alarmist media reports emphasizing adverse effects of EMF also contribute to a nocebo response.

https://www.sciencedirect.com/science/article/pii/S0013935118303347

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Theoretical & numerical assessment of maximally allowable power-density averaging area for EMF exposure assessment above 6 GHz

Neufeld E, Carrasco E, Murbach M, Balzano Q, Christ A, Kuster N.Theoretical and numerical assessment of maximally allowable power-density averaging area for conservative electromagnetic exposure assessment above 6 GHz. Bioelectromagnetics. 01 November 2018. https://doi.org/10.1002/bem.22147

Abstract

The objective of this paper is to determine a maximum averaging area for power density (PD) that limits the maximum temperature increase to a given threshold for frequencies above 6 GHz. This maximum area should be conservative for any transmitter at any distance >2 mm from the primary transmitting antennas or secondary field-generating sources. To derive a generically valid maximum averaging area, an analytical approximation for the peak temperature increase caused by localized exposure was derived. The results for a threshold value of 1 K temperature rise were validated against simulations of a series of sources composed of electrical and magnetic elements (dipoles, slots, patches, and arrays) that represented the spectrum of relevant transmitters. The validation was successful for frequencies in which the power deposition occurred superficially (i.e., >10 GHz). In conclusion, the averaging area for a PD limit of 10 W/m^2 that conservatively limits the temperature increase in the skin to less than 1 K at any distance >2 mm from the transmitters is frequency dependent, increases with distance, and ranges from 3 cm^2 at <10 GHz to 1.9 cm^2 at 100 GHz. In the far-field, the area depends additionally on distance and the antenna array aperture. The correlation was found to be worse at lower frequencies (<10 GHz) and very close to the source, the systematic evaluation of which is part of another study to investigate the effect of different coupling mechanisms in the reactive near-field on the ratio of temperature increase to incident power density. The presented model can be directly applied to any other PD and temperature thresholds.

Excerpts

Standardization The results presented herein have important consequences for safety standards, as they demonstrate a need to use smaller and potentially frequency-dependent averaging areas. The maximal area at a source distance of 2 mm ranges from <2 cm2 at 100 GHz to ≥3 cm2 at <10 GHz. These conditions could be relaxed, should a temperature threshold >1 K be selected or for larger distances from the source. The suggested areas are smaller but comparable to the 4 cm2 previously suggested by Hashimoto et al. [2017] based on computational modeling of localized exposure-induced heating.

Further Investigations The current investigation assumed stationary exposure. However, time-averaged limits are foreseen by the standards to allow for pulsed exposures. The presented investigation can be readily extended to transient exposures by application of 4D rather than 3D Green's functions [Yeung and Atalar, 2001]. In the absence of a steady-state temperature increase, the 1 K criterion could be replaced, for example, with a criterion based on thermal dose [Van Rhoon et al., 2013].

CONCLUSIONS Analytical relationships for localized exposure in the 5G frequency range that permit estimation of temperature increase and of conservative limits on the acceptable power density averaging area have been established, ensuring exposure safety for devices positioned as close as 2 mm from the body. The predictions have been validated against simulations of conservative layered skin configurations exposed to a range of single antennas and antenna arrays in the frequency range of 10–100 GHz. For frequencies >30 GHz, the analytical predictions of temperature increase generally deviated from the simulation results by less than 25%. The results demonstrate that a conservative averaging area can be expressed as function of frequency, distance from the transmitter, and—in the far-field—antenna aperture (see Eq. for a simple approximation at a distance of 2 mm from the source).

https://onlinelibrary.wiley.com/doi/full/10.1002/bem.22147

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Peculiar Effects of Electromagnetic Millimeter Waves on Tumor Development in BALB/c Mice

Bantysh BB, Krylov AY, Subbotina TI, Khadartsev AA, Ivanov DV, Yashin AA. Peculiar Effects of Electromagnetic Millimeter Waves on Tumor Development in BALB/c Mice. Bull Exp Biol Med. 2018 Sep;165(5):692-694. doi: 10.1007/s10517-018-4243-2.

Abstract

The study examined the effects of millimeter electromagnetic waves at a frequency of 130 GHz corresponding to the molecular absorption and radiation spectra of NO and O2 with the total exposition time of 6 h on tumor morphogenesis in 3- and 6-month-old tumor-prone BALB/c mice of both sexes. In experimental mice exposed to electromagnetic radiation, the development of cancer process was slowed down throughout the observation period; moreover, no macroscopic signs of the tumors were revealed. However, in contrast to control mice, experimental animals demonstrated the formation of pathological reactions reflected by hepatic biochemical indices accompanied by the development of dystrophic and microcirculatory alterations in the liver tissue.

https://www.ncbi.nlm.nih.gov/pubmed/30225701

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Possible effects of RF EMF on in vivo C6 brain tumors in Wistar rats

Ouadah NS, Lecomte A, Robidel F, Olsson A, Deltour I, Schüz J, Blazy K, Villégier AS. Possible effects of radiofrequency electromagnetic fields on in vivo C6 brain tumors in Wistar rats. J Neurooncol. 2018 Nov 12. doi: 10.1007/s11060-018-03012-y.

Abstract

PURPOSE: Glioblastoma is a malignant brain tumor which has one of the poorest prognosis. It is not clear if toxic environmental factors can influence its aggressiveness. Recently, it was suggested that brain cancer patients with heavy cell phone use showed reduced survival. Here we aimed to assess the effect of controlled brain averaged specific absorption rate (BASAR) from heavy use of cell phone radiofrequency electromagnetic fields (RF-EMF) on in vivo C6 brain tumors in Wistar rats.

METHODS: C6 cells grafted male rats were exposed to GSM 900 MHz signal at environmental BASAR, 0 (sham), 0.25 or 0.5 W/kg (5 days a week, 45 min a day in restraint), or were cage controls (no restraint). At death, tumor volume and immunohistochemistry for CD31, cleaved caspase (CC) 3 and Ki67 were assessed to examine vascularization, apoptosis and cellular divisions, respectively. Moreover, immune cell invasion, necrosis and mitotic index were determined.

RESULTS: Results showed no BASAR effect on survival (31 days post-graft median), tumor volume, mitotic index, vascularization, infiltration, necrosis or cell division. However, results suggested a BASAR-dependent reduction of immune cell invasion and apoptosis.

CONCLUSIONS: Our data suggested an action of RF-EMF by reducing immune cell invasion and glioblastoma cell apoptosis, at probably too low amplitude to impact survival. Further replication studies are needed to confirm these observations.

https://www.ncbi.nlm.nih.gov/pubmed/30421158

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Exposure to cell phone radiofrequency changes corticotrophin hormone levels and histology of the brain and adrenal glands in male Wistar rat

Shahabi S, Taji IM, Hoseinnezhaddarzi M, Mousavi F, Shirchi S, Nazari A, Zarei H, Pourabdolhossein F.Exposure to cell phone radiofrequency changes corticotrophin hormone levels and histology of the brain and adrenal glands in male Wistar rat. Iranian J Basic Medical Sciences. 21(12):1269-1274. DOI: 10.22038/ijbms.2018.29567.7133

Abstract

Objective(s): Nowadays, the electromagnetic field-emitting devices are used routinely in our lives. Controversial reports exist concerning the effects of mobile radiofrequency (RF) on different parts of the body, especially stress hormones. The main goal of the present work was to study the long-term effects of mobile RF900 MHz exposure with special focus on the adrenal gland pathophysiology and function.

Materials and Methods: Adult male Wistar rats were exposed to mobile RF 6 hr daily for 4-8 weeks. Intact and switched-off exposed animals were considered as controls. Plasma ACTH and cortisol levels were measured by the ELISA method. At the end of the experiment, a histological study was done on adrenal gland and brain tissues by hematoxylin and eosin staining. The thickness of the fasciculate layer of the adrenal gland, and its cell count and perimeter were measured using the Fiji software.

Results: Enhanced plasma ACTH and cortisol levels were found after prolonged exposure to mobile RE The fasciculata layer of adrenal cortex eventually thickened following mobile RF radiation. While the number of cells in zona fasciculata remained constant, the cell size and perimeter increased during RF exposure. Finally, we found that vacuolization in brain tissue and the number and size of vacuoles considerably increased during two months of RF exposure.

Conclusion: Cell phone RF exposure induced significant hormonal and structural changes in adrenal gland and brain tissues. Therefore, the public should be aware and limit their exposure as much as possible.

http://ijbms.mums.ac.ir/article_11712.html

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Changes in testicular morphology & oxidative stress in 60-day-old rats following exposure to continuous 900-MHz EMF throughout adolescence

Hancı H, Kerimoğlu G, Mercantepe T, Odacı E. Changes in testicular morphology and oxidative stress biomarkers in 60-day-old Sprague Dawley rats following exposure to continuous 900-MHz electromagnetic field for 1 h a day throughout adolescence. Reprod Toxicol. 2018 Oct;81:71-78. doi: 10.1016/j.reprotox.2018.07.002.

Abstract

The purpose of this study was to investigate the 60-day-old male rat testis following exposure to continuous 900-megahertz (MHz) electromagnetic field (EMF) throughout the adolescent period using histopathological and biochemical analysis methods. Twenty-four Sprague Dawley rats aged 21 days were randomly and equally (n = 8) divided into three groups. No procedure was performed on the control group rats. The sham group rats were held in an EMF-cage without exposure to EMF. The EMF group rats were exposed to continuous 900-MHz EMF for 1 h each day inside the EMF-cage during adolescence. On postnatal day 60 the testes were extracted and divided into right and left halves. The right half was used for histopathological evaluation and the left half for biochemical analyses. Our results show that changes may occur in morphology and oxidative stress biomarkers in the rat testis following exposure to continuous 900-MHz EMF throughout the adolescent period.

https://www.ncbi.nlm.nih.gov/pubmed/30009952

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2.45 GHz microwave radiation impairs learning, memory, and hippocampal synaptic plasticity in the rat

Karimi N, Bayat M, Haghani M, Saadi H, Ghazipour GR. 2.45 GHz microwave radiation impairs learning, memory, and hippocampal synaptic plasticity in the rat. Toxicol Ind Health. 2018 Oct 21:748233718798976. doi: 10.1177/0748233718798976

Abstract

Microwave (MW) radiation has a close relationship with neurobehavioral disorders. Due to the widespread usage of MW radiation, especially in our homes, it is essential to investigate the direct effect of MW radiation on the central nervous system. Therefore, this study was carried out to determine the effect of MW radiation on memory and hippocampal synaptic plasticity. The rats were exposed to 2.45 GHz MW radiation (continuous wave with overall average power density of 0.016 mW/cm2 and overall average whole-body specific absorption rate value of 0.017 W/kg) for 2 h/day over a period of 40 days. Spatial learning and memory were tested by radial maze and passive avoidance tests. We evaluated the synaptic plasticity and hippocampal neuronal cells number by field potential recording and Giemsa staining, respectively. Our results showed that MW radiation exposure decreased the learning and memory performance that was associated with decrement of long-term potentiation induction and excitability of CA1 neurons. However, MW radiation did not have any effects on short-term plasticity and paired-pulse ratio as a good indirect index for measurement of glutamate release probability. The evaluation of hippocampal morphology indicated that the neuronal density in the hippocampal CA1 area was significantly decreased by MW.

https://www.ncbi.nlm.nih.gov/pubmed/30345889

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The effects of radiofrequency radiation on mice fetus weight, length and tissues

Alimohammadi I, Ahtarinezhad A, Mohamadzadeh Asl B, Masruri B, Moghadasi N. The effects of radiofrequency radiation on mice fetus weight, length and tissues. Data in Brief. 19:2189-2194. August 2018. https://doi.org/10.1016/j.dib.2018.06.107.

Value of data

- The result of this study is useful for workers and users that are exposed to radiofrequency radiation as a physical agent.
- Investigation of radiofrequency radiation effects in organogenesis period during pregnancy and protective role of vitamin C as a water-soluble antioxidant in body tissues and fluids are the innovation of this study.
- These data showed changes of growth parameters and abnormalities in tissues as the result of radiofrequency radiation exposure which could be useful for some organization such as Ministry of Health and Medical Education to recognize possible risks in vulnerable groups like pregnant women and their embryos and protect them more effective.

Abstract

The public concern of harmful effects of radiofrequency radiation exposure, especially with rapid increase in the use of wireless and telecommunication devices, is increasing. Some studies show fetal and developmental abnormalities as the result of radiofrequency radiation exposure. We aimed to investigate possible teratogenic

effects of radiofrequency in 915 MHz on mice fetus and protective role of vitamin C. 21 pregnant mice were divided into 3 groups. Control group was in normal condition without any stressor agent. Exposure group was exposed to 915 MHz RFR (8 h/day for 10 days) and 0.045 μw/cm2 power density. The exposure plus vitamin C group received 200 mg/kg vitamin C by gavage and was exposed to 915 MHz RFR (8 h/day for 10 days) and 0.045 μw/cm2 power density. The fetus weight, C-R length were measured by digital balance and caliper. Tissues were assessed after staining with H & E. Our results showed significant increase in fetus weight and C-R length and also enlarged liver, tail deformation in mice fetus in exposure group. Although usage of vitamin C caused significant decrease in mentioned parameters. The outcome of this study confirms the effects of radiofrequency radiation on growth parameters such as body weight, length and some tissues in mice fetuses and protective effect of vitamin C. However more studies on non-ionization radiation in different frequencies and severity, during pregnancy are needed to clarify the exact mechanisms of these changes and better protection.

Open access paper: https://www.sciencedirect.com/science/article/pii/S2352340918307583

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Bio-physical effects of RF EMR on blood parameters, spermatozoa, liver, kidney and heart of albino rats

Adebayo EA, Adeeyo AO, Ogundiran MA, Olabisi O. Bio-physical effects of radiofrequency electromagnetic radiation (rf-emr) on blood parameters, spermatozoa, liver, kidney and heart of albino rats. Journal of King Saud University - Science. 15 Nov 2018. https://doi.org/10.1016/j.jksus.2018.11.007.

Abstract

Current study aimed at determining the consequence of Radiofrequency (≈1800 MHz) electromagnetic radiation (RF-EMR) on the histological, hematological and histochemical properties of selected tissues of rat and to assess morphological changes associated with such exposures. Three groups of thirty rats of which two groups of twenty rats were subjected to average radiation of ≈1.40 mW/cm2 at 24 m from the base of two different telecommunications network mast for 5 weeks. Histochemical, haematological and histological analyses of the rats were afterward carried out on selected tissues of the experimental animals using standard procedures. Impacts of radiation were noted in the exposed groups of rats. There was rise in white blood cells with variations in other blood parameters; the sperm motility and sperm count of the exposed rats is lower than the control; the liver of the exposed rats shows pronounced dilated sinusoids, distorted architecture, hyperchromatic nuclei, congested central vein, with change of hepatocytes structure; the heart shows gross distortion of cardiac muscular architecture with distorted irregular cardiac muscle fibres and wider interfibres spaces; kidney showing hyperchromatic nuclei, gradual loss and degeneration of flattened squamous epithelial cells lining and testis shows grossly distorted seminiferous tubules and epididymis with loss of cellular structure and an area of inflammatory changes with complete absence of spermatozoa, which may lead to low fertility. This study shows that radiofrequency electromagnetic radiation may induce morphological changes in various tissues of living systems in rat.

Conclusion

From the data presented in this study, it can be observed that impact of RF-EMR from telecommunication base stations are reasonably manifested on internal organs in a similar manner observed in ionizing radiation studies. Some of the organs examined showed histological, hematological and histochemical changes which are different from normal. The study established that the reproductive organs of male rats were seriously impaired, which may have similar effect on higher mammal. It is recommended that further research to study the long term effect of RF-EMR from telecommunication on living systems in Nigeria be intensified.

Open access paper: https://www.sciencedirect.com/science/article/pii/S1018364717308789

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Power-frequency magnetic fields at 50 Hz do not affect fertility and development in rats and mice

Ruan G, Liu X, Zhang Y, Wan B, Zhang J, Lai J, He M, & Chen C. (2018) Power-frequency magnetic fields at 50 Hz do not affect fertility and development in rats and mice. Electromagnetic Biology and Medicine. DOI: 10.1080/15368378.2018.1545664

In the present study, the effects of power-frequency magnetic fields (PF-MF) on fertility and development were investigated in rats and mice. Adult Sprague-Dawley rats and C57BL/6J mice were divided into four groups: a sham exposure group and 30-μT, 100-μT and 500-μT PF-MF exposure groups. The rats were exposed for 24 weeks, and the exposure time for mice ranged from 18 d to 12 weeks, dependent on the different investigated end points. The rats and mice were exposed for 20 h/d. Plasma hormone levels in rats and mice were analyzed. Furthermore, pregnancy rates and implanted embryos were recorded in pregnant mice. Finally, the neonatal growth of mice was evaluated. The results showed that none of the three intensities affected the body weight and paired ovary weight in female rats. Meanwhile, none of the three intensities affected the body weight, weights of paired testes, weights of paired epididymis and sperm count in male rats. Similarly, no significant differences were found in plasma sex hormone levels between the different PF-MF exposure groups and the sham exposure group. In addition, the pregnancy rates and implanted embryos were not significantly different between the four groups. Moreover, PF-MF exposures had no effects on either the number of fetuses in pregnant mice or the growth and development of neonatal mice.

https://www.tandfonline.com/doi/full/10.1080/15368378.2018.1545664

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Effects of EMF on cultured human retinal pigment epithelial cells

Nasrabadi N, Soheili ZS, Bagheri A, Ahmadieh H, Amizadeh Y, Sahebjam F, Tabeie F, Rezaei Kanavi M. The effects of electromagnetic fields on cultured human retinal pigment epithelial cells. Bioelectromagnetics. 2018 Dec;39(8):585-594. doi: 10.1002/bem.22154.

Abstract

A great deal of evidence has confirmed that electromagnetic fields (EMFs) can affect the central nervous system. In this study, cultured neonatal human retinal pigment epithelial (hRPE) cells were exposed to pulsed EMF of 1 mT intensity and 50 Hz frequency 8 h daily for 3 days. In addition to cell proliferation and cell death assays, immunocytochemistry for RPE65, PAX6, nestin, and cytokeratin 8/18 proteins were performed. Real-time reverse transcriptase polymerase chain reaction (RT-PCR) was performed for NES, PAX6, RPE65, and ACTA2 gene expression. Exposed hRPE cells did not demonstrate significant change in terms of cytomorphology, cell proliferation, or cell death. Protein expression of PAX6 was decreased in treated cells compared to controls and remained unchanged for RPE65, cytokeratin 8/18, and nestin. Gene expressions of NES, RPE65, and PAX6 were decreased in treated cells as compared to controls. Gene expression of ACTA2 did not significantly change. In conclusion, viability of cultivated neonatal hRPE cells did not change after short exposure to a safe dose of pulsed EMF albeit that both gene and protein expressions of retinal progenitor cell markers were reduced. Whether longer exposure durations that are being constantly produced by widely-used electronic devices may induce significant changes in these cells, needs further investigation.

https://www.ncbi.nlm.nih.gov/pubmed/30462846

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Low frequency EMF increase human sperm motility - effect of 43 KHz radiation

Wdowiak A, Mazurek PA, Wdowiak A, Bojar I. Low frequency electromagnetic waves increase human sperm motility - A pilot study revealing the potent effect of 43 khz radiation.
Int J Occup Med Environ Health. 2018 Nov 28. pii: 81771. doi: 10.13075/ijomeh.1896.01262.

Abstract

OBJECTIVES: Abnormalities in the timing and course of spermatozoa capacitation and hyperactivation underlie common pathologies related to male infertility. Recent data shows that low frequency electromagnetic waves may influence cell membrane potential and permeability. It is therefore possible that low frequency electromagnetic waves could affect the maturation and motility processes of spermatozoa. The 43-kHz wave generator was used for modeling the impact of environmental exposure to low frequency electromagnetic radiation on human sperm.

MATERIAL AND METHODS: Sperm samples were gathered from 103 fertile, healthy men aged 25-30 years old and performed computer-assisted sperm analysis. After initial examination, each participant's semen sample was divided into 2 aliquots (control and experimental) and placed in separate automated incubators. The samples constituting the experimental group were placed into the exposure system that emitted 43-kHz electromagnetic waves. Sperm motility was assessed at 3 h, 12 h and 24 h.

RESULTS: Exposure to a 43-kHz radio frequency increased the percentage of sperm in progressive motility by up to 5.8% and the velocity of said sperm by up to 2 μm/s. Moreover, the total number of hyperactivated spermatozoa was significantly increased in the semen exposed to the electromagnetic signal.

CONCLUSIONS: *In vivo* environmental exposure to 43-kHz waves may promote the development of infertility related to premature capacitation outside of the vaginal tract. Exposing semen to this particular frequency may also boost the capacitation and hyperactivation of spermatozoa *in vitro*, prior to conducting assisted reproductive therapies.

https://www.ncbi.nlm.nih.gov/pubmed/30484440

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Cell phone use and risk of thyroid cancer: a population-based case-control study in Connecticut

Luo J, Deziel NC, Huang H, Chen Y, Ni X, Ma S, Udelsman R, Zhang Y. Cell phone use and risk of thyroid cancer: a population-based case-control study in Connecticut. Annals of Epidemiology, Published online Oct 29, 2018. https://doi.org/10.1016/j.annepidem.2018.10.004.

Abstract

Purpose This study aims to investigate the association between cell phone use and thyroid cancer.

Methods A population-based case-control study was conducted in Connecticut between 2010 and 2011 including 462 histologically confirmed thyroid cancer cases and 498 population-based controls. Multivariate unconditional logistic regression was used to estimate odds ratios (OR) and 95% confidence intervals (95% CI) for associations between cell phone use and thyroid cancer.

Results Cell phone use was not associated with thyroid cancer (OR: 1.05, 95% CI: 0.74-1.48). A suggestive increase in risk of thyroid microcarcinoma (tumor size ≤10mm) was observed for long-term and more frequent users. Compared to cell phone non-users, several groups had non-statistically significantly increased risk of thyroid microcarcinoma: individuals who had used a cell phone >15 years (OR: 1.29, 95% CI: 0.83-2.00), who

had used a cell phone >2 hours per day (OR: 1.40, 95% CI: 0.83-2.35), who had the most cumulative use hours (OR: 1.58, 95% CI: 0.98-2.54), and who had the most cumulative calls (OR: 1.20, 95% CI: 0.78-1.84).

Conclusion This study found no significant association between cell phone use and thyroid cancer. A suggestive elevated risk of thyroid microcarcinoma associated with long-term and more frequent uses warrants further investigation.

https://www.sciencedirect.com/science/article/pii/S1047279718302849

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Peer-reviewed comments on NTP cellphone radiation study by Hardell and Carlberg

Hardell L, Carlberg M. Comments on the US National Toxicology Program technical reports on toxicology and carcinogenesis study in rats exposed to whole-body radiofrequency radiation at 900 MHz and in mice exposed to whole-body radiofrequency radiation at 1,900 MHz. International Journal of Oncology. Published Oct 24, 2018. https://doi.org/10.3892/ijo.2018.4606

Abstract

During the use of handheld mobile and cordless phones, the brain is the main target of radiofrequency (RF) radiation. An increased risk of developing glioma and acoustic neuroma has been found in human epidemiological studies. Primarily based on these findings, the International Agency for Research on Cancer (IARC) at the World Health Organization (WHO) classified in May, 2011 RF radiation at the frequency range of 30 kHz-300 GHz as a 'possible' human carcinogen, Group 2B. A carcinogenic potential for RF radiation in animal studies was already published in 1982. This has been confirmed over the years, more recently in the Ramazzini Institute rat study. An increased incidence of glioma in the brain and malignant schwannoma in the heart was found in the US National Toxicology Program (NTP) study on rats and mice. The NTP final report is to be published; however, the extended reports are published on the internet for evaluation and are reviewed herein in more detail in relation to human epidemiological studies. Thus, the main aim of this study was to compare earlier human epidemiological studies with NTP findings, including a short review of animal studies. We conclude that there is clear evidence that RF radiation is a human carcinogen, causing glioma and vestibular schwannoma (acoustic neuroma). There is some evidence of an increased risk of developing thyroid cancer, and clear evidence that RF radiation is a multi-site carcinogen. Based on the Preamble to the IARC Monographs, RF radiation should be classified as carcinogenic to humans, Group 1.

Abstract: https://www.spandidos-publications.com/10.3892/ijo.2018.4606

Open access paper: https://www.spandidos-publications.com/10.3892/ijo.2018.4606/download

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Temporal & spatial patterns of Glioblastoma Multiforme & other brain cancer subtypes in relation to mobile phones using synthetic counterfactuals

de Vocht F. Analyses of temporal and spatial patterns of Glioblastoma Multiforme and other brain cancers subtypes in relation to mobile phones using synthetic counterfactuals. Environmental Research. Available online 17 October 2018. https://doi.org/10.1016/j.envres.2018.10.011.

Highlights

• English 1985–2005 brain cancer subtype rates were compared to counterfactual trends
• Excess GBM increases were found in the frontal and temporal lobes, and cerebellum
• Mobile phone use was unlikely to have been an important putative factor
• No evidence of an effect of mobile phone use on acoustic neuroma and meningioma

Abstract

This study assesses whether temporal trends in glioblastoma multiforme (GBM) in different brain regions, and of different malignant and benign (including acoustic neuroma and meningioma) subtypes in the temporal lobe, could be associated with mobile phone use.

Annual 1985–2005 incidence of brain cancer subtypes for England were linked to population-level covariates. Bayesian structural timeseries were used to create 2006–2014 counterfactual trends, and differences with measured newly diagnosed cases were interpreted as causal effects.

Increases in excess of the counterfactuals for GBM were found in the temporal (+38% [95% Credible Interval -7%,78%]) and frontal (+36% [-8%,77%]) lobes, which were in agreement with hypothesised temporal and spatial mechanisms of mobile phone usage, and cerebellum (+59% [-0%,120%]). However, effects were primarily present in older age groups, with largest effects in 75+ and 85+ groups, indicating mobile phone use is unlikely to have been an important putative factor. There was no evidence of an effect of mobile phone use on incidence of acoustic neuroma and meningioma.

Although 1985–2014 trends in GBM in the temporal and frontal lobes, and probably cerebellum, seem consistent with mobile phone use as an important putative factor, age-group specific analyses indicate that it is unlikely that this correlation is causal.

Excerpts

Assessment of specific cancer subtypes in the temporal lobe indicated that the excess incidence was mainly found for GBM, with similar trends observed in the frontal lobe and cerebellum.... The increased rates of specific brain cancer subtypes in excess of the counterfactuals correspond to the spatial and temporal patterns that would be expected if exposure to RF from mobile phones were an important putative factor (Cardis et al., 2008, Morgan et al., 2016) ... However, age group-specific analyses indicate that the excess relative impacts increased with age over 65 years and were primarily found in the very old (75/85+ years of age) for whom it is unlikely that mobile phone use had been an important causal factor. In addition, excess numbers of newly diagnosed cases were also observed in the young (<24 years of age) for whom mobile phone use is also an unlikely causal factor....

The assumption that a 10-year lag was the most plausible period between first exposure and when increased risk could be observed in registry data was based on the previous analyses (De Vocht (2016)). Although sensitivity analysis using a 15-year lag showed no evidence of excesses relative to counterfactuals, this may still have been too short....

This study, in agreement with other data from the UK and elsewhere, shows that the incidence of glioblastoma multiforme (astrocytoma grade IV) has increased significantly since the 1980s, especially in the frontal and temporal lobes and cerebellum. However, it further provides evidence that the trend of increasing numbers of newly diagnosed cases of glioblastoma multiforme in the temporal lobe (but likely in the frontal lobe and cerebellum as well) since the mid-1980s, although seemingly consistent with the hypothesis of exposure to

radiofrequency radiation from mobile phones being an important putative factor, should to a large extent (if not exclusively) be attributed to another factor or factors; of which improvements in diagnostic techniques, especially in the elderly, seems the most plausible. Although these analyses indicate that it is unlikely that exposure to RF from mobile phones is an important putative factor, they also cannot exclude it as a contributing factor completely. It is therefore important to keep monitoring incidence trend data.

Competing financial interests declaration: The author has previously done consulting for EPRI [Electric Power Research Institute], not related to this work. Financial support: No external funding was obtained for this study.

https://www.sciencedirect.com/science/article/pii/S0013935118305462?via%3Dihub

My comment: The study found that the two age groups most vulnerable to carcinogenic effects from cell phone use -- young and elderly adults -- showed increased incidence over time in brain cancer in two lobes of the brain that receive the greatest dose of microwave radiation from a cell phone used near the head. The author rejects the explanation that cell phone use caused the increased cancer risk but accepts the possibility that cell phone radiation may be a contributing factor.

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RF EMF, screen time, and emotional and behavioral problems in 5-year-old children

Guxens M, Vermeulen R, Steenkamer I, Beekhuizen J, Vrijkotte TGM, Kromhout H, Huss A. Radiofrequency electromagnetic fields, screen time, and emotional and behavioural problems in 5-year-old children.Int J Hyg Environ Health. 2018 Oct 9. pii: S1438-4639(18)30502-9. doi: 10.1016/j.ijheh.2018.09.006.

Highlights
• RF-EMF from different sources and screen time assessed in 5-year-old children.
• Teachers and mothers independently reported child emotional and behavioural problems.
• No associations with mobile/cordless phone calls which lead to peak RF-EMF to the head.
• Associations with exposures contributing very little to RF-EMF when maternal-reported.

Abstract

BACKGROUND: Little is known about the exposure of young children to radiofrequency electromagnetic fields (RF-EMF) and potentially associated health effects. We assessed the relationship of RF-EMF exposure from different sources and screen time exposure with emotional and behavioural problems in 5-year-old children.

METHODS: Cross-sectional study including 3102 children aged 5 years from the Amsterdam Born Children and their Development (ABCD) study, in the Netherlands. Residential RF-EMF exposure from mobile phone base stations was estimated with a 3D geospatial radio wave propagation model. Residential presence of RF-EMF indoor sources (cordless phone base stations and Wireless Fidelity (WiFi)), children's mobile phone and cordless phone calls and screen time exposure (computer/video game and television watching) was reported by the mother. Teachers (n = 2617) and mothers (n = 3019) independently reported child emotional and behavioural problems using the Strengths and Difficulties Questionnaire.

RESULTS: No associations were found between mobile phone and cordless phone calls and emotional and behavioural problems. **Children exposed to higher RF-EMF levels from mobile phone base stations showed higher odds of maternal-reported emotional symptoms (OR 1.82, 95%CI 1.07 to 3.09).** Children with cordless phone at home had lower odds of teacher-reported problematic prosocial behaviour (OR 0.68,

95%CI 0.48 to 0.97) and of maternal-reported peer relationship problems (OR 0.61, 95% CI 0.39 to 0.96). Children who watched television ≥1.5 h/day had higher odds of maternal-reported hyperactivity/inattention (OR 3.13, 95%CI 1.43 to 6.82).

CONCLUSION: Mobile phone and cordless phone calls, which lead to peak RF-EMF exposures to the head, were not associated with any emotional and behavioural problems in 5-year-old children. Environmental RF-EMF exposure from mobile phone base stations and from indoor sources and television watching, which both contribute very little to RF-EMF exposure, were associated with specific emotional and behavioural problems but mainly when reported by the mothers. We cannot, however, discard residual confounding or reverse causality. Further longitudinal research in particular as children will increase the use of telecommunication devices with the age may help to better understand the exact contribution of the different RF-EMF exposure sources if any. Moreover, a thorough control for confounding is essential for a correct interpretation of the studies on screen time and emotional and behavioural problems.

https://www.ncbi.nlm.nih.gov/pubmed/30314943

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Expert Views on Their Role as Policy Advisor: Pilot Study for the Cases of Electromagnetic Fields, Particulate Matter, and Antimicrobial Resistance

Spruijt P, Knol AB, Petersen AC, Lebret E. Expert Views on Their Role as Policy Advisor: Pilot Study for the Cases of Electromagnetic Fields, Particulate Matter, and Antimicrobial Resistance. Risk Anal. 2018 Oct 31. doi: 10.1111/risa.13224.

Abstract

This perspective presents empirical data to demonstrate the existence of different expert views on scientific policy advice on complex environmental health issues. These views are partly research-field specific. According to scientific literature, experts differ in the way they provide policy advice on complex issues such as electromagnetic fields (EMF), particulate matter (PM), and antimicrobial resistance (AMR). Where some experts feel their primary task is to carry out fundamental research, others actively engage in the policy dialogue. Although the literature provides ideas about expert roles, there exists little empirical underpinning. Our aim is to gather empirical evidence about expert roles. The results of an international study indicated that experts on EMF, PM, and AMR differ in the way they view their role in the policy dialogue. For example, experts differed in their views on the need for precaution and their motivation to initiate stakeholder cooperation. Besides, most experts thought that their views on the risks of EMF/PM/AMR did not differ from those of colleagues. Great dissensus was found in views on the best ways of managing risks and uncertainties. In conclusion, the theoretical ideal-typical roles from the literature can be identified to a certain extent.

https://www.ncbi.nlm.nih.gov/pubmed/30380164

Excerpts

The principal component analysis (PCA) resulted in six factors, which we interpreted as representing the following six roles: (1) engaged scientist, (2) pro-science expert, (3) regulatory advocate, (4) humble scientist, (5) transparent expert, and (6) issue advocate. Engaged scientists highly valued scientific knowledge and stressed the importance of a continuous dialogue between scientists and policymakers. Pro-science experts

strongly agreed that new policies should be based on scientific knowledge, that knowledge possessed by the general public is less valuable, and that monitoring is the most suitable way to address the risks and uncertainties of EMF/PM. Regulatory advocates strongly agreed that possible health problems are best managed through legislation and regulation, that scientists should publish in peer-reviewed journals as their primary responsibility, and that they are not responsible for maintaining a continuous dialogue with policymakers. Humble scientists strongly agreed that scientists should be humble about the role of science in solving societal problems and had modest judgments regarding most other statements. Transparent experts emphasized the importance of transparency regarding research methods and assumptions, explicating differences of opinion among experts, and informing policymakers about the science underlying policy advice. Finally, issue advocates focused on actively interacting with policymakers and politics; they were fairly neutral in regard to the policy measures that should be taken.

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Review of quality of publications & meta-analysis of genetic damage in mammalian cells exposed to non-ionizing radiofrequency fields

Vijayalaxmi, Prihoda TJ. Comprehensive review of quality of publications and meta-analysis of genetic damage in mammalian cells exposed to non-ionizing radiofrequency fields. Radiat Res. 2018 Oct 19. doi: 10.1667/RR15117.1.

Abstract

There have been numerous published studies reporting on the extent of genetic damage observed in animal and human cells exposed in vitro and in vivo to non-ionizing radiofrequency fields (RF, electromagnetic waves that carry energy as they propagate in air and dense media). Overall, the data are inconsistent; while some studies have suggested significantly increased damage in cells exposed to RF energy compared to unexposed and/or sham-exposed control cells, others have not. Several variables in exposure conditions used in the experiments might have contributed to the controversy.

In this comprehensive review, four specific quality control measures were used to determine the quality of 225 published studies in animal and human cells exposed in vitro and in vivo to RF energy, and the results from 2,160 tests with different sample sizes were analyzed. The four specific quality control measures were as follows: 1. "Blind" collection/analysis of the data to eliminate individual/observer "bias"; 2. Adequate description of "dosimetry" for independent replication/confirmation; 3. Inclusion of "positive controls" to confirm the outcomes; and 4. Inclusion of "sham-exposed controls" which are more appropriate to compare the data with those in RF exposure conditions. In addition, meta-analysis of the genetic damage in cells exposed to RF energy and control cells, thus far available in the RF literature database, was performed to obtain the "d" values, i.e., standardized mean difference between these two types of cells or the effect size. The relationship between d values and the above-mentioned quality control measures was ascertained. In addition, the correlation between the quality control measures and the conclusions reported in the publications (no significant difference between the cells exposed to RF energy and control cells; increased damage in former cells compared to the latter; increased, no significant difference and decreased damage in cells exposed to RF energy in the same experiment; or decreased damage in cells exposed to RF energy) was examined.

The overall conclusions were as follows: 1. When all four quality control measures were mentioned in the publication, the d values were smaller compared to those when one or more quality control measures were not mentioned in the investigation; 2. Based on the inclusion of quality control measures, the weighted outcome in cells exposed to RF energy (d values) indicated a very small effect, if any; 3. The number of published studies

reporting no significant difference in genetic damage of cells exposed to RF energy, compared to that of control cells, increased with increased number of quality control measures employed in investigations; 4. The number of published studies reporting increased genetic damage in cells exposed to RF energy decreased with increased number of quality control measures; and 5. There was a "bias" towards the publications reporting increased genetic damage in cells exposed to RF energy even with very small sample size. Overall, the results from this study underscore the importance of including quality control measures in investigations so that the resulting data are useful, nationally and internationally, in evaluating "potential" health risks from exposure to RF energy.

https://www.ncbi.nlm.nih.gov/pubmed/30339042

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Understanding physical mechanism of low-level microwave radiation effect

Hinrikus H, Bachmann M, Lass J. Understanding physical mechanism of low-level microwave radiation effect. Int J Radiat Biol. 2018 Oct;94(10):877-882. doi: 10.1080/09553002.2018.1478158.

Abstract

PURPOSE:This topic review aims to explain the mechanism of low-level microwave (MW) radiation effect based on published research results. The review presents the analysis of theoretical and experimental results comprising underlying physics and derived biological-physiological consequences supported by experimental data.

CONCLUSIONS: The rotation of dipolar molecules causes polarization of dielectric medium and restructuring of hydrogen bonds between these molecules. The weakened hydrogen bonds decrease viscosity and enhance diffusion at constant temperature. All steps of proposed model have no critical frequency restrictions at MW frequencies and have been confirmed by electromagnetic field (EMF) theory and/or published experimental results. The synchronous cumulative impact of coherent MW electric field makes possible the field-induced effect despite the field strengths are much weaker than intermolecular fields. The rotation of dipolar molecules results in restructuring hydrogen bonds between the molecules despite the energy of MW radiation is much less than the energy of bonding. The cumulative impact of coherent MW field in a medium has been convincingly confirmed by the measurable dielectric permittivity of the medium. The described mechanism of MW field-induced effect confirms that the nature of the effect differs from the thermal effect and that the exposure by MW radiation can create the specific consequences in biology and materials not characteristic for conventional heating.

https://www.ncbi.nlm.nih.gov/pubmed/29775391

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Evaluation of IEEE802.15.4g for Environmental Observations

Muñoz J, Chang T, Vilajosana X, Watteyne T. Evaluation of IEEE802.15.4g for Environmental Observations. Sensors (Basel). 2018 Oct 15;18(10). pii: E3468. doi: 10.3390/s18103468.

Abstract

IEEE802.15.4g is a low-power wireless standard initially designed for Smart Utility Networks, i.e., for connecting smart meters. IEEE802.15.4g operates at sub-GHz frequencies to offer 2⁻3× longer communication range compared to its 2.4 GHz counterpart. Although the standard offers 3 PHYs (Frequncy Shift Keying, Orthogonal Frequency Division Multiplexing and Offset-Quadrature Phase Shift Keying) with numerous configurations, 2-FSK at 50 kbps is the mandatory and most prevalent radio setting used. This article looks at whether IEEE802.15.4g can be used to provide connectivity for outdoor deployments. We conduct range measurements using the totality of the standard (all modulations with all further parametrization) in the 863⁻870 MHz band, within four scenarios which we believe cover most low-power wireless outdoor applications: line of sight, smart agriculture, urban canyon, and smart metering. We show that there are radio settings that outperform the "2-FSK at 50 kbps" base setting in terms of range, throughput and reliability. Results show that highly reliable communications with data rates up to 800 kbps can be achieved in urban environments at 540 m between nodes, and the longest useful radio link is obtained at 779 m. We discuss how IEEE802.15.4g can be used for outdoor operation, and reduce the number of repeater nodes that need to be placed compared to a 2.4 GHz solution.

Open access paper: https://www.mdpi.com/1424-8220/18/10/3468

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Effect of low-level 1800 MHz RF radiation on the rat sciatic nerve and the protective role of paricalcitol

Comelekoglu U, Aktas S, Demirbag B, Karagul MI, Yalin S, Yildirim M, Akar A, Korunur Engiz B, Sogut F, Ozbay E. Effect of low-level 1800 MHz radiofrequency radiation on the rat sciatic nerve and the protective role of paricalcitol. Bioelectromagnetics. 2018 Oct 16. doi: 10.1002/bem.22149.

Abstract

The nervous system is an important target of radiofrequency (RF) radiation exposure since it is the excitable component that is potentially able to interact with electromagnetic fields. The present study was designed to investigate the effects of 1,800 MHz RF radiation and the protective role of paricalcitol on the rat sciatic nerve. Rats were divided into four groups as control, paricalcitol, RF, and RF + paricalcitol. In RF groups, the rats were exposed to 1,800 MHz RF for 1 h per day for 4 weeks. Control and paricalcitol rats were kept under the same conditions without RF application. In paricalcitol groups, the rats were given 0.2 μg/kg/day paricalcitol, three times per week for 4 weeks. Amplitude and latency of nerve compound action potentials, catalase activities, malondialdehyde (MDA) levels, and ultrastructural changes of sciatic nerve were evaluated. In the RF group, a significant reduction in amplitude, prolongation in latency, an increase in the MDA level, and an increase in catalase activity and degeneration in the myelinated nerve fibers were observed. The electrophysiological and histological findings were consistent with neuropathy, and the neuropathic changes were partially ameliorated with paricalcitol administration.

https://www.ncbi.nlm.nih.gov/pubmed/30328127

Excerpts

The effects of 900–1,800 MHz RF on the nervous system have been investigated in different studies. In these studies, it was shown that exposure to RF radiation may cause changes in amygdala morphology and emotional behavior [Narayanan et al., 2018] and changes in cerebral cortex neurotransmitter release [Kim et al., 2017]. In addition, it has been reported that RF radiation may lead to cytotoxicity in hippocampal neuronal HT22 cells [Kim et al., 2017] and degenerative changes in hippocampus pyramidal cells [Hussein et al., 2016].

In a recent study, evidence was provided showing an association between mobile phone use and brain tumors, especially in people who used their mobile phones for more than 10 years [Prasad et al., 2017]. In another study, it was reported that long-term use of mobile phones was linked to an increased risk of intracranial tumors [Bortkiewicz et al., 2017]. These studies show that the nervous systems of both humans and animals are sensitive to RF. However, there are studies in the literature that suggest that exposure to RF radiation does not cause any adverse health effects [Chapman et al., 2016; Mohan et al., 2016; Sato et al., 2017].

In this study, a continuous RF radiation at 1,800 MHz was used. RF simulator (1800CW2, Everest, Adapazari, Turkey) emitting continuous or intermittent wave in 217 Hz modulation had 2 W maximum output power, 2 RF outputting channel, and a monopole antenna (Everest, Adapazari, Turkey). A galvanized plate was placed under a pie cage restrained to decrease magnetic field effect and static electric field effects....

A whole-body average E-field value was calculated from these electric field values. Average E-field was 6.05 ± 0.67 V/m. This measured E-field value was used in an electromagnetic field solver to find the electric field distribution and to calculate SAR....

The distribution of E field and SAR are given in Figure A and B, respectively. As seen from Figure B, the maximum SAR (10 g) is 0.00421 W/kg.

In the present study, the effects of 1800 MHz RF radiation on the sciatic nerve were investigated electrophysiologically, biochemically, and histologically. Our findings showed that 1,800 MHz RF radiation could cause neuropathic changes by inducing oxidative stress. Neuropathic damage was partially improved with 0.2 µg/kg/day paricalcitol, non-hypercalcemic vitamin D analog. However, further studies should be performed by applying different doses to determine the most effective dose of paricalcitol.

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Effects of mobile phone EMF exposure on serum hepcidin and iron status in male albino rats

El-Maleky NF, Ebrahim RH. Effects of exposure to electromagnetic field from mobile phone on serum hepcidin and iron status in male albino rats. Electromagn Biol Med. 2018 Nov 2:1-8. doi: 10.1080/15368378.2018.1531423.

Abstract

BACKGROUND: Electromagnetic fields (EMF) created by mobile phones during communication have harmful effects on different organs.

OBJECTIVES: To explore the effects of exposure to EMF of mobile phones for different durations on hematological parameters and serum hepcidin in male albino rats.

METHODS: Three groups of eight rats: Sham group: rats were exposed to a mobile phone while it was switched off, Experimental group I: rats were exposed to microwave radiation from a mobile phone at 9 am for 30 min. Experimental group II: rats were exposed to microwave radiations from a mobile phone at 9 am for an hour. In all groups, the exposure was conducted daily for a total period of 5 months, followed by estimation of serum hepcidin, total leukocyte count (TLC), interleukin 6 (IL6), serum iron, serum ferritin, plasma hemoglobin (Hb), hematocrit value (Hct), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), unsaturated iron binding capacity (UIBC), total iron binding capacity (TIBC) and 1.25 dihydroxycholecalciferol levels.

RESULTS: In Experimental group II, there was a significant increase in serum hepcidin, TLC, IL6 and serum ferritin; however, serum iron, TIBC, UIBC, 1.25 dihydroxycholecalciferol, plasma Hb, Hct, MCV and MCH were significantly lower in comparison to sham-exposed group. In Experimental group I, there was a significant increase in serum hepcidin, IL6 and TLC, along with non-significant changes in the remaining studied parameters in comparison to the sham-exposed group.

CONCLUSION: Chronic exposure to EMF from mobile phones increases hepcidin level with subsequent impairment of iron parameters, in addition to negatively affecting both UIBC and TIBC.

https://www.ncbi.nlm.nih.gov/pubmed/30388901

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Effects of mobile phone prolonged radiation on kidney cells; an in-vitro study

Mahmoudi, G, Nikzad, S, Mehrpouyan, M, Moslehi, M, Baradaran-Ghahfarokhi, M, Dashty, A. Effects of mobile phone prolonged radiation on kidney cells; an in-vitro study. J Renal Injury Prevention. 7(3):175-179.DOI: 10.15171/jrip.2018.42. Published Sep, 2018.

Abstract

Introduction: Mobile phones have been shown to have hazardous effects on the human renal system, reproduction and development, central nervous system and immune function.

Objectives: This study aimed to investigate whether the mobile phone prolonged radiofrequency (RF) radiation could affect healthy kidney cells in an in-vitro study.

Materials and Methods: Human kidney healthy cells in three groups were placed into three batches. The first and second groups (exposed groups) were exposed to a mobile phone simulator for 1 and 2 h/d, respectively. The irradiation was performed for 8 consecutive days. For the third group (control group), no radiation was applied to the samples and they completed the assay cycle under identical conditions. Cells' survival was evaluated using MTT [3-(4,5-dimethylthiazol-2yl)-2,5-diphenyltetrazolium bromide] assay. Statistical significance of the differences between control and exposed groups were assessed using the repeated measure ANOVA method ($P < 0.05$).

Results: Results showed that radiation exposure from mobile phones simulator decreased the kidney cell survival in the exposed groups (up to 40%). ANOVA test revealed that a significant decrease in cell survival in the exposed group compared to the control group ($P = 0.014$). No significant differences between the irradiated groups were found ($P > 0.05$).

Conclusion: Mobile phone exposure affects kidney cells survival during an in vitro condition. To study the effects of mobile phone radiation on kidney, further in vivo studies on mammalians are needed.

http://www.journalrip.com/PDF/jrip-7-175.pdf?t=636760355158054455

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Dealing with crosstalk in electromagnetic field measurements of portable devices

Eeftens M, Struchen B, Roser K, Zahner M, Fröhlich J, Röösli M. Dealing with crosstalk in electromagnetic field measurements of portable devices. Bioelectromagnetics. 18 October 2018. https://doi.org/10.1002/bem.22142

Abstract

Portable devices measuring radiofrequency electromagnetic fields (RF-EMF) are affected by crosstalk: signals originating in one frequency band that are unintentionally registered in another. If this is not corrected, total exposure to RF-EMF is biased, particularly affecting closely spaced frequency bands such as GSM 1800 downlink (1,805–1,880 MHz), DECT (1,880–1,900 MHz), and UMTS uplink (1,920–1,980 MHz). This study presents an approach to detect and correct crosstalk in RF-EMF measurements, taking into account the real-life setting in which crosstalk is intermittently present, depending on the exact frequency of the signal. Personal measurements from 115 volunteers from Zurich canton, Switzerland were analyzed. Crosstalk-affected observations were identified by correlation analysis, and replaced by the median value of the unaffected observations, measured during the same activity. DECT is frequently a victim of crosstalk, and an average of 43% of observations was corrected, resulting in an average exposure reduction of 38%. GSM 1800 downlink and UMTS uplink were less often corrected (6.9% and 8.9%), resulting in minor reductions in exposure (7.1% and 0.92%). The contribution of DECT to total RF-EMF exposure is typically already low (3.2%), but is further reduced after correction (3.0%). Crosstalk corrections reduced the total exposure by 1.0% on average. Some individuals had a larger reduction of up to 16%. The code developed to make the corrections is provided for free as an R function which is easily applied to any time series of EMF measurements.

Conflicts of interest: Authors Jürg Fröhlich and Marco Zahner declare that they are involved in the company "Fields at Work," which manufactures the ExpoM-RF.

https://onlinelibrary.wiley.com/doi/full/10.1002/bem.22142

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Chronic effect of pulsed 1800 MHz EMR on amino acid neurotransmitters in 3 different areas of juvenile and young adult rat brain

Ahmed NA, Radwan NM, Aboul Ezz HS, Khadrawy YA, Salama NA. The chronic effect of pulsed 1800 MHz electromagnetic radiation on amino acid neurotransmitters in three different areas of juvenile and young adult rat brain. Toxicol Ind Health. 2018 Oct 21:748233718798975. doi: 10.1177/0748233718798975.

Abstract

The extensive use of mobile phones worldwide has raised increasing concerns about the effects of electromagnetic radiation (EMR) on the brain due to the proximity of the mobile phone to the head and the appearance of several adverse neurological effects after mobile phone use. It has been hypothesized that the EMR-induced neurological effects may be mediated by amino acid neurotransmitters. Thus, the present study investigated the effect of EMR (frequency 1800 MHz, specific absorption rate 0.843 W/kg, power density 0.02 mW/cm2, modulated at 217 Hz) on the concentrations of amino acid neurotransmitters (glutamic acid, aspartic acid, gamma aminobutyric acid, glycine, taurine, and the amide glutamine) in the hippocampus, striatum, and hypothalamus of juvenile and young adult rats. The juvenile and young adult animals were each divided into two groups: control rats and rats exposed to EMR 1 h daily for 1, 2, and 4 months. A subgroup of rats were exposed daily to EMR for 4 months and then left without exposure for 1 month to study the recovery from EMR exposure. Amino acid neurotransmitters were measured in the hippocampus, striatum, and hypothalamus using high-performance liquid chromatography. Exposure to EMR induced significant changes in amino acid neurotransmitters in the studied brain areas of juvenile and young adult rats, being more prominent in juvenile

animals. It could be concluded that the alterations in amino acid neurotransmitters induced by EMR exposure of juvenile and young adult rats may underlie many of the neurological effects reported after EMR exposure including cognitive and memory impairment and sleep disorders. Some of these effects may persist for some time after stopping exposure.

https://www.ncbi.nlm.nih.gov/pubmed/30345898

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Evidence of oxidative stress after continuous exposure to Wi-Fi radiation in rat model

Kamali K, Taravati A, Sayyadi S, Gharib FZ, Maftoon H. Evidence of oxidative stress after continuous exposure to Wi-Fi radiation in rat model. Environ Sci Pollut Res Int. 2018 Oct 21. doi: 10.1007/s11356-018-3482-0.

Abstract

Exposure to electromagnetic radiation (EMR) is rapidly increasing in everyday environment, consequently conferring potential health effects. Oxidative stress is emerging as a mechanism implicated in pathophysiology and progression of various diseases. To our knowledge, no report has been made on the status of antioxidant redox systems after continuous exposure to radiofrequency radiation emitted from a Wi-Fi access point in animal model so far. Therefore, we aimed to continuously subject rats in the experimental group to radiofrequency (RF) radiation emitted from a commercially available Wi-Fi device. Male Wister rats were exposed to 2.45 GHz RF radiation emitted from a Wi-Fi for 24 h/day for 10 consecutive weeks. In order to assess the change in antioxidant redox system of plasma after continuous exposure to a Wi-Fi device, the total antioxidant capacity of plasma, level of thiobarbituric acid reactive substances, concentration of reduced glutathione (GSH), and activity of different enzymatic antioxidants, e.g., superoxide dismutase [SOD], catalase [CAT], glutathione peroxidase [GSH-Px], and glutathione S-transferase [GST], were measured. In the Wi-Fi exposed group, a significant decrease was detected in total antioxidant capacity of plasma and the activities of several antioxidant enzymes, including CAT, GSH-Px, and SOD ($P < 0.05$). Meanwhile, the GST activity was significantly increased in this group ($P < 0.05$). However, no significant changes were found in GSH and TBARS levels following exposure to RF radiation. According to the results, oxidative defense system in rats exposed to Wi-Fi signal was significantly affected compared to the control group. Further studies are needed to better understand the possible biological mechanisms of EMR emitted from Wi-Fi device and relevant outcomes.

https://www.ncbi.nlm.nih.gov/pubmed/30343375

Conclusion

According to the results of the current research, long-term exposure to EMR emitted from wireless devices had adverse effects on the antioxidant potential of blood. Therefore, to protect individuals from harmful effects of Wi-Fi signals, it is advised to limit the use of such devices for household and occupational activities, if possible. This study may stimulate future helpful research in the development of new protective or therapeutic approaches. In addition, it is recommended that the target tissues of EMR emitted from wireless devices and the level of other mediators be investigated to understand the exact molecular mechanism and site of action upon continuous exposure to such radiations.

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Introduction to the Special Issue "Electromagnetic Waves Pollution"

Calabrò E. Introduction to the Special Issue "Electromagnetic Waves Pollution." Sustainability 2018, 10(9), 3326; https://doi.org/10.3390/su10093326. Published: Sep 18, 2018. (This article belongs to the Special Issue Electromagnetic Waves Pollution)

Abstract

Modern technology has largely developed using energy forms of which the most relevant is surely electricity. Electric power stations generate alternate current at frequencies of 50 or 60 Hz, transmitted across high voltage transmission lines that are often located too near to buildings where humans live or work. In addition, home devices that work using alternate current expose humans to extremely low-frequency electromagnetic fields. Furthermore, trams, electric trains, and some industrial processes generate static magnetic fields. Electromagnetic fields produce non-ionizing radiation, which gives rise to the so-called electromagnetic waves pollution, also named electrosmog. A large scientific production study showed harmful effects of exposure to EMFs. In view of these results, the International Commission on Non-Ionizing Radiation Protection published international guidelines in order to recommend exposure limits to EMFs for occupational exposure and for general public exposure. The aim of this thematic issue is to give a further contribution to highlight the problem of electromagnetic waves pollution and to investigate the effects of exposure to EMFs on biological systems even below the EMF limits recommended by ICNIRP.

Conclusion

In conclusion, the studies reported in this thematic issue give further proof of significant effects in cellular functions induced by exposure to intensity levels of ELF-EMFs to which humans are generally exposed. Since it cannot be ruled out that such measured alterations can induce the onset of diseases in humans, it would be advisable to design shielding protection against exposure to EMFs or to plan electromagnetic systems and devices working at frequencies far from natural resonant frequencies of biological systems. These frequencies would be discovered in future research.

Open access paper: https://www.mdpi.com/2071-1050/10/9/3326/htm

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Amyotrophic Lateral Sclerosis and Occupational Exposures: A Systematic Literature Review and Meta-Analyses

Gunnarsson LG, Bodin L. Amyotrophic Lateral Sclerosis and Occupational Exposures: A Systematic Literature Review and Meta-Analyses. Int J Environ Res Public Health. 2018 Oct 26;15(11). pii: E2371. doi: 10.3390/ijerph15112371.

Abstract

Objectives: We conducted a systematic literature review to identify studies fulfilling good scientific epidemiological standards for use in meta-analyses of occupational risk factors for amyotrophic lateral sclerosis (ALS).

Methods: We identified 79 original publications on associations between work and ALS. The MOOSE (Meta-analysis Of Observational Studies in Epidemiology) and GRADE (Grading of Recommendations, Assessment, Development and Evaluations) guidelines were used to ensure high scientific quality, and reliable protocols were applied to classify the articles. Thirty-seven articles fulfilled good scientific standards, while 42 were methodologically deficient and thus were excluded from our meta-analyses.

Results: The weighted relative risks for the various occupational exposures were respectively; 1.29 (95% confidence interval (CI): 0.97⁻1.72; six articles) for heavy physical work, 3.98 (95% CI: 2.04⁻7.77; three articles) for professional sports, 1.45 (95% CI: 1.07⁻1.96; six articles) for metals, 1.19 (95% CI: 1.07⁻1.33; 10 articles) for chemicals, 1.18 (95% CI: 1.07⁻1.31; 16 articles) for electromagnetic fields or working with electricity, and 1.18 (95% CI: 1.05⁻1.34; four articles) for working as a nurse or physician.

Conclusions: Meta-analyses based only on epidemiologic publications of good scientific quality show that the risk of ALS is statistically significantly elevated for occupational exposures to excessive physical work, chemicals (especially pesticides), metals (especially lead), and possibly also to electromagnetic fields and health care work. These results are not explained by publication bias.

https://www.ncbi.nlm.nih.gov/pubmed/30373166

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The role of melatonin in preventing ovarian tissue damage in rats exposed to magnetic fields

Küçük Z, Erkayıran U, Çaydere M, Kayaalp D, Karca Altıncaba D. The role of melatonin in preventing ovarian tissue damage in rats exposed to magnetic fields. Turk J Med Sci. 2018 Oct 31;48(5):1073-1079. doi: 10.3906/sag-1707-98.

Abstract

OBJECTIVES: We observed the efficacy of melatonin in preventing ovarian tissue damage in rats exposed to magnetic fields.

MATERIALS AND METHODS: Forty rats were divided into four treatment groups: Group 1, control group (n = 10); Group 2, melatonin administration only (n = 10); Group 3, magnetic field exposure only (n = 10); Group 4, magnetic field exposure with melatonin administration (n = 10). The magnetic field was applied at a dose of 20 μT for 30 min/day for 10 days. Melatonin was orally administered at a dose of 10 mg/kg. We evaluated follicle count, degree of fibrosis, amount of adhesion, amount of apoptosis, ovarian dimensions, and follicular degeneration by dissecting the ovaries of the rats on day 11, and differences among the groups were evaluated.

RESULTS: Group 3 had an increased amount of follicle degeneration, more fibrosis, and more adhesion than Group 4, but these findings were not statistically significant. The apoptosis scores in Groups 1 and 2 were significantly lower than in the other groups. Ovarian dimensions were significantly decreased in Group 3. Follicular degeneration was significantly increased in Group 3.

CONCLUSION: Exogenously administered melatonin, if used at much higher doses orally, may be a noncytotoxic, antiapoptotic agent and may also have a protective effect on ovarian tissue damage that radiation can cause at the level of fine structure

https://www.ncbi.nlm.nih.gov/pubmed/30384578

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ELF EMF decreases serum levels of Interleukin-17, transforming growth factor-β and downregulates Foxp3 in the Spleen

Mahdavinejad L, Alahgholi-Hajibehzad M, Eftekharian MM, Zaerieghane Z, Salehi I, Hajilooi M, Mahaki H, Zamani A. Extremely Low Frequency Electromagnetic Fields Decrease Serum Levels of Interleukin-17, Transforming Growth Factor-β and Downregulate Foxp3 Expression in the Spleen. J Interferon Cytokine Res. 2018 Oct;38(10):457-462. doi: 10.1089/jir.2018.0048.

Abstract

The study aimed to determine effect of extremely low frequency (50 Hz) electromagnetic fields (ELF-EMFs) exposure on serum levels of interleukin-17 (IL-17) and transforming growth factor-β (TGF-β) as signature cytokines of Th17 and regulatory T (Treg) cells, respectively. Retinoid-related orphan receptor γT and transcription factor forkhead box P3 (Foxp3) expression levels as lineage defining of Th17 and Treg cells were also assessed in the spleen and thymus. Eighty male rats were separated into 4 exposed groups (1, 100, 500, and 2,000 μT magnetic flux intensities) and a control. All rats were immunized by human serum albumin after 1 month of the exposure and the experiment was continued in the same manner for 1 month more. The results demonstrated that the weight of thymuses was significantly declined at intensity of 2,000 μT. At the preimmunization phase, the serum levels of IL-17 and TGF-β were significantly decreased at intensities of 1 and 100 μT. The expression of Foxp3 was also downregulated at intensities of 1 and 100 μT. In conclusion, low intensities of ELF-EMF may reduce the serum levels of IL-17 and TGF-β and downregulate the expression of Foxp3 in spleen.

https://www.ncbi.nlm.nih.gov/pubmed/30328796

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Systematic Derivation of Safety Limits for Time-Varying 5G Radiofrequency Exposure Based on Analytical Models and Thermal Dose

Neufeld E, Kuster N. Systematic Derivation of Safety Limits for Time-Varying 5G Radiofrequency Exposure Based on Analytical Models and Thermal Dose. Health Phys. 2018 Sep 21. doi: 10.1097/HP.0000000000000930.

Abstract

Extreme broadband wireless devices operating above 10 GHz may transmit data in bursts of a few milliseconds to seconds. Even though the time- and area-averaged power density values remain within the acceptable safety limits for continuous exposure, these bursts may lead to short temperature spikes in the skin of exposed people. In this paper, a novel analytical approach to pulsed heating is developed and applied to assess the peak-to-average temperature ratio as a function of the pulse fraction α (relative to the averaging time [INCREMENT]T; it corresponds to the inverse of the peak-to-average ratio). This has been analyzed for two different perfusion-related thermal time constants (τ1 = 100 s and 500 s) corresponding to plane-wave and localized exposures. To allow for peak temperatures that considerably exceed the 1 K increase, the CEM43 tissue damage model, with an experimental-data-based damage threshold for human skin of 600 min, is used

to allow large temperature oscillations that remain below the level at which tissue damage occurs. To stay consistent with the current safety guidelines, safety factors of 10 for occupational exposure and 50 for the general public were applied. The model assumptions and limitations (e.g., employed thermal and tissue damage models, homogeneous skin, consideration of localized exposure by a modified time constant) are discussed in detail. The results demonstrate that the maximum averaging time, based on the assumption of a thermal time constant of 100 s, is 240 s if the maximum local temperature increase for continuous-wave exposure is limited to 1 K and $\alpha \geq 0.1$. For a very low peak-to-average ratio of 100 ($\alpha \geq 0.01$), it decreases to only 30 s. The results also show that the peak-to-average ratio of 1,000 tolerated by the International Council on Non-Ionizing Radiation Protection guidelines may lead to permanent tissue damage after even short exposures, highlighting the importance of revisiting existing exposure guidelines.

https://www.ncbi.nlm.nih.gov/pubmed/30247338

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Temperature Increase and Specific Absorption Rate Distribution in Human Breast from Cell Phone Radiation

Kunter, FC, Gündüz C, Seker SS. Temperature increase and Specific Absorption Rate distribution in human breast from cell phone radiation.J Med Imaging Health Informatics. 8(6):1186-1191. DOI: 10.1166/jmihi.2018.2418. Aug 2018.

Abstract

This study describes the cell phone radiation effect on the healthy and unhealthy female breast tissue to establish safety criteria and to detect the cancerous tissue. A computational modeling is performed at 900 MHz and 1800 MHz with a sphere shaped breast and cancerous tissue in different configurations. Thermal investigation is performed through the heat transfer equation to determine temperature and specific absorption rate elevation in the female breast tissue. First, healthy breast tissue is excited with an antenna of which distances to the breast is varying. Next, the distribution of temperature and specific absorption rate are estimated on the different radius of cancerous breast tissue which is located at the center and at the bottom of the breast, respectively. The simulated temperature and the specific absorption rate values imply that the values are ascending with the size of the tumor whereas descending as the source is positioned further.

http://www.ingentaconnect.com/content/asp/jmihi/2018/00000008/00000006/art00012

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Personal Exposure to RF EMF among Australian Adults

Zeleke BM, Brzozek C, Bhatt CR, Abramson MJ, Freudenstein F, Wiedemann P, Geza Benke G. Personal Exposure to Radio Frequency Electromagnetic Fields among Australian Adults. Published Oct 12, 2018 Int. J. Environ. Res. Public Health 2018, 15(10), 2234; https://doi.org/10.3390/ijerph15102234

(This article belongs to the Special Issue Electric, Magnetic, and Electromagnetic Fields in Biology and Medicine: From Mechanisms to Biomedical Applications)

Abstract

The measurement of personal exposure to radiofrequency electromagnetic fields (RF-EMFs) is important for epidemiological studies. RF-EMF exposure can be measured using personal exposimeters that register RF-

EMFs over a wide range of frequency bands. This study aimed to measure and describe personal RF-EMF exposure levels from a wide range of frequency bands. Measurements were recorded from 63 participants over an average of 27.4 (±4.5) hours. RF-EMF exposure levels were computed for each frequency band, as well as from downlink (RF from mobile phone base station), uplink (RF from mobile phone handsets), broadcast, and Wi-Fi. Participants had a mean (±SD) age of 36.9 ± 12.5 years; 66.7% were women; and almost all (98.2%) from urban areas. A Wi-Fi router at home was reported by 61 participants (96.8%), with 38 (61.2%) having a Wi-Fi enabled smart TV. Overall, 26 (41.3%) participants had noticed the existence of a mobile phone base station in their neighborhood. On average, participants estimated the distance between the base station and their usual residence to be about 500 m. The median personal RF-EMF exposure was 208 mV/m. Downlink contributed 40.4% of the total RF-EMF exposure, followed by broadcast (22.4%), uplink (17.3%), and Wi-Fi (15.9%). RF-EMF exposure levels on weekdays were higher than weekends ($p < 0.05$). Downlink and broadcast are the main contributors to total RF-EMF personal exposure. Personal RF-EMF exposure levels vary according to day of the week and time of day.

Open access paper: https://www.mdpi.com/1660-4601/15/10/2234

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Estimation of TETRA radio use in the Airwave Health Monitoring Study of the British police forces

Vergnaud AC, Aresu M, Kongsgård HW, McRobie D, Singh D, Spear J, Heard A, Gao H, Carpenter JR, Elliott P. Estimation of TETRA radio use in the Airwave Health Monitoring Study of the British police forces. Environ Res. 2018 Nov;167:169-174. doi: 10.1016/j.envres.2018.07.015.

Abstract

BACKGROUND: The Airwave Health Monitoring Study aims to investigate the possible long-term health effects of Terrestrial Trunked Radio (TETRA) use among the police forces in Great Britain. Here, we investigate whether objective data from the network operator could be used to correct for misreporting in self-reported data and expand the radio usage availability in our cohort.

METHODS: We estimated average monthly usage of personal radio in the 12 months prior to enrolment from a missing value imputation model and evaluated its performance against objective and self-reported data. Factors associated with TETRA radio usage variables were investigated using Chi-square tests and analysis of variance.

RESULTS: The imputed data were better correlated with objective than self-reported usage (Spearman correlation coefficient = 0.72 vs. 0. 52 and kappa 0.56 [95% confidence interval 0.55, 0.56] vs. 0.46 [0.45, 0.47]), although the imputation model tended to under-estimate use for higher users. Participants with higher personal radio usage were more likely to be younger, men vs. women and officer vs. staff. The median average monthly usage level for the entire cohort was estimated to be 29.3 min (95% CI: [7.2, 66.6]).

CONCLUSION: The availability of objective personal radio records for a large proportion of users allowed us to develop a robust imputation model and hence obtain personal radio usage estimates for ~50,000 participants. This substantially reduced exposure misclassification compared to using self-reported data and will allow us to carry out analyses of TETRA usage for the entire cohort in future work.

https://www.ncbi.nlm.nih.gov/pubmed/30014898

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Nonparticipation selection bias in the MOBI-Kids Study

Turner MC, Gracia-Lavedan E, Momoli F, Langer CE, Castaño-Vinyals G, Kundi M, Maule M, Merletti F, Sadetzki S, Vermeulen R, Albert A, Alguacil J, Aragones N, Badia F, Bruchim R, Carretero G, Kojimahara N, Lacour B, Morales-Suarez-Varela M, Radon K, Remen T, Weinmann T, Yamaguchi N, Cardis E. Nonparticipation selection bias in the MOBI-Kids Study. Epidemiology. Oct 1, 2018. doi: 10.1097/EDE.0000000000000932.

Abstract

BACKGROUND: MOBI-Kids is a 14-country case-control study designed to investigate the potential effects of electromagnetic field exposure from mobile telecommunications devices on brain tumor risk in children and young adults conducted from 2010-2016. This work describes differences in cellular telephone use and personal characteristics among interviewed participants and refusers responding to a brief non-respondent questionnaire. It also assesses the potential impact of non-participationDrafts selection bias on study findings.

METHODS: We compared non-respondent questionnaires completed by 77 case and 498 control refusers with responses from 683 interviewed cases and 1,501 controls (suspected appendicitis patients) in six countries (France, Germany, Israel, Italy, Japan, and Spain). We derived selection bias factors and estimated inverse probability of selection weights for use in analysis of MOBI-Kids data.

RESULTS: The prevalence of ever regular use was somewhat higher among interviewed participants than non-respondent questionnaire respondents aged 10-14 years (68% vs 62% controls, 63% vs 48% cases); in those 20-24 years, the prevalence was ≥ 97%. Interviewed controls and cases in the 15-19- and 20-24-year age groups were more likely to have a time since start of use of 5+ years. Selection bias factors generally indicated a small underestimation in cellular telephone odds ratios (ORs) ranging from 0.96-0.97 for ever regular use and 0.92-0.94 for time since start of use (5+ years), but varied in alternative hypothetical scenarios considered.

CONCLUSIONS: Although limited by small numbers of non-respondent questionnaire respondents, findings generally indicated a small underestimation in cellular telephone ORs due to selective non-participation.

Open access paper: https://www.ncbi.nlm.nih.gov/pubmed/30299406

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Letter to the Editor concerning the paper “A novel database of bio-effects from non-ionizing radiation”

Drießen S, Dechent D, Graefrath D, Petri A-K, Bodewein L, Emonds T, Kraus T. Letter to the Editor concerning the paper “A novel database of bio-effects from non-ionizing radiation." Reviews on Environmental Health. Oct 11, 2018. https://doi.org/10.1515/reveh-2018-0056

Excerpts

Over the past decade my colleagues and I have provided the EMF-Portal, a database on non-ionizing electromagnetic fields, launched by RWTH Aachen University, Germany. Today, the database of the EMF-Portal consists of more than 27,000 scientific publications, and the number is growing every day. The World Health Organization has also honored our EMF platform for many years and recommends it as a reference database.

Over the last 10 years, the EMF-Portal was mainly funded by German institutions, in spite of the fact that about 80% of our users are from other countries. However, because the debate in Germany about electromagnetic fields in the radiofrequency area has greatly decreased, we no longer have the same financial resources at our disposal as in previous years. As a result, we had to stop reviewing and uploading new articles about radiofrequency and mobile communications. Papers on biological effects caused by extremely low frequency fields (<10 MHz) have never been affected by this decision and have been continuously imported into the EMF-Portal. All this information is available on our homepage.

In the meantime, thanks to the financial support of our valuable users, we were able once again, to import articles from the radiofrequency range into the EMF-Portal (up to April 30, 2018). We hope to find a solution that allows for this service to continue past this date.

In addition, we would like to make a comment about the “effect/no effect” feature in the ORSAA database presented by the authors. According to Table 2 in their article, every study is indicated as an “effect study” if an observed change of status occurred in one or more parameters examined. Thus, as an example, the study by Sommer et al. (2) on lymphoma development is counted as an “effect study”, because the body weight of the investigated animals increased, although survival rate and lymphoma incidence did not differ between exposed mice and mice in the control group.

In our opinion, such a global categorization biases studies towards an “effect study” classification although the main outcome was “no effect”. Results of this analysis, as presented in their article, where 3 times more biological “Effect” than “No Effect” papers have been identified, might rather indicate this strong bias. For us, this is a real shortcoming in a self-declared non-biased database. To prevent such a bias and to promote a critical and differentiated discussion, we have decided not to offer such a feature in the EMF-Portal.

https://www.ncbi.nlm.nih.gov/pubmed/30307899

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Probing Origins of 1,800 MHz RF EMR Induced Damage in Mouse Immortalized Germ Cells and Spermatozoa in vitro

Houston BJ, Nixon B, King BV, Aitken RJ, De Iuliis GN. Probing the origins of 1,800 MHz radio frequency electromagnetic radiation induced damage in mouse immortalized germ cells and spermatozoa in vitro. Front. Public Health. 2018 Sep 21. https://doi.org/10.3389/fpubh.2018.00270

As the use of mobile phone devices is now highly prevalent, many studies have sought to evaluate the effects of the radiofrequency-electromagnetic radiation (RF-EMR) on both human health and biology. While several such studies have shown RF-EMR is capable of inducing cellular stress, the physicobiological origin of this stress remains largely unresolved. To explore the effect of RF-EMR on the male reproductive system, we exposed cultured mouse spermatogonial GC1 and spermatocyte GC2 cell lines, as well as cauda epididymal spermatozoa to a waveguide generating continuous wave RF-EMR (1.8 GHz, 0.15 and 1.5 W/kg). This study demonstrated that a 4 h exposure is capable of inducing the generation of mitochondrial reactive oxygen species (ROS) in populations of GC1 (7 vs. 18%; $p < 0.001$) and GC2 cells (11.5 vs. 16 %; $p < 0.01$), identifying Complex III of the electron transport chain (ETC) as the potential source of electrons producing ROS. Assessing the generation of ROS in the presence of an antioxidant, penicillamine, as well as measuring lipid peroxidation via 4-hydroxynonenal levels, indicated that the elevated incidence of ROS generation observed under our exposure conditions did not necessarily induce an overt cellular oxidative stress response. However, exposure to RF-EMR at 0.15 W/kg for 3 h did induce significant DNA fragmentation in spermatozoa (that was no longer significant after 4 h), assessed by the alkaline comet assay ($p < 0.05$). Furthermore, this fragmentation was accompanied by an induction of oxidative DNA damage in the form of 8-hydroxy-2′-

deoxyguanosine, which was significant ($p < 0.05$) after spermatozoa were exposed to RF-EMR for 4 h. At this exposure time point, a decline in sperm motility ($p < 0.05$) was also observed. This study contributes new evidence toward elucidating a mechanism to account for the effects of RF-EMR on biological systems, proposing Complex III of the mitochondrial ETC as the key target of this radiation.

Open access paper: https://www.frontiersin.org/articles/10.3389/fpubh.2018.00270/full

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The effect of 2.45 GHz non-ionizing radiation on the structure and ultrastructure of the testis in juvenile rats

Šimaiová V, Almášiová V, Holovská K, Kisková T, Horváthová F, Ševčíková Z, Tóth Š, Raček A, Račeková E, Beňová K, Dvořák P, Cigánková V. The effect of 2.45 GHz non-ionizing radiation on the structure and ultrastructure of the testis in juvenile rats. Histol Histopathol. 2018 Sep 27:18049. doi: 10.14670/HH-18-049.

Abstract

BACKGROUND: Nowadays, mobile devices that emit non-ionizing electromagnetic radiation (EMR) are predominantly used by juveniles and pubescents. The aim of the present study was to evaluate the effect of whole body pulsed EMR on the juvenile Wistar albino rat testis at a frequency of 2.45 GHz and mean power density of 2.8 mW/cm².

METHODS: The investigated animals (n=24) were divided into two control and two EMR groups (5 and 6 week old rats; 6 rats per group). Both EMR groups were irradiated continually for 3 weeks (2h/day) from postnatal days 14 and 21, respectively.

RESULTS: EMR caused an irregular shape of seminiferous tubules with desquamated immature germ cells in the lumen, a large number of empty spaces along the seminiferous epithelium and dilated and congested blood vessels in the interstitial tissue of the testis. The cytoplasm of Sertoli cells showed strong vacuolization and damaged organelles, with the cytoplasm full of different heterophagic and lipid vacuoles or the cytoplasm of spermatocytes with swollen mitochondria in both irradiated groups. A significant increase in the total tubular area of seminiferous tubules was observed in both EMR groups compared with controls ($P<0.001$). A significant increase in the TUNEL-positive apoptotic nuclei ($P<0.01$) was accompanied by a significant rise in both Cu-Zn-SOD ($P<0.01$) and Mn-SOD ($P<0.001$) positive cells in the 6 week old experimental rats compared to control animals.

CONCLUSION: Our results confirmed a harmful effect of non-ionizing radiation on the structure and ultrastructure of the juvenile rat testis.

https://www.ncbi.nlm.nih.gov/pubmed/30259955

All experimental rats were exposed to whole-body pulsed non-ionizing electromagnetic radiation at a frequency of 2.45 GHz and mean power density of 2.8 mW/ cm² in a purpose-designed chamber (Fig. 1). The uniformity of the electromagnetic field was monitored with a spectral analyser.

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The effect of 20-week continuous 60 Hz magnetic field exposure on testicular function in Sprague-Dawley rats

Park S, Kim YJ, Kim MS, Kim HS, Kim MW, Kang YM, Lee SK, Choi KC, Kim N, Gimm YM, Kim YW. The effect of 20-week continuous 60 Hz magnetic field exposure on testicular function in Sprague-Dawley rats. Bioelectromagnetics. 2018 Oct 5. doi: 10.1002/bem.22146.

Abstract

Accumulating evidence does not yet confirm the effect of power line frequency magnetic field (MF) on human health and fertility. We recently reported that, at continuous 60 Hz MF exposure in mice, the dose given as magnetic flux density (tesla; T) and duration of exposure was related to induce testicular germ cell apoptosis. We aimed to characterize the effect of a 20-week continuous exposure to 60 Hz MF on the motility, morphology, and number of sperm as well as the apoptosis of testicular germ cell in rats. Sprague-Dawley rats were exposed for 20 weeks to 60 Hz MF of 2, 20, or 200 μT for 24 h/day with rats exposed to sham conditions, serving as the control. The exposure to 60 Hz MF of 2 and 20 μT had no effects on testicular in this study. The exposure to 60 Hz MF of 200 μT for 20 weeks induced increases of the apoptotic cells ($P < 0.001$) in germ cells and decreases of sperm numbers ($P < 0.05$). However, the MF did not significantly affect the body or testis mass, seminiferous tubule diameter, or the motility or morphology of sperm. This study concluded that exposure to 60 Hz MF of 200 μT can increase testicular germ cell apoptosis, especially spermatogonia, and reduce sperm count. Also compared to previous mice studies, rats are less sensitive than mice to exposure to 60 Hz MF.

https://www.ncbi.nlm.nih.gov/pubmed/30289990

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Effects of exposure to ELF-EMF on spatial & passive avoidance learning & memory, anxiety-like behavior & oxidative stress in male rats

Asaad Karimi S, Salehi I, Shykhi T, Zare S, Komaki A. Effects of exposure to extremely low-frequency electromagnetic fields on spatial and passive avoidance learning and memory, anxiety-like behavior and oxidative stress in male rats. Behav Brain Res. 2018 Oct 2. pii: S0166-4328(18)31074-X. doi: 10.1016/j.bbr.2018.10.002.

Abstract

There are many controversies about the safety of extremely low-frequency electromagnetic field (ELF-EMF) on body health and cognitive performance. In the present study, we explored the effects of ELF-EMF on oxidative stress and behaviors of rats. Seventy-two adult male Wistar rats were randomly divided into following groups, control, sham exposure group and the ELF-EMF exposure groups (1 μT, 100 μT, 500 μT, and 2000 μT). After 60 days exposure (2 h/day), elevated plus maze (EPM), Morris water maze (MWM) and Passive avoidance learning (PAL) tasks were used to evaluate the anxiety-like behavior, spatial and passive learning and memory, respectively. Some days after behavioral examination, oxidative stress markers were measured. During spatial reference memory test, animals in ELF-EMF exposure groups (100, and 2000 μT) spent more time in target zone ($F (4, 55) = 5.699$, $P = 0.0007$, One-way ANOVA). In PAL retention, the step through latency in the retention test (STLr) in ELF-EMF exposure groups (100,500, and 2000 μT) was significantly greater than control group ($F (4, 55) = 29.13$, $P < 0.0001$, One-way ANOVA). In EPM test, ELF-EMF exposure (500 and

2000 μT) decreased the percentage of the entries into the open arms ($F (4, 55) = 26.31$, $P < 0.0001$, one-way ANOVA). ELF-EMF exposure (100, and 500 μT) increased Malondialdehyde (MDA) concentration ($F (4, 25) = 79.83$, $P < 0.0001$, One-way ANOVA). Our results may allow the conclusion that exposure to ELF-EMFs can improve memory retention (but not acquisition) in the adult male rats. Although exposure to ELF-EMFs could be a factor in the development of anxious state or oxidative stress.

https://www.ncbi.nlm.nih.gov/pubmed/30290199

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Low-intensity EMFs induce human cryptochrome to modulate intracellular reactive oxygen species

Sherrard RM, Morellini N, Jourdan N, El-Esawi M, Arthaut LD, Niessner C, Rouyer F, Klarsfeld A, Doulazmi M, Witczak J, d'Harlingue A, Mariani J, Mclure I, Martino CF, Ahmad M. Low-intensity electromagnetic fields induce human cryptochrome to modulate intracellular reactive oxygen species. PLoS Biol. 2018 Oct 2;16(10):e2006229. doi: 10.1371/journal.pbio.2006229.

Abstract

Exposure to man-made electromagnetic fields (EMFs), which increasingly pollute our environment, have consequences for human health about which there is continuing ignorance and debate. Whereas there is considerable ongoing concern about their harmful effects, magnetic fields are at the same time being applied as therapeutic tools in regenerative medicine, oncology, orthopedics, and neurology. This paradox cannot be resolved until the cellular mechanisms underlying such effects are identified. Here, we show by biochemical and imaging experiments that exposure of mammalian cells to weak pulsed electromagnetic fields (PEMFs) stimulates rapid accumulation of reactive oxygen species (ROS), a potentially toxic metabolite with multiple roles in stress response and cellular ageing. Following exposure to PEMF, cell growth is slowed, and ROS-responsive genes are induced. These effects require the presence of cryptochrome, a putative magnetosensor that synthesizes ROS. We conclude that modulation of intracellular ROS via cryptochromes represents a general response to weak EMFs, which can account for either therapeutic or pathological effects depending on exposure. Clinically, our findings provide a rationale to optimize low field magnetic stimulation for novel therapeutic applications while warning against the possibility of harmful synergistic effects with environmental agents that further increase intracellular ROS.

Author summary

Repetitive low-intensity magnetic stimulation has been used in the treatment of disease for over 50 years. Associated benefits have included alleviation of depression, memory loss, and symptoms of Parkinson disease, as well as accelerated bone and wound healing and the treatment of certain cancers, independently of surgery or drugs. However, the cellular mechanisms underlying these effects remain unclear. Here, we demonstrate that repetitive magnetic field exposure in human cells stimulates production of biological stress response chemicals known as reactive oxygen species (ROS). At moderate doses, we find that reactive oxygen actively stimulates cellular repair and stress response pathways, which might account for the observed therapeutic effects to repetitive magnetic stimulation. We further show that this response requires the function of a well-characterized, evolutionarily conserved flavoprotein receptor known as cryptochrome, which has been implicated in magnetic sensing in organisms ranging from plants to flies, including migratory birds. We conclude that exposure to weak magnetic fields induces the production of ROS in human cells and that this process requires the presence of the cryptochrome receptor.

Editor's Note:

This Short Report received positive reviews by experts. The Academic Editor has written an accompanying Primer that we are publishing alongside this article (https://doi.org/10.1371/journal.pbio.3000018). The linked Primer presents a complementary expert perspective; it discusses considerations about the status of knowledge and experimental systems in the field that encourage cautious interpretation.

Open access paper: https://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.2006229

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Cryptochrome: The magnetosensor with a sinister side?

Landler L, Keays DA (2018) Cryptochrome: The magnetosensor with a sinister side? PLoS Biol 16(10): e3000018. https://doi.org/10.1371/journal.pbio.3000018.

No abstract.

Open access paper: https://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.3000018

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Coupling of oxidative stress responses to tricarboxylic acid cycle & prostaglandin E2 alterations in Caenorhabditis elegans under ELF-EMF

Sun Y, Shi Z, Wang Y, Tang C, Liao Y, Yang C, Cai P. Coupling of oxidative stress responses to tricarboxylic acid cycle and prostaglandin E2 alterations in Caenorhabditis elegans under extremely low-frequency electromagnetic field. Int J Radiat Biol. 2018 Oct 11:1-8. doi: 10.1080/09553002.2019.1524943.

Abstract

PURPOSE: With all-pervasive presence of extremely low-frequency electromagnetic field (ELF-EMF) in modern life, ELF-EMF has been regarded as an essential factor which may induce changes in many organisms. The objective of the present study was to investigate the physiological responses of Caenorhabditis elegans (C. elegans) to 50 Hz, 3 mT ELF-EMF exposure.

MATERIALS AND METHODS: Worms were exposed to ELF-EMF from the egg stage until reaching the fourth larva (L4) stage. After exposure, expressions of the tricarboxylic acid (TCA) cycle enzymes were examined by qRT-PCR and western blot analysis. Two lipid metabolites were detected by GC-MS. Reactive oxygen species (ROS) level was detected by dichlorofluorescein staining and worm antioxidant system was investigated by enzymatic activity analysis, including detection of the superoxide dismutase and catalase (CAT) activity and the total antioxidant capacity (T-AOC).

RESULTS: The TCA cycle enzyme, fumarase was found with decreased expression under ELF-EMF exposure. And arachidonic acid (ArA) and prostaglandin E2(PGE2) showed elevated concentrations, with increased expression of prostaglandin E2 synthase (PGES-2) in ELF-EMF exposed worms. Significant elevation of ROS level was identified accompanied with the significant depression of T-AOC in response to ELF-EMF.

CONCLUSIONS: Our results suggested that exposure to 50 Hz, 3 mT ELF-EMF in C. elegans can elicit disruptions of the TCA cycle metabolism and PGE2 formation, coupling ELF-EMF-induced oxidative stress responses. Our study probably will attract increasing attentions to the controllable application of ELF-EMF associated with health and disease.

https://www.ncbi.nlm.nih.gov/pubmed/30307357

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Effects of weak static magnetic fields on the gene expression of seedlings of Arabidopsis thaliana

Dhiman SK, Galland P. Effects of weak static magnetic fields on the gene expression of seedlings of Arabidopsis thaliana. J Plant Physiol. 2018 Sep 3;231:9-18. doi: 10.1016/j.jplph.2018.08.016.

Abstract

Magnetic-field reception of animals and plants is currently discussed in the framework of a cryptochrome-based radical-pair mechanism. Efforts to unravel magnetoreception in plants suffered historically from several shortcomings, most prominently, the conspicuous absence of detailed stimulus-response relationships. To determine the sensitivity of seedlings of Arabidopsis thaliana to weak static magnetic fields we generated stimulus-response curves between near zero and 188 μT for the transcript levels of the genes rbcl, cab4, pal4 and ef1. The moderate magneto-responsiveness of dark-grown seedlings was greatly enhanced under blue light, and for rbcl and pal4 also under red light. The stimulus-response curves obtained under blue light of constant photon-fluence rate displayed multiple maxima and thus a pattern fundamentally different from that prevalent in plant and animal physiology. A double mutant lacking cryptochromes 1 and 2 displayed altered stimulus-response curves without losing, however, magneto-responsiveness completely. A reversal of the magnetic field direction substantially affected the gene expression and the quantity of CAB-protein (chlorophyll a,b-binding protein). The majority of our results are at variance with the notion of cryptochromes acting as the only magnetic-field sensors. They do not, however, exclude the possibility that cryptochromes participate in the magnetic field reception of Arabidopsis. The findings have the unexpected implication that cryptochrome- and phytochrome-mediated plant responses can be modulated by the strength and the orientation of the local geomagnetic field.

https://www.ncbi.nlm.nih.gov/pubmed/30199755

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Some recommendations for experimental work in magnetobiology, revisited

Makinistian L, Muehsam DJ, Bersani F, Belyaev I. Some recommendations for experimental work in magnetobiology, revisited. Bioelectromagnetics. 2018 Oct 10. doi: 10.1002/bem.22144.

No abstract.

https://www.ncbi.nlm.nih.gov/pubmed/30303544

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Weak power frequency magnetic fields induce microtubule cytoskeleton reorganization depending on epidermal growth factor receptor & calcium signaling

Wu X, Du J, Song W, Cao M, Chen S, Xia R. Weak power frequency magnetic fields induce microtubule cytoskeleton reorganization depending on the epidermal growth factor receptor and the calcium related signaling. PLoS One. 2018 Oct 12;13(10):e0205569. doi: 10.1371/journal.pone.0205569.

Abstract

We have shown previously that a weak 50 Hz magnetic field (MF) invoked the actin-cytoskeleton, and provoked cell migration at the celllevel, probably through activating the epidermal growth factor receptor (EGFR) related motility pathways. However, whether the MF also affects the microtubule (MT)-cytoskeleton is still unknown. In this article, we continuously investigate the effects of 0.4 mT, 50 Hz MF on the MT, and try to understand if the MT effects are also associated with the EGFR pathway as the actin-cytoskeleton effects were. Our results strongly suggest that the MF effects are similar to that of EGF stimulation on the MT cytoskeleton, showing that 1) the MF suppressed MT in multiple cell types including PC12 and FL; 2) the MF promoted the clustering of the EGFR at the protein and the cell levels, in a similar way of that EGF did but with higher sensitivity to PD153035 inhibition, and triggered EGFR phosphorylation on sites of Y1173 and S1046/1047; 3) these effects were strongly depending on the Ca2+ signaling through the L-type calcium channel (LTCC) phosphorylation and elevation of the intracellular Ca2+ level. Strong associations were observed between EGFR and the Ca2+ signaling to regulate the MF-induced-reorganization of the cytoskeleton network, via phosphorylating the signaling proteins in the two pathways, including a significant MT protein, tau. These results strongly suggest that the MF activates the overall cytoskeleton in the absence of EGF, through a mechanism related to both the EGFR and the LTCC/Ca2+ signaling pathways.

Open access paper: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0205569

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Commentary on NTP cell phone data for assessing human health risks despite unfounded criticisms aimed at minimizing findings

Melnick RL. Commentary on the utility of the National Toxicology Program study on cell phone radiofrequency radiation data for assessing human health risks despite unfounded criticisms aimed at minimizing the findings of adverse health effects. Environ Res. 2018 Sep 19;168:1-6. doi: 10.1016/j.envres.2018.09.010.

Abstract

The National Toxicology Program (NTP) conducted two-year studies of cell phone radiation in rats and mice exposed to CDMA- or GSM-modulated radiofrequency radiation (RFR) at exposure intensities in the brain of rats that were similar to or only slightly higher than potential, localized human exposures from cell phones held next to the head. This study was designed to test the (null) hypothesis that cell phone radiation at non-thermal exposure intensities could not cause adverse health effects, and to provide dose-response data for any detected toxic or carcinogenic effects. Partial findings released from that study showed significantly increased incidences and/or trends for gliomas and glial cell hyperplasias in the brain and schwannomas and Schwann cell hyperplasias in the heart of exposed male rats. These results, as well as the findings of significantly increased DNA damage (strand breaks) in the brains of exposed rats and mice, reduced pup birth weights when pregnant dams were exposed to GSM- or CDMA-modulated RFR, and the induction of cardiomyopathy of the right ventricle in male and female rats clearly demonstrate that the null hypothesis has been disproved. The NTP findings are most important because the International Agency for Research on Cancer (IARC)

classified RFR as a "possible human carcinogen" based largely on increased risks of gliomas and acoustic neuromas (which are Schwann cell tumors on the acoustic nerve) among long term users of cell phones. The concordance between rats and humans in cell type affected by RFR strengthens the animal-to-human association. This commentary addresses several unfounded criticisms about the design and results of the NTP study that have been promoted to minimize the utility of the experimental data on RFR for assessing human health risks. In contrast to those criticisms, an expert peer-review panel recently concluded that the NTP studies were well designed, and that the results demonstrated that both GSM- and CDMA-modulated RFR were carcinogenic to the heart (schwannomas) and brain (gliomas) of male rats.

https://www.ncbi.nlm.nih.gov/pubmed/30243215

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Evaluation of Genotoxicity of Cell Phone Radiation in Male and Female Rats and Mice Following Subchronic Exposure

Smith-Roe SL, Wyde ME, Stout MD, Winters JW, Hobbs CA, Shepard KG, Green AS, Kissling GE, Tice RR, Bucher JR, Witt KL. Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure. 49th Annual Meeting of the Environmental Mutagenesis and Genomics Society. San Antonio, Texas, Sep 22-26, 2018. Environmental and Molecular Mutagenesis; 59 (Suppl. 1): 85-85. Meeting abstract: P9. Sep 2018.

National Toxicology Program/NIEHS, Research Triangle Park, NC, and Integrated Laboratory Systems, Inc., Research Triangle Park, NC.

Abstract

The National Toxicology Program tested the two common radiofrequency radiation (RFR) modulations emitted by cellular telephones in a 2-year rodent cancer bioassay that included additional animal cohorts for interim assessments of genotoxicity endpoints.

Male and female Sprague Dawley rats and B6C3F1/N mice were exposed from gestation day 5 or postnatal day 35, respectively, to code division multiple access (CDMA) or global system for mobile (GSM) modulations semi-continuously for 18 h/day in 10 min intervals in reverberation chambers at specific absorption rates (SAR) of 1.5, 3, or 6 W/kg (rats) or 2.5, 5, or 10 W/kg (mice). Rats and mice were exposed at 900 MHz or 1900 MHz, respectively. The interim cohorts, 5 animals per treatment group, were examined after 19 (rats) or 13 (mice) weeks of exposure for evidence of RFR-induced genotoxicity. DNA damage was assessed in three brain regions (frontal cortex, hippocampus, and cerebellum), and in liver cells and blood leukocytes using the comet assay. Chromosomal damage was assessed in peripheral blood erythrocytes using the micronucleus assay.

DNA damage was significantly increased in the frontal cortex of male mice (both modulations), peripheral leukocytes of female mice (CDMA only), and hippocampus of male rats (CDMA only). DNA damage was nominally elevated in several other tissues of RFR-exposed rats, although statistical significance was not achieved. No significant increases in micronucleated red blood cells were observed in rats or mice.

These results suggest that exposure to RFR has the potential to induce measurable DNA damage under certain exposure conditions.

https://onlinelibrary.wiley.com/doi/abs/10.1002/em.22231

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Personal exposure to radio-frequency electromagnetic fields in Europe: Is there a generation gap?

Eeftens M, Struchen B, Birks LE, Cardis E, Estarlich M, Fernandez MF, Gajšek P, Gallastegi M, Huss A, Kheifets L, Meder IK, Olsen J, Torrent M, Trček T, Valič B, Vermeulen R, Vrijheid M, van Wel L, Guxens M, Röösli M. Personal exposure to radio-frequency electromagnetic fields in Europe: Is there a generation gap? Environ Int. 2018 Sep 11;121(Pt 1):216-226. doi: 10.1016/j.envint.2018.09.002.

Highlights

• Exposure to RF-EMF from uplink sources is higher in parents than in their children.
• Diurnal patterns for uplink indicate more phone use between 8 AM and 8 PM.
• Exposure to RF-EMF is correlated between children and parents from the same family.
• Higher RF-EMF levels are found in transport, where the uplink contribution is relatively high.
• The lowest levels are measured at home, school and work, where people spend most time.

Abstract

BACKGROUND: Exposure to radiofrequency electromagnetic fields (RF-EMF) from mobile communication technologies is changing rapidly. To characterize sources and associated variability, we studied the differences and correlations in exposure patterns between children aged 8 to 18 and their parents, over the course of the day, by age, by activity pattern, and for different metrics of exposure.

METHODS: Using portable RF-EMF measurement devices, we collected simultaneous real-time personal measurements of RF-EMF over 24 to 72 h in 294 parent-child pairs from Denmark, the Netherlands, Slovenia, Switzerland, and Spain. The devices measured the power flux density (mW/m2) in 16 different frequency bands every 4 s, and activity diary Apps kept by the participants were used to collect time-activity information in real-time. We analyzed their exposures by activity, for the different source constituents of exposure: downlink (radiation emitted from mobile phone base stations), uplink (transmission from phone to base station), broadcast, DECT (digital enhanced cordless telecommunications) and Wi-Fi. We looked at the correlations between parents and children overall, during day (06:00-22.00) and night (22:00-06:00) and while spending time at home.

RESULTS: The mean of time-weighted average personal exposures was 0.16 mW/m2 for children and 0.15 mW/m2 for parents, on average predominantly originating from downlink sources (47% for children and 45% for parents), followed by uplink (18% and 27% respectively) and broadcast (25% and 19%). On average, exposure for downlink and uplink were highest during the day, and for Wi-Fi and DECT during the evening. Exposure during activities where most of the time is spent (home, school and work) was relatively low whereas exposure during travel and outside activities was higher. Exposure to uplink increased with age among young people, while DECT decreased slightly. Exposure to downlink, broadcast, and Wi-Fi showed no obvious trend with age. We found that exposure to total RF-EMF is correlated among children and their parents (Rspearman = 0.45), especially while at home (0.62) and during the night (0.60). Correlations were higher for environmental sources such as downlink (0.57) and broadcast (0.62) than for usage-related exposures such as

uplink (0.29).

CONCLUSION: The generation gap between children and their parents is mostly evident in uplink exposure, due to more and longer uplink and cordless phone calls among parents, and their tendency to spend slightly more time in activities with higher environmental RF-EMF exposure, such as travel. Despite these differences in personal behavior, exposure to RF-EMF is moderately correlated between children and their parents, especially exposures resulting from environmental RF-EMF sources.

https://www.ncbi.nlm.nih.gov/pubmed/30216774

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Mobile antenna's impact on human health

Subhan F, Khan A, Ahmed S, Malik SN, Bakshah ST, Tahir S. Mobile antenna's and its impact on human health. J Medical Imaging and Health Informatics. 8(6):1266-1273. DOI: 10.1166/jmihi.2018.2296. Aug 2018.

Abstract

Mobile phones operate by communicating with a base station or cellular antennas. As mobile phone and its base station is a two way radio, they emit radio frequency radiation as a means of communication and hence can expose people near them to these radiations. Several research studies have found a link between cellular antennas and health effects on people living near antennas. These include cardiovascular problems, skin complaints, fatigue, sleep disturbance, memory loss, irritability, visual disruptions, hearing problems, depression, and dizziness. An extensive literature review was done to study the effect of mobile antennas on health including cancer. These studies concluded that incidence of cancer cases was remarkably higher among people who resided in 400 meters from mobile antennas, in comparison to those who lived further away. Females reported statistically more health complaints than males. Inhabitants living close to cellular antennas are also at increased risk for developing neuropsychiatric complaints. There are many proposed national and international criteria, for regulating and approving safety guidelines. All telecommunication companies should follow these safety standards.

http://www.ingentaconnect.com/contentone/asp/jmihi/2018/00000008/00000006/art00023

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Individual variation in temporal relationships between RF exposure & physical symptoms: A new approach in studying 'electrosensitivity'

Bogers RP, van Gils A, Clahsen SCS, Vercruijsse W, van Kamp I, Baliatsas C, Rosmalen JGM, Bolte JFB. Individual variation in temporal relationships between exposure to radiofrequency electromagnetic fields and non-specific physical symptoms: A new approach in studying 'electrosensitivity'. Environ Int. 2018 Sep 15;121(Pt 1):297-307. doi: 10.1016/j.envint.2018.08.064.

Abstract

BACKGROUND: Everyday exposure to radiofrequency electromagnetic fields (RF-EMF) emitted from wireless devices such as mobile phones and base stations, radio and television transmitters is ubiquitous. Some people attribute non-specific physical symptoms (NSPS) such as headache and fatigue to exposure to RF-EMF. Most previous laboratory studies or studies that analyzed populations at a group level did not find evidence of an association between RF-EMF exposure and NSPS.

OBJECTIVES: We explored the association between exposure to RF-EMF in daily life and the occurrence of

NSPS in individual self-declared electrohypersensitive persons using body worn exposimeters and electronic diaries.

METHODS: We selected seven individuals who attributed their NSPS to RF-EMF exposure. The level of and variability in personal RF-EMF exposure and NSPS were determined during a three-week period. Data were analyzed using time series analysis in which exposure as measured and recorded in the diary was correlated with NSPS.

RESULTS: We found statistically significant correlations between perceived and actual exposure to wireless internet (WiFi - rate of change and number of peaks above threshold) and base stations for mobile telecommunications (GSM + UMTS downlink, rate of change) and NSPS scores in four of the seven participants. In two persons a higher EMF exposure was associated with higher symptom scores, and in two other persons it was associated with lower scores. Remarkably, we found no significant correlations between NSPS and time-weighted average power density, the most commonly used exposure metric.

CONCLUSIONS: RF-EMF exposure was associated either positively or negatively with NSPS in some but not all of the selected self-declared electrohypersensitive persons.

https://www.ncbi.nlm.nih.gov/pubmed/30227317

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A 3D human body blockage model for outdoor millimeter-wave cellular communication

Han B. Wang L, Schotten HD. A 3D human body blockage model for outdoor millimeter-wave cellular communication. Physical Communication, 25(Part 2):502-510. Dec 2017.

Blocking is one of the most important challenges in exploiting millimeter-wave for fifth-generation (5G) cellular communication systems. Compared to blockages caused by buildings or terrains, human body blockage exhibits a higher complexity due to the mobility and dynamic statistics of humans. To support development of outdoor millimeter-wave cellular systems, in this paper we present a novel 3D physical model of human body blockage. Based on the proposed model, the impact of human body blockage on frame-based data transmission is discussed, with respect to the system specifications and environment conditions.

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Mobile Phone Distance from Head and Temperature Changes of Radio Frequency Waves on Brain Tissue

Forouharmajd F, Ebrahimi H, Pourabdian S. Mobile Phone Distance from Head and Temperature Changes of Radio Frequency Waves on Brain Tissue. Int J Prev Med. 2018 Jul 20;9:61. doi: 10.4103/ijpvm.IJPVM_70_17.

Abstract

Background: Analyzing the possible negative effects of using cell phones on the users' health is an important and vital affair due to rapid growth and extensive use of these devices on human communications and interactions. The aim of this study was to determine the effect of increasing the distance of cell phones to brain tissue on the temperature of the central and gray matters of brain due to the heat generated by radio frequency

waves.

Methods:This study was an experimental study. A cow's brain tissue was analyzed in a compartment with three thicknesses of 2, 12, and 22 mm, in the distances of 4 mm and 4 cm from a cell phone for 15 min. Lutron thermometer was used to measure the tissue temperature, and the data analysis were done by Lutron and MATLAB software packages.

Results: The tissue temperature was increased while confronting with a cell phone in distances of 4 mm and 4 cm in all the three thicknesses of 2, 12, and 22 mm. The tissue temperature was higher after removing the confrontation at 4 mm distance as compared to the distance of 4 cm.

Conclusions: During confrontation and after that with the cell phone, reducing the distance of brain tissue and the cell phone increased the tissue temperature intensely. In fact, by increasing the cell phone distance from brain tissue, the thermal effect of radiofrequency waves was reduced.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6071445/

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The effects of radiofrequency radiation on mice fetus weight, length and tissues

Alimohammadi I, Ashtarinezhad A, Asl BM, Masruri B, Moghadasi N. The effects of radiofrequency radiation on mice fetus weight, length and tissues. Data Brief. 2018 Jun 30;19:2189-2194. doi: 10.1016/j.dib.2018.06.107.

Abstract

The public concern of harmful effects of radiofrequency radiation exposure, especially with rapid increase in the use of wireless and telecommunication devices, is increasing. Some studies show fetal and developmental abnormalities as the result of radiofrequency radiationexposure. We aimed to investigate possible teratogenic effects of radiofrequency in 915 MHz on mice fetus and protective role of vitamin C. 21 pregnant mice were divided into 3 groups. Control group was in normal condition without any stressor agent. Exposure group was exposed to 915 MHz RFR (8 h/day for 10 days) and 0.045 μw/cm2 power density. The exposure plus vitamin C group received 200 mg/kg vitamin C by gavage and was exposed to 915 MHz RFR (8 h/day for 10 days) and 0.045 μw/cm2 power density. The fetus weight, C-R length were measured by digital balance and caliper. Tissues were assessed after staining with H & E. Our results showed significant increase in fetus weight and C-R length and also enlarged liver, tail deformation in mice fetus in exposure group. Although usage of vitamin C caused significant decrease in mentioned parameters. The outcome of this study confirms the effects of radiofrequency radiation on growth parameters such as body weight, length and some tissues in mice fetuses and protective effect of vitamin C. However more studies on non-ionization radiation in different frequencies and severity, during pregnancy are needed to clarify the exact mechanisms of these changes and better protection.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6141437/

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Effect of exposure to 1800 MHz RFR on epidermal growth factor, caspase-3, Hsp27 and p38MAPK gene expressions in the rat eye

Eker ED, Arslan B, Yildirim M, Akar A, Aras N. The effect of exposure to 1800 MHz radiofrequency radiation on epidermal growth factor, caspase-3, Hsp27 and p38MAPK gene expressions in the rat eye. Bratisl Lek Listy. 2018;119(9):588-592. doi: 10.4149/BLL_2018_106.

Abstract

OBJECTIVE: Radiofrequency electromagnetic fields (RF-EMF) may induce DNA damage and oxidative stress in human lens epithelial cells (LECs). We aimed to investigate the expression levels of heat shock protein 27 (Hsp27), p38 mitogen-activated protein kinase (p38MAPK), epidermal growth factor receptor (EGFR) and caspase-3 gene expression levels in rat eye that was exposed to 1800 MHz RF-EMF.

METHODS: Thirty-seven female Wistar albino rats were divided into three groups. The rats in the study group (n = 9) were exposed to 1800 MHz RF-EMF at an electric field 6.8 ± 0.1 V/m and 0.06 W/kg specific absorption rate (SAR) for 2 hours per day for eight weeks. Sham group (n = 9) was kept under similar conditions as the exposed group without exposure to RF-EMF. The rats in all three groups were sacrificed and their eyes were removed. Hsp27, p38MAPK, EGFR, caspase-3 gene expression levels were investigated in detail with real-time polymerase chain reactions (Real-Time PCR).

RESULTS: caspase-3 and p38MAPK gene expression were significantly upregulated in the ocular tissues following exposure to RF-EMF ($p < 0.05$).

CONCLUSION: According to our findings, eye cells recognize EMF as a stress factor, and in response, activate caspase-3 and p38MAPK gene expressions. These results confirm that RF-EMF can cause cellular damage in rat ocular cells (Tab. 2, Fig. 3, Ref. 37).

Open access paper: http://bit.ly/2xBGnpu

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Physiopathological effects of quercetin on oxidative stress from 4.5 g mobile phone radiation exposed to liver tissue of rat

Postaci I, Coskun O, Senol N, Aslankoc R, Comlekci S. The physiopathological effects of quercetin on oxidative stress in radiation of 4.5 g mobile phone exposed liver tissue of rat. Bratisl Lek Listy. 2018;119(8):481-489. doi: 10.4149/BLL_2018_088.

Abstract

OBJECTIVE: The study was aimed to evaluate the physiopathological consideration of the effects of electromagnetic field (EMF) from the radiation of 4.5 G mobile phones on the liver tissue of rats and quercetin (Qu) applied as an antioxidant for reducing these effects.

METHODS: Male Wistar-Albino rats were divided into four groups with 8 rats in each group. Group 1 (control group), Group 2 (sham group), Group 3 (EMF group) and Group 4 (EMF + Qu). From the animals sacrificed at the end of the 30th day; liver tissues were taken for histopathological and immunohistochemical examinations.

RESULTS: In the liver tissue of the electromagnetic field group; dilatation of sinusitis was determined to be higher than in the sham group. It was concluded that the concentration of caspase-3 and TNF-α

immunopositive cells was in the EMF group (+3) level and also the immunostaining was stronger, it caused an increase in malondialdehyde level, the difference between the groups was statistically significant, in terms of superoxide dismutase, catalase activities, the difference was not significant.

CONCLUSION: It was determined that 2600 MHz EMF exposure caused damage to the liver, 100 mg/kg/day quercetin was not sufficient to prevent this damage (Tab. 5, Fig. 15, Ref. 27).

http://bit.ly/2Q311FY

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Modulatory effect of 900 MHz radiation on biochemical and reproductive parameters in rats

Narayanan SN, Lukose ST, Arun G, Mohapatra N, Pamala J, Concessao PL, Jetti R, Kedage V, Nalini K, Bhat PG. Modulatory effect of 900 MHz radiation on biochemical and reproductive parameters in rats. Bratisl Lek Listy. 2018;119(9):581-587. doi: 10.4149/BLL_2018_105.

Abstract

In the present study, the effect of 900 MHz radiation exposure on blood biochemical and reproductive parameters was evaluated in adolescent rats. Male albino Wistar rats (8-10 weeks of age) were exposed to 900 MHz radiation (1hr/day, power density - 146.60 μW/cm2) from a mobile phone for 28 days. On 29th day the animals were euthanized and malondialdehyde (MDA), total antioxidants (TA) levels and Glutathione-S transferase (GST) activity were studied in the blood. Reproductive parameters such as total sperm count, percentage of non-motile sperms, and sperm morphology were determined. Testes sections were stained with H(et)E staining and their cellular integrity was evaluated. Caspase-3 activity in the testes was also determined. MDA concentration was increased but TA levels and GST activity were not found to be different in 900 MHz group compared to controls. Sperm motility was found to be slightly reduced in 900 MHz group. Percentage of abnormal sperm was significantly elevated in 900 MHz group. Additionally, loss of germ cells particularly spermatocytes and spermatids was found in the testes of 900 MHz group. Testes caspase-3 activity was slightly elevated in 900 MHz exposed rats. Chronic 900 MHz exposure induced oxidative damage in the blood and lead to alterations in reproductive parameters in rats (Fig. 4, Ref. 33).

Open access paper: http://bit.ly/2pxJx9B

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Exposure to non-ionizing electromagnetic radiation of public risk prevention instruments threatens the quality of spermatozoids

Tirpak F, Slanina T, Tomka M, Zidek R, Halo M Jr, Ivanic P, Gren A, Formicki G, Stachanczyk K, Lukac N, Massanyi P. Exposure to non-ionizing electromagnetic radiation of public risk prevention instruments threatens the quality of spermatozoids. Reprod Domest Anim. 2018 Sep 7. doi: 10.1111/rda.13338.

Abstract

The use of artificial insemination in cattle breeding has evolved to global extent and insemination doses are often shipped via air transport which requires strict radiation-based examinations. For the determination of effect of non-ionizing radiation (NIR), to which are beings frequently exposed due to protection of airport or cultural event security, freshly ejaculated and cryopreserved bovine spermatozoa were used as experimental

model. Following radiation with hand-held metal detector in various exposition times (0, 10 seconds, 15, 30 and 60 minutes - groups FR, FR10, FR15, FR30 and FR60) the spermatozoa underwent motility and DNA fragmentation analyses. Study on cryoconserved semen treated with NIR was performed in time intervals 0, 10 seconds, 1 and 5 minutes (insemination doses radiated before cryoconservation - CB, CB10, CB1, CB5; samples radiated after freezing - CA, CA10, CA1 and CA5). Fresh semen and insemination doses radiated after cryoconservation showed significantly lower total and progressive motility. No effect on motility parameters was detected in semen extended with cryopreservative medium and radiated prior to freezing. Surprisingly, NIR showed a potential to stimulate spermatozoa velocity; however the effect was modulated throughout the post-thawing incubation. Based on the DNA fragmentation assay, sperm DNA stayed intact. Present study underlines the potential harm of NIR, which is frequently used in everyday life, with overall adverse impact on human and animal reproduction. Current study also points out on interesting short-term spermatozoa stimulation induced by NIR.

https://www.ncbi.nlm.nih.gov/pubmed/30192989

The aim of the present study, carried out on the bovine spermatozoa, was to evaluate the possible risk of 93 kHz non-ionizing radiation associated with decreased fertilizing properties (sperm motility traits) of fresh and cryopreserved spermatozoa.

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Genotoxicity of intermediate frequency magnetic fields in vitro and in vivo

Herrala M, Kumari K, Koivisto H, Luukkonen J, Tanila H, Naarala J, Juutilainen J. Genotoxicity of intermediate frequency magnetic fields in vitro and in vivo. Environ Res. 2018 Sep 8. pii: S0013-9351(18)30494-8. doi: 10.1016/j.envres.2018.09.009.

Abstract

We assessed genotoxic effects of intermediate frequency magnetic fields (MF) in vitro and in vivo. Rat primary astrocytes were exposed for 24 h to a 7.5 kHz MF at a magnetic flux density of 30 or 300 μT. Male C57BL/6 J mice were exposed continuously for 5 weeks to a 7.5 kHz MF at 12 or 120 μT, and blood samples were collected for the genotoxicity assays. To evaluate possible co-genotoxicity, the in vitro experiments included combined exposure with menadione (an agent that induces mitochondrial superoxide production and DNA damage) and methyl methanesulfonate (an alkylating agent). DNA damage and DNA repair (in vitro) were measured using the alkaline Comet assay and formation of micronuclei was assessed microscopically (in vivo) or using flow cytometry (in vitro). The results did not support genotoxicity or co-genotoxicity of 7.5 kHz MFs at magnetic flux densities up to 300 μT in vitro or in vivo. On the contrary, there was some evidence that exposure to 7.5 kHz MFs might reduce the level of genetic damage. Strongest indication of any biological effects was obtained from measurements of relative cell number, which was significantly and consistently increased after MF exposure in all in vitro experiments. Health implications of this finding are unclear, but it suggests that 7.5 kHz MFs may stimulate cell proliferation or suppress cell death.

https://www.ncbi.nlm.nih.gov/pubmed/30243651

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Characterization of Children's Exposure to Extremely Low Frequency Magnetic Fields by Stochastic Modeling

Bonato M, Parazzini M, Chiaramello E, Fiocchi S, Le Brusquet L, Magne I, Souques M, Röösli M, Ravazzani P. Characterization of Children's Exposure to Extremely Low Frequency Magnetic Fields by Stochastic Modeling. Int J Environ Res Public Health. 2018 Sep 8;15(9). pii: E1963. doi: 10.3390/ijerph15091963.

Abstract

In this study, children's exposure to extremely low frequency magnetic fields (ELF-MF, 40–800 Hz) is investigated. The interest in this thematic has grown due to a possible correlation between the increased risk of childhood leukemia and a daily average exposure above 0.4 μT, although the causal relationship is still uncertain. The aim of this paper was to present a new method of characterizing the children's exposure to ELF-MF starting from personal measurements using a stochastic approach based on segmentation (and to apply it to the personal measurements themselves) of two previous projects: the ARIMMORA project and the EXPERS project. The stochastic model consisted in (i) splitting the 24 h recordings into stationary events and (ii) characterizing each event with four parameters that are easily interpretable: the duration of the event, the mean value, the dispersion of the magnetic field over the event, and a final parameter characterizing the variation speed. Afterward, the data from the two databases were divided in subgroups based on a characteristic (i.e., children's age, number of inhabitants in the area, etc.). For every subgroup, the kernel density estimation (KDE) of each parameter was calculated and the p-value histogram of the parameters together was obtained, in order to compare the subgroups and to extract information about the children's exposure. In conclusion, this new stochastic approach allows for the identification of the parameters that most affect the level of children's exposure.

Open access paper: http://www.mdpi.com/1660-4601/15/9/1963

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Demystifying Monarch Butterfly Migration

Reppert SM, de Roode JC. Demystifying Monarch Butterfly Migration. Curr Biol. 2018 Sep 10;28(17):R1009-R1022. doi: 10.1016/j.cub.2018.02.067.

Abstract

Every fall, millions of North American monarch butterflies undergo a stunning long-distance migration to reach their overwintering grounds in Mexico. Migration allows the butterflies to escape freezing temperatures and dying host plants, and reduces infections with a virulent parasite. We discuss the multigenerational migration journey and its evolutionary history, and highlight the navigational mechanisms of migratory monarchs. Monarchs use a bidirectional time-compensated sun compass for orientation, which is based on a time-compensating circadian clock that resides in the antennae, and which has a distinctive molecular mechanism. Migrants can also use a light-dependent inclination magnetic compass for orientation under overcast conditions. Additional environmental features, e.g., atmospheric conditions, geologic barriers, and social interactions, likely augment navigation. The publication of the monarch genome and the development of gene-editing strategies have enabled the dissection of the genetic and neurobiological basis of the migration. The monarch butterfly has emerged as an excellent system to study the ecological, neural, and genetic basis of long-distance animal migration.

https://www.ncbi.nlm.nih.gov/pubmed/30205052

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Exposure to 50 Hz Magnetic Fields in Homes and Areas Surrounding Urban Transformer Stations in Silla (Spain)

Navarro-Camba EA, Segura-García J, Gomez-Perretta C. Exposure to 50 Hz Magnetic Fields in Homes and Areas Surrounding Urban Transformer Stations in Silla (Spain): Environmental Impact Assessment. Sustainability 2018, 10(8), 2641; doi:10.3390/su10082641

Abstract

Exposure to extremely low frequency electromagnetic fields (ELFs) is almost inevitable almost anywhere in the world. An ELF magnetic field (ELF-MF) of around 1 mG = 0.1 μT is typically measured in any home of the world with a certain degree of development and well-being. There is fear and concern about exposure to electromagnetic fields from high- and medium-voltage wiring and transformer stations, especially internal transformer stations (TSs), which in Spain are commonly located inside residential buildings on the ground floor. It is common for neighbors living near these stations to ask for stations to be moved away from their homes, and to ask for information about exposure levels and their effects. Municipality is the closest administration to the citizens that must solve this situation, mediating between the citizens, the utility companies and the national administration. In this case, the municipality of Silla (València, Spain) wanted to know the levels of exposure in the dwellings annexed to the TSs, to compare them with Spanish legislation and the recommendations coming from epidemiological studies. This article presents the first systematic campaign of ELF-MF measurements from TSs carried out in a Spanish city. Many measurements were carried out in the rooms of the apartments doing spatial averages of spatial grid measurements. Measurements are made in the bed and bedrooms and a weighted average and an environmental impact indicator were obtained for each location. We found that old TSs usually provide the highest peak exposure levels. A notable result of this work is that approximately one quarter of the population living above or next to a TS would be exposed to a weighted MF level greater than 0.3 μT, and that about a 10% of this population would not be able to relocate their bedroom or living room to minimize the level of exposure.

Open access paper: http://www.mdpi.com/2071-1050/10/8/2641

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Investigating the role of internal layout of magnetic field-generating equipment on workers' exposure at power substations

Hosseini M, Farhang Matin L, Monazzam MR, Khosroabadi H. Investigating the role of internal layout of magnetic field-generating equipment on workers' exposure at power substations. Int J Occup Saf Ergon. 2018 Sep 12:1-7. doi: 10.1080/10803548.2018.1475927.

Abstract

INTRODUCTION: This research is an attempt to show the role of interior layout of equipment in generating magnetic fields.

MATERIALS AND METHODS: The levels of an extremely low-frequency magnetic field were measured in accordance with Standard No. IEEE 644:1994 in three substations and a control building in a petrochemical power plant in southern Iran. Then, workers' occupational exposure (time-weighted average [TWA]) was

calculated and the sources of maximum magnetic field generation at each place were identified. Their interior design was changed to achieve the optimal layout of equipment subsequently; the workers' TWA was recalculated for the new situation.

RESULTS: The obtained results showed that electrical engineers and technicians were exposed to the maximum TWA of 10.14 μT. The operators in the control room were exposed to the lowest TWA of 0.84 μT. The results also showed that after the change of interior design and proper layout design of the equipment in the substations, the TWA was reduced by 0.73 μT.

CONCLUSION: The research findings revealed that the most harmonious arrangement of equipment in an industrial unit plays a major role in reducing the exposure of workers to magnetic fields and ultimately increases the level of their health in the workplace.

https://www.ncbi.nlm.nih.gov/pubmed/30205763

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Study of Electrical Stimulation with Different Electric Field Intensities in Regulating Differentiation of PC12 Cells

Jing W, Zhang Y, Cai Q, Chen G, Wang L, Yang X, Zhong W. Study of Electrical Stimulation with Different Electric Field Intensities in Regulating Differentiation of PC12 Cells. ACS Chem Neurosci. 2018 Sep 13. doi: 10.1021/acschemneuro.8b00286.

Abstract

The strategy of using electrical stimulation (ES) to promote neural differentiation and regeneration of injured nerves is proven feasible. The study on the possible molecular mechanisms in relation to this ES promotion effect should be helpful to understand the phenomenon. In this study, it was identified the neuronal differentiation of PC12 cells was enhanced when the electric field intensity was in the range of 30-80 mV/mm, lower or higher electric field intensity displayed inferior effect. Under ES, however, levels of intracellular reactive oxygen species (ROS), intracellular Ca2+ dynamics and expression of TREK-1 were measured gradually increasing alongside higher electric field intensity. Trying to understand the relationship between the ES enhancement on differentiation and these variations in cell activities, parallel experiments were conducted by introducing exogeneous H2O2 into culture systems at different concentrations. Similarly, the effects of H2O2 concentration on neuronal differentiation of PC12 cells, intracellular ROS and Ca2+ levels, and TREK-1 expression were systematically characterized. In comparative studies, it was found the two cases that ES of 50 mV/mm for 2 h/day and H2O2 of 5 μM in culture medium shared comparable results in intracellular ROS and Ca2+ levels, and TREK-1 expression. Higher H2O2 concentration (e.g. 10 μM and 20 μM) demonstrated adverse effect on cell differentiation and caused DNA damage. A stronger ES (e.g. 100 mV/mm), being associated with higher intracellular ROS level, also resulted in weaker enhancement on the neuronal differentiation of PC12 cells. These facts suggested that the intracellular ROS generated under ES might be an intermediate signal transducer involved in cascade reactions relative to cell differentiation.

https://www.ncbi.nlm.nih.gov/pubmed/30212623

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Diplomats' Mystery Illness and Pulsed Radiofrequency/Microwave Radiation

Golomb B. Diplomats' mystery illness and pulsed radiofrequency/microwave radiation. Neural Comput. 2018 Sep 5. doi: 10.1162/neco_a_01133.

Abstract

IMPORTANCE: A "mystery" illness striking US and Canadian diplomats to Cuba (and now China) "has confounded the FBI, the State Department and US intelligence agencies." Sonic explanations for the so-called "health attacks" have long dominated media reports, propelled by peculiar sounds heard and auditory symptoms experienced. Sonic mediation was justly rejected by experts. We assessed whether pulsed radiofrequency/microwave radiation (RF/MW) exposure can accommodate reported facts in diplomats, including unusual ones.

OBSERVATIONS: 1. Noises: Chirping, ringing or grinding noises were heard at night, during episodes reportedly triggering health problems, by many diplomats. Pulsed RF/MW engenders just these "sounds" via the "Frey effect." Ability to hear the sounds depends on high frequency hearing and low ambient noise. "Sounds" differ by head dimensions. 2. Signs/symptoms: Hearing loss and tinnitus are prominent in affected diplomats - and in RF/MW-affected individuals. Each of protean symptoms that diplomats report, also affect persons reporting symptoms from RF/MW: Sleep problems, headaches, and cognitive problems dominate in both groups. Sensations of pressure or vibration figure in each. Both encompass vision, balance and speech problems, and nosebleeds. Brain injury and brain swelling are reported in both. 3. Mechanisms: Oxidative stress provides a documented mechanism of RF/MW injury compatible with reported signs and symptoms; sequelae of endothelial dysfunction (yielding blood flow compromise), membrane damage, blood brain barrier disruption, mitochondrial injury, apoptosis, and autoimmune triggering afford downstream mechanisms, of varying persistence, that merit investigation. 4. Of note, microwaving of the US embassy in Moscow is historically documented.

CONCLUSIONS AND RELEVANCE: Reported facts appear consistent with RF/MW as the source of injury in Cuba diplomats. Non-diplomats citing symptoms from RF/MW, often with an inciting pulsed-RF/MW exposure, report compatible health conditions. Under the RF/MW hypothesis, lessons learned for diplomats and for RF/MW-affected "civilians" may each aid the other.

https://www.ncbi.nlm.nih.gov/pubmed/30183509

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Selected Health and Law Issues Regarding Mobile Communications with Respect to 5G

Mandl P, Pezzei P, Leitgeb E. Selected Health and Law Issues Regarding Mobile Communications with Respect to 5G. Presented at 2018 International Conference on Broadband Communications for Next Generation Networks and Multimedia Applications (CoBCom). Graz, Austria. July 11-13, 2018.

Abstract

Over the next years the demand of wireless communication will increase tremendously. More and more mobile end devices require a high data rate connection e.g. to a smart home (Internet of Things, IoT) or to the internet. The radiation power pattern of base stations and mobile end devices will completely change for the 5G Next Generation Mobile Network technology which will use frequency bands up to 100 GHz. Therefore the electromagnetic exposure especially to human body will increase in the future, because most of the wireless connections are realized in RF technology. In this contribution two different measurement setups are

presented. The first shows the electromagnetic radiation regarding a base station powered by a mobile phone provider over a timespan of a number of days. The second figures out the electromagnetic radiation of a handheld mobile end device to a human head in an area with very poor reception values. The results of those measurements where compared with legal and health limits. All measured and calculated results regarding the base stations were within the legal exposure limits. The calculated legal exposure limits of mobile devices were exceeded twice in areas within very poor reception values. Regarding the expected higher bandwidth and corresponding higher electromagnetic exposure to human bodies in future there have to be periodic measurements to comply with radiation limits.

Conclusions

It has been shown that there is currently no overshooting of legal limits in the transmission of base stations. The presented measurement campaign regarding the base station showed that the E-Field reached a maximum of 0.673 *V/m* (legal limit: *47.631 V/m*) and the H-Field a maximum of 2 *mA/m* (legal limit: 128 *mA/m*). However, the coming mobile radio standards like 5G is expected to use frequency bands up to 100 GHz, a much higher density of base stations and 100 times higher bandwidths than nowadays which subsequently causes higher transmission power of base stations. Regarding the above mentioned circumstances **it will be necessary to measure the radiation exposure of base stations in the future on a regular basis in order to ensure the legal limits and to reduce possible health hazards. It also will be necessary to develop new measurement strategies and/or technologies regarding the large frequency spectrum 5G will use up to 100 GHz.**

When measuring directly on a mobile phone (simulating the use of an end device directly on the human head), it was found that the calculated SAR of 3.834 *W/kg* exceeds the legal limit of 2 W*/ kg*. This shows clearly that the legal limit values can be exceeded significantly in areas with very poor reception values ...

Increasing the distance between a mobile end device and the head, e.g. by using a hands-free set or a headset can significantly reduce the human exposure to electromagnetic radiation when such a device is used in badly supplied areas and transmits with maximum power.

https://ieeexplore.ieee.org/document/8443980/

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Clear evidence of cell-phone RF radiation cancer risk

Lin JC. Clear evidence of cell-phone RF radiation cancer risk. IEEE Microwave Magazine. 19(6):16-24. Sep/Oct 2018. DOI: 10.1109/MMM.2018.2844058.

Abstract

During 26-28 March 2018, the National Institute of Environmental Health Sciences (NIEHS) National Toxicology Program (NTP), a part of the U.S. National Institutes of Health, convened a three-day technical reports peer-review panel meeting in Research Triangle Park, North Carolina, to review the NTP's draft reports on its carcinogenesis studies of cell-phone RF radiation in mice and rats.

https://ieeexplore.ieee.org/document/8425056/

A summary and excerpts from the paper: **http://bit.ly/NTPcellphonestudies**

In a new paper, “Clear evidence of cell-phone RF radiation cancer risk” published in the journal *IEEE Microwave Magazine*, Dr. James C. Lin states that the results of the National Toxicology Program (NTP) cell phone radiation study suggest that current radio frequency (RF) exposure guidelines are inadequate to protect human health (1). Furthermore, the paper recommends that the International Agency for Research on Cancer (IARC) re-assess the research and consider upgrading the classification of RF radiation from "possibly carcinogenic to humans" (Group 2B) to probably carcinogenic (i.e., Group 2A).

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Peer Review of the Draft NTP Technical Reports on Cell Phone Radiofrequency Radiation

National Toxicology Program (NTP). Peer Review of the Draft NTP Technical Reports on Cell Phone Radiofrequency Radiation. National Institute of Environmental Health Sciences. 2018. pp. 1-51.

No abstract.

Open access paper: https://ntp.niehs.nih.gov/ntp/about_ntp/trpanel/2018/march/peerreview20180328_508.pdf

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Editorial: Effects of Combined EMF Exposures and Co-exposures

Mattsson M-O, Zeni O, Simkó M, Scarfì MR.Editorial: Effects of Combined EMF Exposures and Co-exposures. Frontiers in Public Health. 20 August 2018. https://doi.org/10.3389/fpubh.2018.00230.

No Abstract

Excerpt

The very complex exposure situation in real-life environments has been well illustrated in this Research Topic, and the need for better understanding of basic biological interaction mechanisms is obvious from the analyses presented here. The area is very much under-investigated, and the full impact and potential of EMF exposures for both possible adverse and beneficial effects cannot be realized without substantial additional research efforts.

Open access: https://www.frontiersin.org/articles/10.3389/fpubh.2018.00230/full

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Effects of mobile phone exposure on biochemical parameters of cord blood: A preliminary study

Bektas H, Bektas MS, Dasdag S. Effects of mobile phone exposure on biochemical parameters of cord blood: A preliminary study. Electromagn Biol Med. 2018 Aug 29:1-8. doi: 10.1080/15368378.2018.1499033.

Abstract

The purpose of this study is to investigate foetal impact of radiofrequencies (RFs) emitted from mobile phones in postnatal cord blood. The study carried on 149 pregnant women divided into four groups such as nonusers of mobile phone (n: 37; control group), 2-15 min/d (n: 39; group 1), 15-60 min/d (n: 37; group 2) and participants using mobile phone for more than 60 min/d (n: 36; group 3). Cord blood of the infants was taken in all groups for biochemical analyses immediately after birth. The results of the study showed that the biggest

foetal impact was observed in the third study group which was pregnant exposed RFRs (RF radiation) more than 1 h/d (1 hour per day). AST (aspartat aminotransferaz), ALT (alanine aminotransferase), LDH (lactate dehydrogenase), CK (creatine kinase), CK-MB (creatine kinase-miyocardial band), CRP (c-reactive protein), PCT (procalcitonin), TnT (troponin T), uric acid and lactate levels of third group were found higher than the other groups ($p < 0.001$). However, Mean platelet volume values of third group were found lower than the other groups ($p < 0.001$). Finally, this is the first human study which was performed on pregnant and infants because there is no previous work in this area. However, the results of this study revealed that long-term RFR exposure of pregnant may result in some biochemical changes in the infants. Therefore, our suggestion to pregnant is to avoid from RFR exposure emitted from mobile phones at least during pregnancy.

https://www.ncbi.nlm.nih.gov/pubmed/30156944

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Comments regarding: "Occupational exposure to high-frequency EMF & brain tumor risk in INTEROCC study: An individualized assessment approach"

Mortazavi SMJ. Comments regarding: "Occupational exposure to high-frequency electromagnetic fields and brain tumor risk in the INTEROCC study: An individualized assessment approach". Environ Int. 2018 Aug 24. pii: S0160-4120(18)31561-7. doi: 10.1016/j.envint.2018.08.008.

Abstract

This commentary addresses the paper by Vila et al. entitled "Occupational exposure to high-frequency electromagnetic fields and brain tumor risk in the INTEROCC study: An individualized assessment approach" that is published in Environment International. The authors have examined the link between occupational exposures to radiofrequency (RF) and intermediate frequency (IF) electromagnetic fields (EMF) and glioma and meningioma brain tumor risk in the INTEROCC multinational population-based case-control study. This study showed no clear association with exposure to RF or IF EMFs and the risk of glioma or meningioma brain tumors. Recent studies show that in many cases there are large errors and/or major shortcomings in the studies claiming no link between mobile phone and brain cancer. Although the paper by Vila et al. is well-structured and can be considered as a significant contribution to this field, there are several items that merit further attention and are not fully addressed. These include the selection bias, confounding factors other than age, sex, region and country, and criteria used in this study for considering exposures as occupational.

https://www.ncbi.nlm.nih.gov/pubmed/30146273

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Statistical approach for human EMF exposure assessment in future wireless ATTO-cell networks

Shikhantsov S, Thielens A, Vermeeren G, Demeester P, Martens L, Torfs G, Joseph W. Statistical approach for human electromagnetic exposure assessment in future wireless ATTO-cell networks. Radiat Prot Dosimetry. 2018 Jul 30. doi: 10.1093/rpd/ncy120.

Abstract

In this article, we study human electromagnetic exposure to the radiation of an ultra dense network of nodes integrated in a floor denoted as ATTO-cell floor, or ATTO-floor. ATTO-cells are a prospective 5 G wireless

networking technology, in which humans are exposed by several interfering sources. To numerically estimate this exposure we propose a statistical approach based on a set of finite difference time domain simulations. It accounts for variations of antenna phases and makes use of a large number of exposure evaluations, based on a relatively low number of required simulations. The exposure was expressed in peak-spatial 10-g SAR average (psSAR10g). The results show an average exposure level of ~4.9 mW/kg and reaching 7.6 mW/kg in 5% of cases. The maximum psSAR10g value found in the studied numerical setup equals around 21.2 mW/kg. Influence of the simulated ATTO-floor size on the resulting exposure was examined. All obtained exposure levels are far below 4 W/kg ICNIRP basic restriction for general public in limbs (and 20 W/kg basic restriction for occupational exposure), which makes ATTO-floor a potential low-exposure 5 G candidate.

https://www.ncbi.nlm.nih.gov/pubmed/30085262

Excerpt

The ATTO-floor is a new concept for ultra-high capacity wireless networking, designed to provide wireless access to robots that can freely move around the floor surface. ATTO-cells are integrated into the floor and cover its entire area. According to the current design[(1)] (Figure 1) an ATTO-cell has dimensions of 15-by-15 cm^2 and an antenna is supplied with a maximum power of 1 mW. It operates at a center frequency of 3.5 GHz. Possible applications of the ATTO technology include industrial warehouses or factories of the future, where multitudes of mobile robots and human workers operate simultaneously. Robots, being equipped with an antenna featuring downward-pointing pattern, are the target users. Due to the provisioned fast handover system, at any time instance a robot is only connected to the closest antenna, thus, it is unlikely for humans to be exposed by the ATTO-floor directly. In other words, most of the time humans will be exposed to the scattered fields of antennas serving surrounding robots.

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Study of the Correlation between Outdoor and Indoor Electromagnetic Exposure near Cellular Base Stations in Leuven, Belgium

Nkemlyare R, Volskiy V, Vandenbosch G. Study of the Correlation between Outdoor and Indoor Electromagnetic Exposure near Cellular Base Stations in Leuven, Belgium. Environmental Research. Publ online 22 Aug 2018. https://doi.org/10.1016/j.envres.2018.08.025

Highlights

• GSM 900 is the dominating source of exposure
• Exposure levels meet international recommendations and local legislation
• In absolute levels the outdoor field exposure is ca. the double of the indoor field exposure
• EM exposure levels are reproducible over a time span of ca. one month

Abstract

A measuring campaign for the assessment of electromagnetic radiation near base stations in the city center of Leuven, Belgium, has been carried out. The main objective of this assessment is to study the correlation between the outdoor and the indoor exposure produced by cellular base stations and to investigate the changes of electromagnetic exposure within a typical day and over 1 month in the vicinity of these base stations. The study was also carried out as a function of location and time using highly precise measurement equipment. The measurements were performed in both public and private areas in sixty (30 indoor and 30

outdoor) different locations in Leuven. The measurement was focused on mobile communication networks: GSM (Global System for Mobile Communication, 900 MHz and 1800 MHz) and UMTS (Universal Mobile Telecommunications System, 2110 MHz) were the frequency bands of interest. The data at these frequencies were extracted from raw measurements in the 824 MHz to 2170 MHz frequency band. The results show that all analyzed locations are in compliance with the exposure limits recommended by ICNIRP (International Commission on Non-Ionizing Radiation Protection) and that the (maximum) indoor exposure correlates to the outdoor exposure with a factor of about 0.5.

Conclusions

The electromagnetic radiation exposure of the general public generated by base stations in Leuven, Belgium, was duly assessed using spectrum analyzer measurements at 60 locations and at several moments during the day. All measured values are considerably below norm levels for Flanders, which means that they are far below the ICNIRP exposure limits for the general public. The average levels over time and over the whole city center are: outdoors about 0.64 V/m for GSM 900, 0.53 for GSM 1800, and 0.33 for UMTS, and indoors about 0.32 V/m for GSM 900, 0.26 for GSM 1800, and 0.17 for UMTS. To the average, the outdoor exposure levels are thus a factor of two higher than the indoor levels. In general, the dominating source of exposure is GSM 900. The maximum field value measured was equal to 1.80 V/m, due to the GSM 900 signal. In this study, the average effect of absorption and reflection, typically used to explain the lower values indoors, is in agreement with the average attenuation through walls used in propagation models.

https://www.sciencedirect.com/science/article/pii/S0013935118304651

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On the effects of glasses on the SAR in human head resulting from wireless eyewear devices at phone call stat

Lan JQ, Liang X, Hong T, Du GH. On the effects of glasses on the SAR in human head resulting from wireless eyewear devices at phone call state. Progress in Biophysics and Molecular Biology. 136:29-36. Aug 2018.

Abstract

This paper evaluates the effects of glasses on the specific absorption rates (SAR) in the human head resulting from wireless eyewear device at phone call state. We mainly concentrate on the SAR in the eyes since their sensitivity to electromagnetic fields (EMF). We find wearing glasses obviously alters the distribution and magnitude of the SAR. The maximal SAR in the ocular tissues with glasses is even 6 times more than that without glasses. Wearing glasses also induce the new hotspot in the eyes which may cause the biggest SAR increment in the ocular tissues. Moreover, calculated results indicate that the maximal SAR is sensitive to the size of glasses and radiation frequency. Because of this, we believe wearing glasses may possibly increase the risk of health hazard to eyes of wireless eyewear device user. These calculated results could be a valuable reference for the glasses designer to reduce the SAR in the eyes.

https://www.sciencedirect.com/science/article/pii/S0079610717300822

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Subjective symptoms, onset/trigger factors, allergic diseases, & exposures in Japanese patients with multiple chemical sensitivity

Hojo S, Mizukoshi A, Azuma K, Okumura J, Ishikawa S, Miyata M, Mizuki M, Ogura H, Sakabe K. Survey on changes in subjective symptoms, onset/trigger factors, allergic diseases, and chemical exposures in the past decade of Japanese patients with multiple chemical sensitivity. Int J Hyg Environ Health. 2018 Aug 13. pii: S1438-4639(18)30271-2. doi: 10.1016/j.ijheh.2018.08.001.

Abstract

BACKGROUND: Recently, with rapid changes in the Japanese lifestyle, the clinical condition of patients with multiple chemical sensitivity (MCS) may also have undergone change. Thus, we conducted a new survey for subjective symptoms, ongoing chemical exposures, the prevalence of allergic diseases, and presumed onset/trigger factors in patients with MCS and compared results with those of an old survey from ten years ago.

METHODS: The new survey was conducted from 2012 to 2015 and the old survey was independently conducted from 1999 to 2003, meaning it was not a follow-up study. Patients were initially diagnosed by physicians at five medical institutions with MCS specialty outpatient services, with 111 and 103 patients participating in the new and old surveys, respectively. The controls were a general population living in Japan, with 1313 and 2382 participants in the new and old surveys, respectively. Subjective symptoms and ongoing chemical exposure were evaluated using a quick environmental exposure sensitivity inventory. Additionally, from clinical findings recorded by an attending physician, the prevalence of allergic diseases and presumed onset/trigger factors were evaluated. Differences between new and old surveys were analyzed using logistic regression analyses and significance tests.

RESULTS: Compared with ten years ago: (1) Regarding factors affecting patients with ongoing chemical exposures, the proportion of patients affected decreased significantly for two items only (insecticides and second-hand smoke). The proportion of controls showing ongoing exposure to 8 out of 10 items changed significantly. (2) In patients, scores for chemical intolerances, other intolerances, and life impacts increased significantly. (3) In terms of the prevalence of allergic diseases among patients with MCS, bronchial asthma (adjusted odds ratio [AOR]: 5.19), atopic dermatitis (AOR: 3.77), allergic rhinitis (AOR: 5.34), and food allergies (AOR: 2.63) increased significantly, while hay fever (AOR: 0.38) and drug allergies (AOR: 0.40) decreased significantly. (4) With regard to construction and renovation, which was the presumed predominant onset/trigger factor for MCS 10 years ago, this decreased from 68.9% to 35.1%; in contrast, electromagnetic fields (0.0%-26.1%), perfume (0.0%-20.7%), and medical treatment (1.9%-7.2%) increased significantly, confirming the diversification of onset/trigger factors.

CONCLUSION: Compared to ten years ago, for patients with MCS, an increase in avoidance behavior toward chemical substance exposures, which were presumed to be aggravating factors for symptoms, was confirmed. It has been suggested that the ongoing chemical exposure of the general population in Japan has largely changed. In addition, for patients with MCS, chemical intolerances and life impacts have become severe, the prevalence of the main allergic diseases has increased, and onset/trigger factors have become diversified.

https://www.ncbi.nlm.nih.gov/pubmed/30115513

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Design and Calibration of a mm-Wave Personal Exposure Meter for 5G Exposure Assessment in Indoor Diffuse Environments

Aminzadeh R, Khadir Fall A, Sol J, Thielens A, Besnier P, Zhadobov M, De Geeter N, Vasudevan PP, Dupré L, Van Holen R, Martens L, Wout J. Design and Calibration of a mm-Wave Personal Exposure Meter for 5G Exposure Assessment in Indoor Diffuse Environments. Journal of Infrared, Millimeter, and Terahertz Waves. pp 1–19. Published Online: 23 August 2018.

Abstract

For the first time, a mm-wave personal exposure meter (mm-PEM) for the 5th generation of mobile networks (5G) exposure assessment in indoor diffuse fields is presented. The design is based on simulations and on-phantom calibration measurements in a mm-wave reverberation chamber (RC) at 60 GHz. The mm-PEM consists of an array of nine antennas on the body. Using the mm-PEM, the incident power density (IPD) is measured in the unloaded RC, for the antenna(s) on the phantom and RC loaded with phantom. The uncertainty of the mm-PEM is then determined in terms of its response, which is defined as the ratio of antenna aperture for the above measurement scenarios. Using nine antennas, the designed meter has a response of 1.043 (0.17 dB) at 60 GHz, which is very close to 1 (0 dB), the desired ideal response value. The mm-PEM measured an IPD of 96.6 $W\,m^{-2}$ at 60 GHz in the RC, for an input power of 1 W. In addition, the average absorption cross-section of the phantom is determined as 225 cm^2, which is an excellent agreement with its physical dimensions.

Conclusion

A mm-wave personal exposure meter (mm-PEM) is designed for assessment of personal exposure to 5G in indoor diffuse environments. The mm-PEM is calibrated on a skin-equivalent phantom in a reverberation chamber (RC) in the range of 59.5 to 60.5 GHz. We showed that increasing the number of antennas up to nine, a response of 1.043 at 60 GHz is obtained. This response is very close to 1, which is the desired response of the mm-PEM; so, the mm-PEM can measure the IPD in free space but in the presence of human body. The response of the mm-PEM in diffuse fields is also determined in terms of numerical simulations using the FDTD. Good agreement between measurements and simulations is achieved. According to the results, we recommend to calibrate the mm-PEM in the loaded RC. The average absorption cross-section of the skin phantom is determined as 225 cm^2 from the measurements, which is in excellent agreement with the physical geometry of the phantom. Future research includes design of acquisition nodes (antenna and receiver electronics) for the mm-PEM to measure the IPD directly. Additionally, the calibrations will be performed on a cylindrical or spherical phantom to study the effect of body shadowing on the response of the designed mm-PEM and to design a distributed exposure meter for the mm-waves.

https://link.springer.com/article/10.1007/s10762-018-0533-z

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The Effect of a Single 30-Min Long Term Evolution Mobile Phone-Like Exposure on Thermal Pain Threshold of Young Healthy Volunteers

Vecsei Z, Thuróczy G, Hernádi I. The Effect of a Single 30-Min Long Term Evolution Mobile Phone-Like Exposure on Thermal Pain Threshold of Young Healthy Volunteers. Int J Environ Res Public Health. 2018 Aug 27;15(9). pii: E1849. doi: 10.3390/ijerph15091849.

Abstract

Although the majority of mobile phone (MP) users do not attribute adverse effects on health or well-being to MP-emitted radiofrequency (RF) electromagnetic fields (EMFs), the exponential increase in the number of RF devices necessitates continuing research aimed at the objective investigation of such concerns. Here we investigated the effects of acute exposure from Long Term Evolution (LTE) MP EMFs on thermal pain

threshold in healthy young adults. We use a protocol that was validated in a previous study in a capsaicin-induced hyperalgesia model and was also successfully used to show that exposure from an RF source mimicking a Universal Mobile Telecommunications System (UMTS) MP led to mildly stronger desensitization to repeated noxious thermal stimulation relative to the sham condition. Using the same experimental design, we did not find any effects of LTE exposure on thermal pain threshold. The present results, contrary to previous evidence obtained with the UMTS modulation, are likely to originate from placebo/nocebo effects and are unrelated to the brief acute LTE EMF exposure itself. The fact that this is dissimilar to our previous results on UMTS exposure implies that RF modulations might differentially affect pain perception and points to the necessity of further research on the topic.

Open access paper: http://www.mdpi.com/1660-4601/15/9/1849

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Exposure levels of ELF magnetic fields in the residential areas of Mangaung Metropolitan Municipality

Rathebe P, Weyers C, Raphela F. Exposure levels of ELF magnetic fields in the residential areas of Mangaung Metropolitan Municipality. Environ Monit Assess. 2018 Aug 23;190(9):544. doi: 10.1007/s10661-018-6916-8.

Abstract

The aim of this study was to evaluate the exposure levels of ELF magnetic fields in the residential areas of Mangaung metropolitan municipality. Fifteen residential sites were randomly selected in Bloemfontein, nine in Botshabelo and six in Thaba Nchu areas of Mangaung. Measurements were collected at the distances of 3 m, 6 m and 9 m outside electrical substations, near every corner, using a Trifield meter model XE 100. Measurements were also collected from four different corners inside substations, near barrier screening and were referred to as a distance of 0 m (reference point). The results indicated a non-significant difference among 15 residential areas; BRE1 to BRE15 and six areas; TNRE1 to TRNE6. The exposure levels were significantly high in one residential area BORE1 (0.55 μT) as compared to other residential sites in Botshabelo ($p < 0.001$). The results obtained from the measurements also show a significant difference between the residential areas BORE4 and BORE8 ($p < 0.01$) as well as BORE4 and BORE9 ($p < 0.006$). The four distance interims also demonstrated a highly significant difference ($p < 0.0001$) when compared to one another. The t test showed a statistically significant difference for exposure levels recorded at 3 m, 6 m and 9 m in comparison to 0 m ($p < 0.01$). The exposure levels recorded at 3 m were also significantly different to those recorded at 6 m ($p < 0.05$) and 9 m ($p < 0.01$). The exposure levels measured at all distances are below the ICNIRP guidelines and the fields decrease rapidly with an increased distance from the source.

https://www.ncbi.nlm.nih.gov/pubmed/30140955

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Association between parental occupational exposure to ELF magnetic fields and childhood nervous system tumors risk: A meta-analysis

Su L, Zhao C, Jin Y, Lei Y, Lu L, Chen G. Association between parental occupational exposure to extremely low frequency magnetic fields and childhood nervous system tumors risk: A meta-analysis. Sci Total Environ. 2018 Nov 15;642:1406-1414.

Highlights

• A meta-analysis identified 22 studies on parental occupational ELF-MF exposure and risk of childhood nervous system tumors.
• Parental occupational ELF-MF exposure was associated with increased risk of childhood CNS tumors but not neuroblastoma.
• Maternal but not paternal occupational ELF-MF exposure significantly increased risk of childhood CNS tumors.

Abstract

BACKGROUND AND OBJECTIVE: Previous epidemiological studies suggested association between parental occupational exposure to extremely low frequency magnetic fields (ELF-MF) and risk of childhood nervous system tumors, but the results were inconsistent. We conducted a meta-analysis of case-control and cohort studies to re-evaluate this association.

METHODS: Relevant studies were identified by searching PubMed and Web of Science databases as well as by manual searching. Summary odds ratio (OR) with 95% confidence interval (CI) were pooled with a fixed-effects or random-effects model.

RESULTS: A total of 22 eligible articles (21 case-control studies and 1 cohort study) were included for the quantitative analysis. The results showed that parental occupational ELF-MF exposure was significantly associated with an increased risk of childhood nervous system tumors (OR = 1.11, 95% CI = 1.02-1.21), and this association remained in studies on central nervous system (CNS) tumors (OR = 1.13, 95% CI = 1.02-1.27) but not neuroblastoma (OR = 1.02, 95% CI = 0.92-1.14). Furthermore, maternal (OR = 1.14, 95% CI = 1.05-1.23) but not paternal (OR = 1.05, 95% CI = 0.98-1.13) occupational ELF-MF exposure significantly increased risk of childhood nervous system tumors. Increased risk of childhood CNS tumors was significant associated with maternal (OR = 1.16, 95% CI = 1.06-1.26) but not paternal (OR = 1.15, 95% CI = 0.98-1.34) occupational ELF-MF exposure.

CONCLUSION: In conclusion, our results provide limited evidence for the association between maternal occupational exposure to ELF-MF and increased risk of childhood CNS tumors, which should be explained with cautions. Future studies are needed to further evaluate the association of paternal occupational ELF-MF exposure with risk of childhood CNS tumors.

https://www.ncbi.nlm.nih.gov/pubmed/30045521

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The human skin as a sub-THz receiver - Does 5G pose a danger to it or not?

Betzalel N, Ben Ishai P, Feldman Y. The human skin as a sub-THz receiver - Does 5G pose a danger to it or not? Environ Res. 2018 May;163:208-216. doi: 10.1016/j.envres.2018.01.032.

Highlights

• The sweat duct is regarded as a helical antenna in the sub-THz band, reflectance depends on perspiration.
• We outline the background for non-thermal effects based on the structure of sweat ducts.
• We have introduced a realistic skin EM model and found the expected SAR for the 5G standard.

Abstract

In the interaction of microwave radiation and human beings, the skin is traditionally considered as just an absorbing sponge stratum filled with water. In previous works, we showed that this view is flawed when we demonstrated that the coiled portion of the sweat duct in upper skin layer is regarded as a helical antenna in the sub-THz band. Experimentally we showed that the reflectance of the human skin in the sub-THz region depends on the intensity of perspiration, i.e. sweat duct's conductivity, and correlates with levels of human stress (physical, mental and emotional). Later on, we detected circular dichroism in the reflectance from the skin, a signature of the axial mode of a helical antenna. The full ramifications of what these findings represent in the human condition are still unclear. We also revealed correlation of electrocardiography (ECG) parameters to the sub-THz reflection coefficient of human skin. In a recent work, we developed a unique simulation tool of human skin, taking into account the skin multi-layer structure together with the helical segment of the sweat duct embedded in it. The presence of the sweat duct led to a high specific absorption rate (SAR) of the skin in extremely high frequency band. In this paper, we summarize the physical evidence for this phenomenon and consider its implication for the future exploitation of the electromagnetic spectrum by wireless communication. Starting from July 2016 the US Federal Communications Commission (FCC) has adopted new rules for wireless broadband operations above 24 GHz (5 G). This trend of exploitation is predicted to expand to higher frequencies in the sub-THz region. One must consider the implications of human immersion in the electromagnetic noise, caused by devices working at the very same frequencies as those, to which the sweat duct (as a helical antenna) is most attuned. We are raising a warning flag against the unrestricted use of sub-THz technologies for communication, before the possible consequences for public health are explored.

https://www.ncbi.nlm.nih.gov/pubmed/29459303

Excerpt

The need for high data transmission rates, coupled with advances in semiconductor technology, is pushing the communications industry towards the sub-THz frequency spectrum. While the promises of a glorious future, resplendent with semi-infinite data streaming, may be attractive, there is a price to pay for such luxury. We shall find our cities, workspace and homes awash with 5 G base stations and we shall live though an unprecedented EM smog. The benefits to our society of becoming so wired cannot ignore possible health concerns, as yet unexplored. There is enough evidence to suggest that the combination of the helical sweat duct and wavelengths approaching the dimensions of skin layers could lead to non-thermal biological effects. Such fears should be investigated and these concerns should also effect the definition of standards for the application of 5G communications.

Prior study:

Betzalel N, Feldman Y, Ishai PB. The Modeling of the Absorbance of Sub-THz Radiation by Human Skin. IEEE Transactions on Terahertz Science and Technology 7(5):521-528. Sep 2017.

Abstract

In the near future, applications will come online that require data transmission in ultrahigh rates of 100 Gbit per second and beyond. In fact, the planning for new industry regulations for the exploitation of the sub-THz band are well advanced under the auspices of IEEE 802.15 Terahertz Interest Group. One aspect of this endeavor is to gauge the possible impact on human health by the expected explosion in commercial use of this band. It is,

therefore, imperative to estimate the respective specific absorption rates of human tissues. In the interaction of microwave radiation and human beings, the skin is traditionally considered as just an absorbing sponge stratum filled with water. This approach is justified when the impinging wavelength is greater than the dimensions of the skin layer. However, in the sub-THz band this condition is violated. In 2008, we demonstrated that the coiled portion of the sweat duct in upper skin layer could be regarded as a helical antenna in the sub-THz band. The full ramifications of what these findings represent in the human condition are still very unclear, but it is obvious that the absorption of electromagnetic energy is governed by the topology for the skin and its organelles, especially the sweat duct.

Conclusion

The need for high data transmission rates, coupled with advances in semiconductor technology, is pushing the communications industry toward the sub-THz frequency spectrum. While this is a relatively underutilized area of the EM spectrum, it does come with a price. The affinity of atmospheric absorption in this band means that many small short range and relatively powerful transmitters will be required for decent coverage. The results of our study emphasize that rather than gallop toward these solutions with abandon, the human health implications must be considered first, as wavelengths approach the dimensions of skin-based features. The results point to the dominant role of the sweat duct in EM skin absorbance. We can conclude and say that if the new regime of WLAN communication, the 5G standard, will happen in the next years, the concern regarding biological influence on the human body should be considered.

https://ieeexplore.ieee.org/document/8016593/

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Effects of EMF exposure on the antioxidant defense system

Kıvrak EG, Yurt KK, Kaplan AA, Alkan I, Altun G. Effects of electromagnetic fields exposure on the antioxidant defense system. J Microsc Ultrastruct. 2017 Oct-Dec;5(4):167-176.

Abstract

Technological devices have become essential components of daily life. However, their deleterious effects on the body, particularly on the nervous system, are well known. Electromagnetic fields (EMF) have various chemical effects, including causing deterioration in large molecules in cells and imbalance in ionic equilibrium. Despite being essential for life, oxygen molecules can lead to the generation of hazardous by-products, known as reactive oxygen species (ROS), during biological reactions. These reactive oxygen species can damage cellular components such as proteins, lipids and DNA. Antioxidant defense systems exist in order to keep free radical formation under control and to prevent their harmful effects on the biological system. Free radical formation can take place in various ways, including ultraviolet light, drugs, lipid oxidation, immunological reactions, radiation, stress, smoking, alcohol and biochemical redox reactions. Oxidative stress occurs if the antioxidant defense system is unable to prevent the harmful effects of free radicals. Several studies have reported that exposure to EMF results in oxidative stress in many tissues of the body. Exposure to EMF is known to increase free radical concentrations and traceability and can affect the radical couple recombination. The purpose of this review was to highlight the impact of oxidative stress on antioxidant systems.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6025786/

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Non-ionizing EMF hazard in the 21th century

Koh WJ, Moochhala SM. Non-ionizing EMF hazard in the 21th century. 2018 IEEE International Symposium on Electromagnetic Compatibility and 2018 IEEE Asia-Pacific Symposium on Electromagnetic Compatibility (EMC/APEMC).

Abstract

With the fast advancement in technologies and the heavy reliance on wireless devices, we are exposed to ever increasing electromagnetic field (EMF) radiation from home to office to public places. The two most widely referenced standards for non-ionizing EMF radiation protection - IEEE C95.1 and ICNIRP - were last updated in 2005 and 1998 respectively. A comparison of the two standards with the Russian standard shows that the Russian maximum permissible exposure (MPE) is 41 and 5.8 times lower in terms of electric field strength at 1MHz respectively. Despite numerous tests showing potential hazards to humans from radiation levels below the MPE levels stated in ICNIRP guidelines and C95.1, ICNIRP and IEEE continue to ignore calls by scientists to review their MPE levels. This paper addresses the current and future trends in communication and wireless technologies and their impact on the EMF radiation level that the general public will be exposed to. Studies on biological effects due to EMF radiation carried out over the last 20+ years will also be discussed. Based on the effects of these studies from radiation levels well below the MPE in C95.1 and ICNIRP guidelines, this paper recommends a review of the current safety levels.

Conclusion

With the fast advancement in telecommunication and wireless technologies and the heavy reliance on AC and DC power supplies, we will be constantly and increasingly exposed to EMF everywhere we go, including where we sleep. Based on the findings from numerous EM-Bio effect studies, it is evident that non-thermal and low radiation level (below MPE levels specified in C95.1 and ICNIRP guidelines) EMF could have significant effects on human body. it should be mentioned here that very specific exposure conditions may trigger biological response in one individual, but not in others. And some may take longer time than others for the symptoms to appear. Any health safety standard must protect not just those who are healthy but include those in poor health, the young and the pregnant women.

WHO's decision to classify mobile phone radiation as possibly carcinogenic came more than 20 years after mobile phones were introduced. Should we wait another 20 years for severe biological effects to show up and then regret that we did not do something earlier? We hope IEEE and ICNIRP can seriously consider potential effects from long term exposure of EMF radiation and review their MPE levels as soon as possible. If the committees still think that the results are inconclusive, then they may want to define a set of objective specific testing protocols so scientists and researchers can work on it to produce clear and definitive results.

https://ieeexplore.ieee.org/document/8393832/

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Longitudinal associations between risk appraisal of base stations for mobile phones, radio or television and non-specific symptoms

Martens AL, Slottje P, Smid T, Kromhout H, Vermeulen RCH, Timmermans DRM. Longitudinal associations between risk appraisal of base stations for mobile phones, radio or television and non-specific symptoms. Journal of Psychosomatic Research. 112:81-89. Sep 2018.https://doi.org/10.1016/j.jpsychores.2018.07.008

Highlights

• We studied longitudinal associations in a general population cohort.
• Risk appraisal of base stations was associated with higher symptom scores.

• The results indicate the presence of bidirectional longitudinal associations.

• Female sex, younger age, higher education, were associated with high risk appraisal.

Abstract

Introduction: Studies found that higher risk appraisal of radiofrequency electromagnetic fields is associated with reporting more non-specific symptoms such as headache and back pain. There is limited data available on the longitudinal nature of such associations and what aspects of risk appraisal and characteristics of subjects are relevant.

Objective: To examine cross-sectional and longitudinal associations between risk appraisal measures and non-specific symptoms, and assess the role of subject characteristics (sex, age, education, trait negative affect) in a general population cohort.

Methods: This study was nested in the Dutch general population AMIGO cohort that was established in 2011/2012, when participants were 31–65 years old. We studied a sample of participants (n = 1720) who filled in two follow-up questionnaires in 2013 and 2014, including questions about perceived exposure, perceived risk, and health concerns as indicators of risk appraisal of base stations, and non-specific symptoms.

Results: Perceived exposure, perceived risk, and health concerns, respectively, were associated with higher symptom scores in cross-sectional and longitudinal analyses. Only health concerns (not perceived exposure and perceived risk) temporally preceded high symptom scores and vice versa. Female sex, younger age, higher education, and higher trait negative affect were associated with higher risk appraisal of mobile phone base stations.

Discussion: The findings in this study strengthen the evidence base for cross-sectional and longitudinal associations between higher risk appraisal and non-specific symptoms in the general population. However, the directionality of potential causal relations in non-sensitive general population samples should be examined further in future studies, providing information to the benefit of risk communication strategies.

https://www.sciencedirect.com/science/article/pii/S0022399918302058

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Exposure to GSM 900-MHz mobile radiation impaired inhibitory avoidance memory consolidation in rat: Involvements of opioidergic and nitrergic systems

Ahmadi S, Alavi SS, Jadidi M, Ardjmand A. Exposure to GSM 900-MHz mobile radiation impaired inhibitory avoidance memory consolidation in rat: Involvements of opioidergic and nitrergic systems. Brain Research. 1701:36-45. Dec 2018. https://doi.org/10.1016/j.brainres.2018.07.016.

Highlights

• Four weeks of exposure to GSM radiation impaired IA memory performance.\
• Post-training i.c.v. injections of naloxone recovered the impairment of IA memory.
• Pre-test i.c.v. injections of L-NAME impaired the positive effect of naloxone
• Pre-test co-administration of L-arginine and L-NAME recovered the impairment.
• Opioid and NO systems are involved in the effects of GSM exposure on IA memory.

Abstract

The use of mobile phones is increasing, and the main health concern is the possible deleterious effects of radiation on brain functioning. The present study aimed to examine the effects of exposure to a global system for mobile communication (GSM) with mobile phones on inhibitory avoidance (IA) memory performance as well as the involvement of endogenous opioids and nitric oxide (NO) in this task. Male Wistar rats, 10–12 weeks old, were used. The results showed that four weeks of mobile phone exposure impaired IA memory performance in rats. The results also revealed that post-training, but not pre-training, as well as pre-test intracerebroventricular (i.c.v.) injections of naloxone (0.4, 4 and 40 ng/rat), dose-dependently recovered the impairment of IA memory performance induced by GSM radiation. Additionally, the impairment of IA memory performance was completely recovered in the exposed animals with post-training treatment of naloxone (40 ng/rat) plus pre-test i.c.v. injections of L-arginine (100 and 200 nmol/rat). However, pre-test i.c.v. injections of L-NAME (10 and 20 nmol/rat), impaired IA memory performance in the animals receiving post-training naloxone (40 ng/rat). In the animals receiving post-training naloxone treatment, the impairment of IA memory performance due to pre-test i.c.v. injections of L-NAME was recovered by the pre-test co-administration of L-arginine. It was concluded that the recovery from impairment of IA memory in GSM-exposed animals with post-training naloxone treatment was the result of blockade of the opioidergic system in early memory consolidation as well as activation of the nitrergic system in the retrieval phase of memory.

https://www.sciencedirect.com/science/article/pii/S0006899318304001

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Evaluating temperature changes of brain tissue due to induced heating of cell phone waves

Forouharmajd F, Pourabdian S, Hossein E. Evaluating temperature changes of brain tissue due to induced heating of cell phone waves. Intl J Prev Med. 9:40. Apr 2018

Background: Worries have recently been increased in the absorption of radiofrequency waves and their destructing effects on human health by increasing use of cell phones (mobile phones). This study performed to determine the thermal changes due to mobile phone radio frequency waves in gray and white brain tissue. Methods: This study is an empirical study, where the thermal changes of electromagnetic waves resulted from cell phones (900 MHZ, specific absorption rate for head 1.18 w/kg) on the 15 brain tissue of a cow were analyzed in a compartment with three different thickness of 2 mm, 12 mm, and 22 mm, for 15 min. The Lutron thermometer (model: MT-917) with 0.01 degrees C precision was used for measuring the tissue temperature. For each thickness was measured three times. Data analysis is done by Lutron and MATLAB software packages. Results: In confronting of the tissue with the cell phone, the temperature was increased by 0.53 degrees C in the 2 mm thickness that is the gray matter of the brain, increased by 0.99 degrees C in the 12 mm thickness, and also increased by 0.92 degrees C in the 22 mm thickness. Brain temperature showed higher rates than the base temperature after 15 min of confrontation with cell phone waves in all the three thicknesses. Conclusions: Cell phone radiated radio frequency waves were effective on increasing brain tissue temperature, and this temperature increase has cumulative effect on the tissue, being higher, for some time after the confrontation than the time with no confrontation.

Open access paper: http://www.ijpvmjournal.net/article.asp?issn=2008-7802;year=2018;volume=9;issue=1;spage=40;epage=40;aulast=Forouharmajd

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Modeling tissue heating from exposure to RF energy & relevance of tissue heating to exposure limits

Foster, KR, Ziskin MC, Balzano Q; Bit-Babik G. Modeling Tissue Heating From Exposure to Radiofrequency Energy and Relevance of Tissue Heating to Exposure Limits: Heating Factor. Health Physics: 115(2):295-307. Aug 2018

Abstract

This review/commentary addresses recent thermal and electromagnetic modeling studies that use image-based anthropomorphic human models to establish the local absorption of radiofrequency energy and the resulting increase in temperature in the body. The frequency range of present interest is from 100 MHz through the transition frequency (where the basic restrictions in exposure guidelines change from specific absorption rate to incident power density, which occurs at 3–10 GHz depending on the guideline). Several detailed thermal modeling studies are reviewed to compare a recently introduced dosimetric quantity, the heating factor, across different exposure conditions as related to the peak temperature rise in tissue that would be permitted by limits for local body exposure. The present review suggests that the heating factor is a robust quantity that is useful for normalizing exposures across different simulation models. Limitations include lack of information about the location in the body where peak absorption and peak temperature increases occur in each exposure scenario, which are needed for careful assessment of potential hazards. To the limited extent that comparisons are possible, the thermal model (which is based on Pennes' bioheat equation) agrees reasonably well with experimental data, notwithstanding the lack of theoretical rigor of the model and uncertainties in the model parameters. In particular, the blood flow parameter is both variable with physiological condition and largely determines the steady state temperature rise. We suggest an approach to define exposure limits above and below the transition frequency (the frequency at which the basic restriction changes from specific absorption rate to incident power density) to provide consistent levels of protection against thermal hazards. More research is needed to better validate the model and to improve thermal dosimetry in general. While modeling studies have considered the effects of variation in thickness of tissue layers, the effects of normal physiological variation in tissue blood flow have been relatively unexplored.

https://www.ncbi.nlm.nih.gov/pubmed/29957690

Conclusion

Advances in computational dosimetry and thermal modeling, reviewed in this paper, have filled in many details about the relation between psSAR and peak increase in temperature. These studies show that the heating factor is a robust measure of this relation. However, additional information is needed to assess potential thermal hazards of RF exposure, including the location and magnitude of the temperature increases in the body.

This present and two previous reviews in this series (Foster et al. 2016, 2017) show that thermal models can be useful for revising and updating RF exposure limits. While the theory that underlies the models, Pennes' BHTE, is generally reliable, it is not exact. Thermal models for RF heating of tissue require additional experimental validation including effects of variability in tissue blood perfusion, possible thermoregulatory responses of the body to RF heating, and other factors. Finally, more experimental data are needed for thermal hazards of RF energy at frequencies above the threshold. Apart from thermal hazards, a comprehensive review of all reported biological effects of RF energy above the transition frequency in the standards is also needed.

Q.B., K.R.F, and M.Z. were supported in this project by Mobile and Wireless Forum, which did not review and had no control over preparation of this manuscript. The authors thank A. Hirata, Nagoya Institute of Technology, Japan, for providing results used to prepare Fig. 3, and Dr. Vitas Anderson and Dr. C-K Chou for helpful discussion of earlier drafts of this paper. The views and opinions expressed herein are solely those of the authors and are not to be attributed to Motorola Solutions or any of its operating companies.

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900 MHz GSM Cell Phone Radiation Alters Human MCF-7 Cells & Stem Cells

Shahbazi-Gahrouei D, Hashemi-Beni B, Moradi A, Aliakbari M, Shahbazi-Gahrouei S. Exposure to Global System for Mobile Communication 900 MHz Cellular Phone Radiofrequency Alters Growth, Proliferation and Morphology of Michigan Cancer Foundation-7 Cells and Mesenchymal Stem Cells. Int J Prev Med. 2018 Jun 19;9:51.

Abstract

Background: Today, using cellular phone and its harmful effects in human life is growing. The aim of this study is to investigate the effect of the global system for mobile communication (GSM) 900 MHz cellular phone radiofrequency waves on growth, morphology, and proliferation rate of mesenchymal stem cells and Michigan Cancer Foundation (MCF-7) cells within the specific distance and intensity.

Methods: MCF-7 and human adipose-derived stem cells (HADSCs) were exposed to GSM cellular phones 900 MHz frequency with intensity of 354.6 μW/cm2 during different exposure times 6, 21, 51, and 101 min/day with an interval of 10 min for each subsequent radiation exposure for 3 and 5 days at 10 and 20 cm distances from antenna. 3-(4,5-dimethythiazol- 2-yl)-2,5-diphenyl tetrazolium bromide assay and trypan blue test were used to determine the growth of cells and cell viability, respectively. Statistical analyses were carried out using three-way ANOVA. Differences were significant when $P < 0.05$.

Results: The proliferation rates of both MCF-7 and HADSCs cells in all exposure groups were significantly lower than controls ($P < 0.05$). There was a significant effect on the percentage of cell survival with increase the period of time from 3 to 5 days for MCF-7 ($P < 0.01$) and HADSCs ($P = 0.02$), respectively. Variations in distance had no significant effect on the percentage of cell survival ($P = 0.35$) on MCF-7 ($P = 0.02$) and HADSCs ($P = 0.09$) cells, respectively.

Conclusions: The results showed that radiation of GSM 900 MHz cellular phone may be reduced cell viability and proliferation rates of both cells. It is recommended to reduce exposure time, increase distance from antenna, and reserve the use of cell phones for shorter conversations to prevent its biological and harmful effects. Further studies with other intensities and frequencies on different cells are recommended.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6028991/

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What is adverse effect of Wireless Local Area Network, using 2.45 GHz, on the reproductive system?

Bilgici B, Gun S, Avci B, Akar A, Engiz BK. What is adverse effect of Wireless Local Area Network, using 2.45 GHz, on the reproductive system? Int J Radiat Biol. 2018 Jul 20:1-25.

Abstract

PURPOSE: To investigate the inflammatory effect and testicular damage on rats exposed to low level of electromagnetic fields (EMF) at 2.45 GHz microwave radiation.

METHODS: Twenty two Wistar rats were divided into two groups. Group 1 was the control group and not exposed to EMF. Group 2 was exposed to low level EMF (average E-field 3.68± 0.36 V/m, whole body average SAR, 0.0233W/kg, in 10g tissue) at 2.45 GHz for 1 hour/day for 30 consecutive days. At the end of the study, interleukin-6 (IL-6), interleukin-10 (IL-10), interleukin-32 (IL-32), C-reactive protein (CRP) were measured in rat serum and IL-6, IL-10, IL-32 were measured in rat testis tissue. Furthermore, testicular tissues were evaluated histopathologically in terms of spermatogenesis and coagulation necrosis.

RESULTS: Serum IL-6 and CRP levels were found to be significantly different in the study group compared to the control group ($p < 0.05$), but no significant difference was found in serum IL-10, IL-32 levels and testis tissue IL-6, IL-10, IL-32 levels compared to the control group ($p > 0.05$). On the other hand, histopathological evaluation of testicular tissue revealed a significant difference in necrosis and spermatogenesis when compared with the control group ($p < 0.05$) Conclusions: It may be concluded that low level EMF at 2.45 GHz increases inflammation and testicular damage and negative impact on male reproductive system function.

https://www.ncbi.nlm.nih.gov/pubmed/30028652

Excerpt:

In this study, Microwave system with monopole antenna (2004X-RF, Everest Co., Adapazari, Turkey) was used to produce the low level EMF at 2.45 GHz. Microwave radiation generator can radiate at 2.45 GHz frequency, with a range of 0-1 Watt output power, and produce continuous or pulsed (modulated at 217 Hz) radiation.

My note: This study did not test Wi-Fi.

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DNA electromagnetic properties and interactions - An investigation on intrinsic bioelectromagnetism within DNA

Bukhari MH, Batool S, Raza Y, Bagasra O, Rizvi A, Shah A.DNA electromagnetic properties and interactions - An investigation on intrinsic bioelectromagnetism within DNA. Electromagnetic Biology & Medicine. Jul 19, 2018. https://doi.org/10.1080/15368378.2018.1499032.

Abstract

The question whether intrinsic bioelectromagnetism exists within DNA or not is an important and so far unexplored area of biology. We carried out a study of isolated genetic material, utilizing both prokaryotic and eukaryotic DNA, to measure any possible intrinsic electromagnetic effects or fields emanated within the molecules. Studies were carried out with extremely sensitive ultra-low-noise trans-impedance amplifiers and a high-precision data acquisition system to record any possible faintest electromagnetic signals from the concentrated, as well as diluted DNA, in vitro. Some experiments were performed to investigate any possible electromagnetic effects of high-frequency (HF) RF fields on the DNA under test. However, after extensive testing and careful measurements, we failed to detect any possible intrinsic or induced electromagnetic activity

from the DNA as compared to simple water or empty chambers. We reached a conclusion that there does not seem to be any measurable intrinsic electromagnetic activity or fields present in the DNA material, whether in concentrated or diluted form, and if there were, any such activity or fields would be extremely minuscule to be detected with scientific precision by current human measurement methods.

https://www.tandfonline.com/doi/full/10.1080/15368378.2018.1499032

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Exposure to 50 Hz Magnetic Fields in Homes and Areas Surrounding Urban Transformer Stations in Silla (Spain): Environmental Impact Assessment

Enrique A. Navarro-Camba EA , Segura-García J, Gomez-Perretta C. Exposure to 50 Hz Magnetic Fields in Homes and Areas Surrounding Urban Transformer Stations in Silla (Spain): Environmental Impact Assessment.
Sustainability 2018, 10(8), 2641; 27 July 2018. (This article belongs to the Special Issue Electromagnetic Waves Pollution)

Abstract

Exposure to extremely low frequency electromagnetic fields (ELFs) is almost inevitable almost anywhere in the world. An ELF magnetic field (ELF-MF) of around 1 mG = 0.1 μT is typically measured in any home of the world with a certain degree of development and well-being. There is fear and concern about exposure to electromagnetic fields from high- and medium-voltage wiring and transformer stations, especially internal transformer stations (TSs), which in Spain are commonly located inside residential buildings on the ground floor. It is common for neighbors living near these stations to ask for stations to be moved away from their homes, and to ask for information about exposure levels and their effects. Municipality is the closest administration to the citizens that must solve this situation, mediating between the citizens, the utility companies and the national administration. In this case, the municipality of Silla (València, Spain) wanted to know the levels of exposure in the dwellings annexed to the TSs, to compare them with Spanish legislation and the recommendations coming from epidemiological studies. This article presents the first systematic campaign of ELF-MF measurements from TSs carried out in a Spanish city. Many measurements were carried out in the rooms of the apartments doing spatial averages of spatial grid measurements. Measurements are made in the bed and bedrooms and a weighted average and an environmental impact indicator were obtained for each location. We found that old TSs usually provide the highest peak exposure levels. A notable result of this work is that approximately one quarter of the population living above or next to a TS would be exposed to a weighted MF level greater than 0.3 μT, and that about a 10% of this population would not be able to relocate their bedroom or living room to minimize the level of exposure.

Open access paper: http://www.mdpi.com/2071-1050/10/8/2641

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Measurement and analysis of power-frequency magnetic fields in residences: Results from a pilot study

Halgamuge MN, McLean L. Measurement and analysis of power-frequency magnetic fields in residences: Results from a pilot study. Measurement. 125:415-424. Sep 2018.

Highlights

- Exposure to high magnetic fields in residential situations occurs in proximity to appliances.
- Emissions from some appliances exceeded the general public exposure levels of the ICNIRP limits.
- Taking precautions, such as reducing distance from sources can significantly reduce exposures.
- Collected data can be useful as an additional data base for future epidemiological studies.

Abstract

Aim Extremely low-frequency magnetic fields (ELF-MFs) are emitted by electrical household appliances, wiring, meter boxes, conductive plumbing, power lines and transformers. Some of the studies investigating the link between ELF-MFs and health problems have not adequately characterized the magnetic field exposure of subjects, as they did not always measure residential magnetic fields or measure in locations where residents are most exposed. Considering this, there is a need for good quality assessments of residential ELF-MFs in different geographical regions to collect general public exposure data and to identify high sources of magnetic fields. Such studies have the potential to add significant scientific knowledge about residential exposure and appropriate precautions to reduce exposure, improve the quality of life and substantially reduce health care costs.

Subject and methods In this work, we analyzed the ELF-MFs from 3163 datasets collected from 100 houses in Australia. Measurements were carried out in different geographical locations and were assessed for compliance with the International Commission on Non-Ionizing Radiation Protection (ICNIRP) Guidelines. Then we compared our measurements with another twenty-three peer-reviewed studies, published 1987–2015, reporting magnetic field measurements in residences.

Results The observed average (geometric mean) magnetic field values were; bed 0.85, bedroom 1.39 mG, baby cot 0.39 mG, children's play area 0.47 mG, and family room 0.30 mG. Our results show considerable variation in the fields to which residents are typically exposed, particularly in beds (21.83%) and bedrooms (33.33%) where the percentage of measurements greater than 4 mG was considerable. Some emissions exceeded the general public exposure levels of the ICNIRP Guidelines, with the potential for residents to be exposed above these levels. However, away from electrical appliances, the average field in all rooms was 0.30–1.39 mG. We show that simple precautions can be applied to reduce exposure to ELF-MFs in residences and thereby minimize potential risks to health and wellbeing.

Conclusion Our investigation provides a new data collection model for future surveys, which could be conducted with larger samples to verify our observations. Additionally, this data could be useful as a reference for researchers and those members of the general public who do not have access to the necessary measuring equipment.

Conclusion

Exposure to high magnetic fields in residential situations occurs in proximity to appliances, especially microwave ovens, conductive water pipes, meter boxes, and wiring, as well as external sources such as power lines, transformers and substations. Emissions of some appliances exceeded the general public exposure levels of the ICNIRP exposure guideline. However, there is no conclusive proof that electromagnetic fields cause health problems. Taking precautions, such as increasing distance from sources can significantly reduce exposures. In this work, we analyzed the power frequency magnetic fields using 3163 datasets from 100

houses in Australia. Our work provides a model for future surveys, especially for epidemiological studies. This work also will be useful to householders to understand the typical magnetic field strength to which they are exposed everyday. Future surveys could be conducted with larger samples, to verify our observations and to correlate these exposures with symptoms experienced by householders. Future studies could also consider measurements of radiofrequency radiation from wireless devices in the home.

https://www.sciencedirect.com/science/article/pii/S0263224118303920?via%3Dihub

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Millitesla magnetic field effects on the photocycle of an animal cryptochrome

Sheppard DM, Li J, Henbest KB, Neil SR, Maeda K, Storey J, Schleicher E, Biskup T, Rodriguez R, Weber S, Hore PJ, Timmel CR, Mackenzie SR. Millitesla magnetic field effects on the photocycle of an animal cryptochrome. Sci Rep. 2017 Feb 8;7:42228. doi: 10.1038/srep42228.

Abstract

Drosophila have been used as model organisms to explore both the biophysical mechanisms of animal magnetoreception and the possibility that weak, low-frequency anthropogenic electromagnetic fields may have biological consequences. In both cases, the presumed receptor is cryptochrome, a protein thought to be responsible for magnetic compass sensing in migratory birds and a variety of magnetic behavioural responses in insects. Here, we demonstrate that photo-induced electron transfer reactions in Drosophila melanogaster cryptochrome are indeed influenced by magnetic fields of a few millitesla. The form of the protein containing flavin and tryptophan radicals shows kinetics that differ markedly from those of closely related members of the cryptochrome-photolyase family. These differences and the magnetic sensitivity of Drosophila cryptochrome are interpreted in terms of the radical pair mechanism and a photocycle involving the recently discovered fourth tryptophan electron donor.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5296725/

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6-mT 0-120-Hz magnetic fields differentially affect cellular ATP levels

Wang D, Zhang L, Shao G, Yang S, Tao S, Fang K, Zhang X. 6-mT 0-120-Hz magnetic fields differentially affect cellular ATP levels. Environ Sci Pollut Res Int. 2018 Aug 3. doi: 10.1007/s11356-018-2868-3.

Abstract

Adenosine triphosphate (ATP), an indispensable molecule that provides energy for essentially all cellular processes, has been shown to be affected by some magnetic fields (MFs). Although people are frequently exposed to various static and power frequency MFs in their daily lives, the exact effects of these MFs of different frequencies have not been systematically investigated. Here, we tested 6-mT MFs with 0, 50, and 120 Hz for their effects on cellular ATP levels in 11 different cell lines. We found that the 6-mT static magnetic field (SMF) either does not affect or increase cellular ATP levels, while 6-mT 50-Hz MF either does not affect or decrease cellular ATP levels. In contrast, 6-mT 120-Hz MF has variable effects. We examined the mitochondrial membrane potential (MMP) as well as reactive oxygen species (ROS) in four different cell lines, but did not find their direct correlation with ATP levels. Although none of the ATP level changes induced by

these three different frequencies of 6-mT MFs are dramatic, these results may be used to explain some differential cellular responses of various cell lines to different frequency MFs.

https://www.ncbi.nlm.nih.gov/pubmed/30074140

Excerpt

In conclusion, although the ATP level changes induced by 6-mT MFs are not dramatic, the exact effects are cell type-, MF frequency-, and time-dependent. These may help to explain some observed cellular phenomenon of low-frequency MFs. Given the prevalence of power frequency and SMF exposure for human bodies, such as the MFs generated by electric power lines, home appliance, and household items, people should be aware of their potential effects on cellular ATP, which is the foundation of many cellular processes.

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Thermal and non-thermal health effects of low intensity non-ionizing radiation: An international perspective

Belpomme D, Hardell, L, Belyaev I, Burgio E, Carpenter DO. Thermal and non-thermal health effects of low intensity non-ionizing radiation: An international perspective. Environ Pollut. 2018 Jul 6;242(Pt A):643-658. doi: 10.1016/j.envpol.2018.07.019.

Highlights

• Exposure to electromagnetic fields has increased dramatically.
• Electromagnetic fields at low and non-thermal intensities increase risk of cancer in animals and humans.
• Some individuals are particularly sensitive and develop a syndrome of electrohypersensitivity.
• There is an urgent need to recognize hazards associated with excessive exposure to non-thermal levels of electromagnetic fields.

Abstract

Exposure to low frequency and radiofrequency electromagnetic fields at low intensities poses a significant health hazard that has not been adequately addressed by national and international organizations such as the World Health Organization. There is strong evidence that excessive exposure to mobile phone-frequencies over long periods of time increases the risk of brain cancer both in humans and animals. The mechanism(s) responsible include induction of reactive oxygen species, gene expression alteration and DNA damage through both epigenetic and genetic processes. In vivo and in vitro studies demonstrate adverse effects on male and female reproduction, almost certainly due to generation of reactive oxygen species. There is increasing evidence the exposures can result in neurobehavioral decrements and that some individuals develop a syndrome of "electro-hypersensitivity" or "microwave illness", which is one of several syndromes commonly categorized as "idiopathic environmental intolerance". While the symptoms are non-specific, new biochemical indicators and imaging techniques allow diagnosis that excludes the symptoms as being only psychosomatic. Unfortunately standards set by most national and international bodies are not protective of human health. This is a particular concern in children, given the rapid expansion of use of wireless technologies, the greater susceptibility of the developing nervous system, the hyperconductivity of their brain tissue, the greater penetration of radiofrequency radiation relative to head size and their potential for a longer lifetime exposure.

https://www.ncbi.nlm.nih.gov/pubmed/30025338

Final section of the paper:

Public Health Implications of Human Exposure to EMFs

The incidence of brain cancer in children and adolescents has increased between 2000 and 2010 (Ostrom et al., 2015). Gliomas are increasing in the Netherlands (Ho et al., 2014), glioblastomas are increasing in Australia (Dobes et al., 2011) and England (Philips et al., 2018) and all brain cancers are increasing in Spain (Etxeberrua et al., 2015) and Sweden (Hardell and Carlberg, 2017). The latency period between initial exposure and clinical occurrence of brain cancer is not known but is estimated to be long. While not all reports of brain cancer rates show an increase, some do. The continually increasing exposure to EMFs from all sources may contribute to these increases. The prevalence of EHS is unknown, but various reports suggest that it is between 1 and 10% of the population (Hallberg and Oberfeld, 2006; Huang et al., 2018). Male fertility has been declining (Geoffroy-Siraudin et al., 2012; Levine et al., 2017). EMFs increase the risk of each of these diseases and others. Alzheimer's disease is increasing in many countries worldwide and its association with ELF-EMF occupational exposure has been clearly demonstrated through several independent epidemiological studies (Davanipour and Sobel, 2009; Sobel et al., 1996; Qiu et al., 2004) and a meta-analysis of these studies (García et al., 2008). A recent meta-analysis (Huss et al., 2018) has reported an increased risk of amyotrophic lateral sclerosis in workers occupationally exposure to ELF-EMFs.

Safety limits for RF exposure have been based (until today) on the thermal effects of EMFs. But these standards do not protect people, particularly children, from the deleterious health effects of non-thermal EMFs (Nazıroğlu et al., 2013; Mahmoudabadi et al., 2015). Each of these diseases is associated with decrements in health and quality of life. Brain cancer patients often die is spite of some improvement in treatment, while EHS patients present with increased levels of distress, inability to work, and progressive social withdrawal. The ability for humans to reproduce is fundamental for the maintenance of our species.

The scientific evidence for harm from EMFs is increasingly strong. We do not advocate going back to the age before electricity or wireless communication, but we deplore the present failure of public health international bodies to recognize the scientific data showing the adverse effects of EMFs on human health. It is encouraging that some governments are taking action. France has removed WiFi from pre-schools and ordered Wi-Fi to be shut off in elementary schools when not in use (http://www.telegraph.co.uk.news/2017/12/11/france-ipose-total-ban-mobile-phones-schools/). The State of California Department of Public Health has issued a warning on use of mobile phones and offered advice on how to reduce exposure (State of California, 2017). There are many steps that are neither difficult nor expensive that can be taken to use modern technology but in a manner that significally reduces threats to human health.

It is urgent that national and international bodies, particularly the WHO, take this significant public health hazard seriously and make appropriate recommendations for protective measures to reduce exposures. This is especially urgently needed for children and adolescents. It is also important that all parts of society, especially the medical community, educators, and the general public, become informed about the hazards associated with exposure to EMFs and of the steps that can be easily taken to reduce exposure and risk of associated disease.

https://www.ncbi.nlm.nih.gov/pubmed/30025338

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Cohort study of adolescents' memory performance & brain dose of microwave radiation from wireless EMF

Foerster M., Thielens A., Joseph W., Eeftens M., Röösli M. (2018) A prospective cohort study of adolescents' memory performance and individual brain dose of microwave radiation from wireless communication. Environmental Health Perspectives. https://ehp.niehs.nih.gov/ehp2747

Abstract

BACKGROUND: The potential impact of microwave radiofrequency electromagnetic fields (RF-EMF) emitted by wireless communication devices on neurocognitive functions of adolescents is controversial. In a previous analysis, we found changes in figural memory scores associated with a higher cumulative RF-EMF brain dose in adolescents.

OBJECTIVE: We aimed to follow-up our previous results using a new study population, dose estimation, and approach to controlling for confounding from media usage itself.

METHODS: RF-EMF brain dose for each participant was modeled. Multivariable linear regression models were fitted on verbal and figural memory score changes over 1 y and on estimated cumulative brain dose and RF-EMF related and unrelated media usage (n=669–676). Because of the hemispheric lateralization of memory, we conducted a laterality analysis for phone call ear preference. To control for the confounding of media use behaviors, a stratified analysis for different media usage groups was also conducted.

RESULTS: We found decreased figural memory scores in association with an interquartile range (IQR) increase in estimated cumulative RF-EMF brain dose scores: −0:22 (95% CI: −0:47, 0.03; IQR: 953 mJ=kg per day) in the whole sample, −0:39 (95% CI: −0:67, −0:10; IQR: 953 mJ=kg per day) in right-side users (n=532), and −0:26 (95% CI: −0:42, −0:10; IQR: 341 mJ=kg per day) when recorded network operator data were used for RF-EMF dose estimation (n=274). Media usage unrelated to RF-EMF did not show significant associations or consistent patterns, with the exception of consistent (nonsignificant) positive associations between data traffic duration and verbal memory.

CONCLUSIONS: Our findings for a cohort of Swiss adolescents require confirmation in other populations but suggest a potential adverse effect of of RF-EMF brain dose on cognitive functions that involve brain regions mostly exposed during mobile phone use. https://doi.org/10.1289/EHP2427

Conclusion

We found preliminary evidence suggesting that RF-EMF may affect brain functions such as figural memory in regions that are most exposed during mobile phone use. Our findings do not provide conclusive evidence of causal effects and should be interpreted with caution until confirmed in other populations. Associations with media use parameters with low RF-EMF exposures did not provide clear or consistent support of effects of media use unrelated to RF-EMF (with the possible exception of consistent positive associations between verbal memory and data traffic duration). It is not yet clear which brain processes could be potentially affected and what biophysical mechanism may play a role. Potential long-term risk can be minimized by avoiding high brain-exposure situations as occurs when using a mobile phone with maximum power close to the ear because of, for example, bad network quality.

Original study from 2015:

Schoeni A., Roser K., Röösli M. (2015) Memory performance, wireless communication and exposure to radiofrequency electromagnetic fields: a prospective cohort study in adolescents. Environmental International. 85: 343-351.

Highlights

• This is a prospective cohort study with approx. one year of follow-up.
• Self-reported and operator recorded mobile phone use data were collected.
• The cumulative RF-EMF dose for the brain and for the whole body was calculated.
• Associations were stronger for RF-EMF dose than for use of wireless devices.
• RF-EMF exposure might impair memory performance in adolescents.

Abstract

BACKGROUND: The aim of this study is to investigate whether memory performance in adolescents is affected by radiofrequency electromagnetic fields (RF-EMF) from wireless device use or by the wireless device use itself due to non-radiation related factors in that context.

METHODS: We conducted a prospective cohort study with 439 adolescents. Verbal and figural memory tasks at baseline and after one year were completed using a standardized, computerized cognitive test battery. Use of wireless devices was inquired by questionnaire and operator recorded mobile phone use data was obtained for a subgroup of 234 adolescents. RF-EMF dose measures considering various factors affecting RF-EMF exposure were computed for the brain and the whole body. Data were analysed using a longitudinal approach, to investigate whether cumulative exposure over one year was related to changes in memory performance. All analyses were adjusted for relevant confounders.

RESULTS: The kappa coefficients between cumulative mobile phone call duration and RF-EMF brain and whole body dose were 0.62 and 0.67, respectively for the whole sample and 0.48 and 0.28, respectively for the sample with operator data. In linear exposure-response models an interquartile increase in cumulative operator recorded mobile phone call duration was associated with a decrease in figural memory performance score by -0.15 (95% CI: -0.33, 0.03) units. For cumulative RF-EMF brain and whole body dose corresponding decreases in figural memory scores were -0.26 (95% CI: -0.42, -0.10) and -0.40 (95% CI: -0.79, -0.01), respectively. No exposure-response associations were observed for sending text messages and duration of gaming, which produces tiny RF-EMF emissions.

CONCLUSIONS: A change in memory performance over one year was negatively associated with cumulative duration of wireless phone use and more strongly with RF-EMF dose. This may indicate that RF-EMF exposure affects memory performance.

https://www.sciencedirect.com/science/article/pii/S0160412015300659?via%3Dihub

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Occupational exposure to high-frequency EMF and brain tumor risk in INTEROCC study

Vila J, Turner MC, Gracia-Lavedan E, Figuerola J, Bowman JD, Kincl L, Richardson L, Benke G, Hours M, Krewski D, McLean D, Parent ME, Sadetzki S, Schlaefer K, Schlehofer B, Schüz J, Siemiatycki J, van Tongeren M, Cardis E, INTEROCC Study Group.Occupational exposure to high-frequency electromagnetic fields and brain tumor risk in the INTEROCC study: An individualized assessment approach. Environ Int. 2018 Jul 8;119:353-365. doi: 10.1016/j.envint.2018.06.038.

Introduction: In 2011, the International Agency for Research on Cancer classified radiofrequency (RF) electromagnetic fields (EMF) as possibly carcinogenic to humans (group 2B), although the epidemiological evidence for the association between occupational exposure to RF-EMF and cancer was judged to be inadequate, due in part to limitations in exposure assessment. This study examines the relation between occupational RF and intermediate frequency (IF) EMF exposure and brain tumor (glioma and meningioma) risk in the INTEROCC multinational population-based case-control study (with nearly 4000 cases and over 5000 controls), using a novel exposure assessment approach.

Methods: Individual indices of cumulative exposure to RF and IF-EMF (overall and in specific exposure time windows) were assigned to study participants using a source-exposure matrix and detailed interview data on work with or nearby EMF sources. Conditional logistic regression was used to investigate associations with glioma and meningioma risk.

Results: Overall, around 10% of study participants were exposed to RF while only 1% were exposed to IF-EMF. There was no clear evidence for a positive association between RF or IF-EMF and the brain tumors studied, with most results showing either no association or odds ratios (ORs) below 1.0. The largest adjusted ORs were obtained for cumulative exposure to RF magnetic fields (as A/m-years) in the highest exposed category (≥90th percentile) for the most recent exposure time window (1-4 years before the diagnosis or reference date) for both glioma, OR = 1.62 (95% confidence interval (CI): 0.86, 3.01) and meningioma (OR = 1.52, 95% CI: 0.65, 3.55).

Conclusion: Despite the improved exposure assessment approach used in this study, no clear associations were identified. However, the results obtained for recent exposure to RF electric and magnetic fields are suggestive of a potential role in brain tumor promotion/progression and should be further investigated.

https://www.ncbi.nlm.nih.gov/pubmed/29996112

Excerpt

In conclusion, despite the improved quantitative exposure assessment used in this study, the results do not support a positive association between occupational exposure to high-frequency EMF and either glioma or meningioma risk. However, given our limited statistical power, due to the small number of exposed participants, and despite our results´ lack of significance (Greenland et al., 2016; Rothman, 2016; Smith and Kriebel, 2010), our findings foster the need for further research focusing on RF magnetic fields and tumor promotion, as well as possible interactions with other frequencies and with chemicals. Moreover, since most RF studies until now have focused on the effects of electric fields, more studies of RF magnetic fields are needed, particularly looking at differences between near-field (e.g. walkie-talkies) and far-field exposures (e.g. radars). Furthermore, the development of biology-based dose metrics which take into account both electric and magnetic fields from various sources (Hansson Mild and Mattson, 2017) may provide further insights on the potential biophysical mechanism(s), other than heating and nerve electro-stimulation (ICNIRP, 1998; IEEE, 2006), by which long-term exposure to high-frequency EMF may damage health.

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"Biological effects of non-ionizing electromagnetic fields: Two sides of a coin".

Saliev T, Begimbetova D, Masoud AR, Matkarimov B. "Biological effects of non-ionizing electromagnetic fields: Two sides of a coin.". Prog Biophys Mol Biol. 2018 Jul 17. pii: S0079-6107(18)30100-7. doi: 10.1016/j.pbiomolbio.2018.07.009.

Abstract

Controversial, sensational and often contradictory scientific reports have triggered active debates over the biological effects of electromagnetic fields (EMFs) in literature and mass media the last few decades. This could lead to confusion and distraction, subsequently hampering the development of a univocal conclusion on the real hazards caused by EMFs on humans. For example, there are lots of publications indicating that EMF can induce apoptosis and DNA strand-breaks in cells. On the other hand, these effects could rather be beneficial, in that they could be effectively harnessed for treatment of various disorders, including cancer. This review discusses and analyzes the results of various in vitro, in vivo and epidemiological studies on the effects of non-ionizing EMFs on cells and organs, including the consequences of exposure to the low and high frequencies EM spectrum. Emphasis is laid on the analysis of recent data on the role of EMF in the induction of oxidative stress and DNA damage. Additionally, the impact of EMF on the reproductive system has been discussed, as well as the relationship between EM radiation and blood cancer. Apart from adverse effects, the therapeutic potential of EMFs for clinical use in different pathologies is also highlighted.

https://www.ncbi.nlm.nih.gov/pubmed/30030071

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Effect of RF EMF from mobile phones on nickel release from orthodontic brackets: An in vitro study

Seyed Mohammad S, Mortazavi J, Paknahad M, Khaleghi I, Eghlidospour M. Effect of radiofrequency electromagnetic fields (RF-EMFS) from mobile phones on nickel release from orthodontic brackets: An in vitro study. International Orthodontics, Available online 12 July 2018.

Summary

Background The worldwide dramatic increase in the use of cell phones has generated great concerns about their potential adverse health effects.

Objective The aim of the present study was to evaluate the effects of radiofrequency electromagnetic fields (RF-EMFs) emitted from mobile phones on the level of nickel release from orthodontic brackets.

Methods Twenty stainless steel brackets were divided randomly into experimental and control groups (n = 10). Brackets were immersed in artificial saliva at 37 °C for 6 months. Experimental group were exposed to GSM 900 MHz RF-EMFs emitted from a mobile phone stimulator for 4 hours. The specific absorption rate (SAR) was 2.287 W/kg. The concentration of nickel in the artificial saliva in both groups was evaluated by using the cold-vapour atomic absorption spectrometry. The Mann-Whitney test was used to assess significant differences in nickel release between the exposed and non-exposed groups.

Results The mean nickel levels in the exposed and non-exposed groups were 11.95 and 2.89 μg/l, respectively. This difference between the concentrations of nickel in the artificial saliva of these groups was statistically significant (P = 0.001).

Conclusion Exposure to RF-EMFs emitted from mobile phones can lead to human exposure to higher levels of nickel in saliva in patients with orthodontic appliances. As nickel exposure can lead to allergic reaction in humans and considering this point that about 10–20% of the population can be hypersensitive to nickel, further studies are needed to evaluate the effects of radiofrequency electromagnetic fields (RF-EMFs) emitted from common devices such as mobile phones or Wi-Fi routers on the level of nickel release from orthodontic brackets.

https://www.sciencedirect.com/science/article/pii/S1761722718300962?via%3Dihub

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Mobile phone chips reduce increases in EEG brain activity induced by mobile phone EMF

Henz D, Schöllhorn WI, Poeggeler B. Mobile Phone Chips Reduce Increases in EEG Brain Activity Induced by Mobile Phone-Emitted Electromagnetic Fields. Front Neurosci. 2018 Apr 4;12:190. doi: 10.3389/fnins.2018.00190.

Abstract

Recent neurophysiological studies indicate that exposure to electromagnetic fields (EMFs) generated by mobile phone radiation can exert effects on brain activity. One technical solution to reduce effects of EMFs in mobile phone use is provided in mobile phone chips that are applied to mobile phones or attached to their surfaces. To date, there are no systematical studies on the effects of mobile phone chip application on brain activity and the underlying neural mechanisms. The present study investigated whether mobile phone chips that are applied to mobile phones reduce effects of EMFs emitted by mobile phone radiation on electroencephalographic (EEG) brain activity in a laboratory study. Thirty participants volunteered in the present study. Experimental conditions (mobile phone chip, placebo chip, no chip) were set up in a randomized within-subjects design. Spontaneous EEG was recorded before and after mobile phone exposure for two 2-min sequences at resting conditions. During mobile phone exposure, spontaneous EEG was recorded for 30 min during resting conditions, and 5 min during performance of an attention test (d2-R). Results showed increased activity in the theta, alpha, beta and gamma bands during EMF exposure in the placebo and no chip conditions. Application of the mobile phone chip reduced effects of EMFs on EEG brain activity and attentional performance significantly. Attentional performance level was maintained regarding number of edited characters. Further, a dipole analysis revealed different underlying activation patterns in the chip condition compared to the placebo chip and no chip conditions. Finally, a correlational analysis for the EEG frequency bands and electromagnetic high-frequency (HF) emission showed significant correlations in the placebo chip and no chip condition for the theta, alpha, beta, and gamma bands. In the chip condition, a significant correlation of HF with the theta and alpha bands, but not with the beta and gamma bands was shown. We hypothesize that a reduction of EEG beta and gamma activation constitutes the key neural mechanism in mobile phone chip use that supports the brain to a degree in maintaining its natural activity and performance level during mobile phone use.

Conclusion

The findings of this study are mainly in line with previous studies to date in the field of neuroscience investigating the effects of EMF exposure from mobile phone use on brain activity. Increases in EEG activations were obtained by exposure to EMFs from mobile phone in all tested frequency bands. A reduction of these EMF induced activations is observed when a mobile phone chip is applied, particularly in the high-

frequency ranges (beta and gamma bands). The observation is made both in resting as well as in working conditions. A deeper analysis of the EEG signals indicates that when applying the mobile phone chip less activation sources are found in the brain when exposed to mobile phone-emitted EMFs compared to the experimental conditions when a placebo chip is applied, or when no chip is applied. The findings of this study encourage further investigations on the long-term effects of mobile phone chip use in mobile phones in working settings as beneficial effects are shown for the short-term use of mobile phone chips on brain activity.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5893900/

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Extremely High Frequency EMF Facilitate Electrical Signal Propagation by Increasing Transmembrane Potassium Efflux in Artificial Axon Model

D'Agostino S, Della Monica C, Palizzi E, Di Pietrantonio F, Benetti M, Cannatà D, Cavagnaro M, Sardari D, Stano P, Ramundo-Orlando A. Extremely High Frequency Electromagnetic Fields Facilitate Electrical Signal Propagation by Increasing Transmembrane Potassium Efflux in an Artificial Axon Model. Sci Rep. 2018 Jun 18;8(1):9299. doi: 10.1038/s41598-018-27630-8.

Abstract

Among the many biological effects caused by low intensity extremely high frequency electromagnetic fields (EHF-EMF) reported in the literature, those on the nervous system are a promising area for further research. The mechanisms by which these fields alter neural activity are still unclear and thus far there appears to be no frequency dependence regarding neuronal responses. Therefore, proper in vitro models for preliminary screening studies of the interaction between neural cells with EMF are needed. We designed an artificial axon model consisting of a series of parallel RC networks. Each RC network contained an aqueous solution of lipid vesicles with a gradient of potassium (K+) concentration as the functional element. We investigated the effects of EHF-EMF (53.37 GHz-39 mW) on the propagation of the electric impulse. We report that exposure to the EHF-EMF increases the amplitude of electrical signal by inducing a potassium efflux from lipid vesicles. Further, exposure to the EHF-EMF potentiates the action of valinomycin - a K+ carrier - increasing the extent of K+ transport across the lipid membrane. We conclude that exposure to the EHF-EMF facilitates the electrical signal propagation by increasing transmembrane potassium efflux, and that the model presented is promising for future screening studies of different EMF frequency spectrum bands.

Open access paper: https://www.nature.com/articles/s41598-018-27630-8

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Wi-Fi radiation (2.4 GHz) causes impaired insulin secretion and increased oxidative stress in rat pancreatic islets

Masoumi A, Karbalaei N, Mortazavi SMJ, Shabani M. Radiofrequency radiation emitted from Wi-Fi (2.4 GHz) causes impaired insulin secretion and increased oxidative stress in rat pancreatic islets.Int J Radiat Biol. 2018 Jun 18:1-20. doi: 10.1080/09553002.2018.1490039.

Abstract

PURPOSE: There is a great concern regarding the possible adverse effects of electromagnetic radiation (EMR). This study investigated the effects of EMR induced by Wi-Fi (2.45GHz) on insulin secretion and

antioxidant redox systems in the rat pancreas.

MATERIALS AND METHODS: Adult male Sprague-Dawley rats in the weight range of 230 to 260 g were divided into control, sham, Wi-Fi exposed groups. After long term exposure (4 h/day for 45 days) to Wi-Fi electromagnetic radiation, plasma levels of glucose and insulin during intraperitoneal glucose tolerance test were measured. Islet insulin secretion and content, lipid peroxidation and antioxidant status in pancreas of rats were determined.

RESULTS: Our data showed that the weight gain in the WI-FI exposed group was significantly lower than the control group ($p<0.05$). Wi-Fi (2.45 GHz) exposed group showed hyperglycemia. Plasma insulin level and glucose-stimulated insulin secretion from pancreatic islet were significantly reduced in the Wi-Fi exposed group. EMR emitted from Wi-Fi caused a significant increase in lipid peroxidation and a significant decrease in GSH level, SOD and GPx activities of the pancreas.

CONCLUSION: these data showed that EMR of Wi-Fi leads to hyperglycemia, increased oxidative stress and impaired insulin secretion in the rat pancreatic islets.

https://www.ncbi.nlm.nih.gov/pubmed/29913098

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2450 MHz exposure causes cognition deficit with mitochondrial dysfunction & activation of intrinsic pathway of apoptosis in rats

Gupta SK, Mesharam MK, Krishnamurthy S. Electromagnetic radiation 2450 MHz exposure causes cognition deficit with mitochondrial dysfunction and activation of intrinsic pathway of apoptosis in rats. J Biosci. 2018 Jun;43(2):263-276.

Abstract

Electromagnetic radiation (EMR) can induce or modulate several neurobehavioral disorders. Duration and frequency of exposure of EMR is critical to develop cognitive disorders. Even though EMR-2450 is widely used, its effects on cognition in relation to mitochondrial function and apoptosis would provide better understanding of its pathophysiological effects. Therefore, a comparative study of different frequencies of EMR exposure would give valuable information on effects of discrete frequencies of EMR on cognition. Male rats were exposed to EMR (900, 1800 and 2450 MHz) every day for 1 h for 28 consecutive days. The cognitive behavior in terms of novel arm entries in Y-maze paradigm was evaluated every week after 1 h to last EMR exposure. Animals exposed to EMR-2450 MHz exhibited significant cognitive deficits. EMR- 2450 MHz caused loss of mitochondrial function and integrity, an increase in amyloid beta expression. There was release of cytochrome-c and activation of apoptotic factors such as caspase-9 and -3 in the hippocampus. Further, there was decrease in levels of acetylcholine, and increase in activity of acetyl cholinesterase, indicating impairment of cholinergic system. Therefore, exposure of EMR-2450 in rats caused cognitive deficit with related pathophysiological changes in mitochondrial and cholinergic function, and amyloidogenesis.

Excerpts

The animals after being exposed to 900, 1800 and 2450 MHz EMR, the average power density was found to be 0.1227 W/m2. While the overall value of whole body average SAR was found to be approximately, 0.0227, 0.030 and 0.0616 W/kg for 900, 1800 and 2450 MHz respectively.

Experimental rats (n=6) were subjected to continuous modulated electromagnetic radiation exposure of 900, 1800 and 2450 MHz (for modulation: modulating signal 217 Hz, modulation index 0.1%), for daily 1 h for each group for 28 days between 10.00 AM to 1.00 PM. Control group was placed in anechoic chamber without any exposure.

In summary, EMR at 2450 MHz induced cognitive behavioral deficit with concomitant loss in mitochondrial function. Alteration in the activity of mitochondrial complex enzyme systems caused oxidative stress and decrease in MMP, which ultimately lead to loss of mitochondrial integrity. Further, mitochondrial stress as observed from increasesin cytochrome-c activated the expression of caspase-9 and caspase-3, indicating mitochondrial-linked apoptosis. Furthermore, exposure with EMR-2450 increased expression of hippocampal Ab and decreased cholinergic neurotransmission in the hippocampus, which are considered to be important factors for development of cognitive dysfunction

Open access paper: https://www.ias.ac.in/article/fulltext/jbsc/043/02/0263-0276

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Aloe prevents EMF-induced oxidative stress and protects male reproductive system in vitro

Solek P, Majchrowicz L, Koziorowski M. Aloe arborescens juice prevents EMF-induced oxidative stress and thus protects from pathophysiology in the male reproductive system in vitro. Environ Res. 2018 Jun 7;166:141-149.

Abstract

More and more studies suggest that prolonged exposure to EMF may cause adverse biological effects and point directly to a significantly negative correlation between EMF and human health, especially men fertility. In our previous study, we reported that this could be related to the EMF-induced reactive oxygen species formation, followed by DNA damage, cell cycle arrest and apoptosis induction. In this study, we decided to expand our research by the search for substances which would prevent EMF-induced damage in spermatogenic cells. Such an agent seems to be Aloe arborescens Mill. juice, which was shown to possess a wide range of protective properties. The administration of aloe extract helps among others to prevent the formation of free radicals by various biochemical pathways. Therefore, the main aim of our study was to provide a significant knowledge concerning the mechanism involved in the multi-pathway cytoprotective response of aloe juice against EMF. The study was carried out in an in vitro mouse spermatogenesis pathway cell lines (GC-1 spg and GC-2 spd). Our results suggest that the aloe juice has many positive effects, especially for the cellular antioxidant systems by reducing the intracellular reactive oxygen species pool induced by EMF. In consequence, aloe juice prevents DNA damage, cell cycle arrest and therefore the viability and metabolic activity of both cell line tested are preserved. In conclusion, our study provides new insight into the underlying mechanisms through which aloe juice prevents spermatogenic cells from cytotoxic and genotoxic events.

https://www.ncbi.nlm.nih.gov/pubmed/29886390

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Understanding effects of EMF emissions from Marine Renewable Energy Devices on commercially important edible crab

Scott K, Harsanyi P, Lyndon AR. Understanding the effects of electromagnetic field emissions from Marine Renewable Energy Devices (MREDs) on the commercially important edible crab, Cancer pagurus (L.). Mar Pollut Bull. 2018 Jun;131(Pt A):580-588.

Abstract

The effects of simulated electromagnetic fields (EMF), emitted from sub-sea power cables, on the commercially important decapod, edible crab (Cancer pagurus), were assessed. Stress related parameters were measured (l-Lactate, d-Glucose, Haemocyanin and respiration rate) along with behavioural and response parameters (antennular flicking, activity level, attraction/avoidance, shelter preference and time spent resting/roaming) during 24-h periods. Exposure to EMF had no effect on Haemocyanin concentrations, respiration rate, activity level or antennular flicking rate. EMF exposure significantly disrupted haemolymph l-Lactate and d-Glucose natural circadian rhythms. Crabs showed a clear attraction to EMF exposed shelter (69%) compared to control shelter (9%) and significantly reduced their time spent roaming by 21%. Consequently, EMF emitted from Marine Renewable Energy Devices (MREDs) will likely affect edible crabs both behaviourally and physiologically, suggesting that the impact of EMF on crustaceans must be considered when planning MREDs.

https://www.ncbi.nlm.nih.gov/pubmed/29886985

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Duration-dependent effect of exposure to static electric field on learning and memory ability in mice

Xu Y, Gu X, Di G. Duration-dependent effect of exposure to static electric field on learning and memory ability in mice. Environ Sci Pollut Res Int. 2018 Jun 7.

Abstract

With the rapid development of ultra-high-voltage direct-current (UHVDC) transmission, the strength of environmental static electric field (SEF) around UHVDC transmission lines increased substantially, which has aroused widely public attention on the potential health effects of SEF. In this study, the effect of SEF exposure on learning and memory ability was investigated. Institute of Cancer Research mice were exposed to 56.3 kV/m SEF for a short term (7 days) or long term (49 days). Behaviors in the Morris water maze (MWM) test, hippocampal neurotransmitter contents, and oxidative stress indicators were examined. Results showed that short-term SEF exposure significantly prolonged escape latency and decreased the number of platform-site crossovers, as well as decreased the time spent in the target quadrant in the MWM test. Meanwhile, serotonin level and the ratio of glutamate level to γ-aminobutyric acid level changed significantly. Besides, malondialdehyde content and glutathione peroxidase activity increased significantly, while superoxide dismutase activity decreased significantly. After long-term SEF exposure, all indices above showed no significant differences between the SEF and sham exposure groups. These data indicated that short-term exposure to 56.3 kV/m SEF could cause abnormal neurotransmitter levels and oxidative stress in the hippocampus, which led to the decline in learning and memory ability. Under the condition of long-term exposure, the SEF-induced disturbances in neurotransmitter contents and redox balance were offset by the compensatory responses of mice, and thus, the learning and memory ability returned to normal level. The temporary and reversible decline in learning and memory ability was only a common biological effect of SEF rather than a health hazard.

https://www.ncbi.nlm.nih.gov/pubmed/29881961

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Gating currents

Bezanilla F. Gating currents. J Gen Physiol. 2018 Jun 25. pii: jgp.201812090. doi: 10.1085/jgp.201812090.

Abstract

Many membrane proteins sense the voltage across the membrane where they are inserted, and their function is affected by voltage changes. The voltage sensor consists of charges or dipoles that move in response to changes in the electric field, and their movement produces an electric current that has been called gating current. In the case of voltage-gated ion channels, the kinetic and steady-state properties of the gating charges provide information of conformational changes between closed states that are not visible when observing ionic currents only. In this *Journal of General Physiology* Milestone, the basic principles of voltage sensing and gating currents are presented, followed by a historical description of the recording of gating currents. The results of gating current recordings are then discussed in the context of structural changes in voltage-dependent membrane proteins and how these studies have provided new insights on gating mechanisms.

https://www.ncbi.nlm.nih.gov/pubmed/29941430

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Solutions for EM exposure assessment of 5G wireless devices

Douglas MG, Pfeifer S, Kuehn S, Neufeld E, Pokovic K, et al. Solutions for EM exposure assessment of 5G wireless devices. IEEE International Symposium on Electromagnetic Compatibility and 2018 IEEE Asia-Pacific Symposium on Electromagnetic Compatibility (EMC/APEMC), 2018. IEEE, 2018, ISBN 9781509039555: 92-94. doi:10.1109/ISEMC.2018.8394066

Abstract

A novel measurement system and a 3D field reconstruction method are described for determining the power density in the close near field of wireless devices transmitting at frequencies from 6–110 GHz. Measurements are compared against simulated results. The accuracy is better than 0.5 dB for distances greater than λ/5 from the radiating source.

https://ieeexplore.ieee.org/document/8394066/

Excerpts

Fifth generation wireless communication systems enable mobile devices to transmit at millimeter wave frequencies. For electromagnetic (EM) exposure assessment, this poses a challenge for wireless device manufacturers and regulatory agencies. At frequencies above 10 GHz, ICNIRP [1] defines limits on power density, which is measured in air at the location of the body. Power density is not correlated with the induced fields in the body. Moreover, it is poorly defined at very close distances of the source to the body because the electric and magnetic fields are not orthogonal and because the body interacts with the reactive near field. In the far field, power density is only a surrogate for induced exposure. On the other hand, power density is easier to measure than induced field, which is concentrated at the skin surface [2]. Therefore, reliable equipment is needed to measure the power density of millimeter wave devices. Another problem is that

the prescribed averaging area can be too large compared to the exposed area and is inconsistent between different standards [3].

A novel measurement system and field reconstruction algorithm are presented that enable power density to be measured with an accuracy better than 0.5 dB for distances greater than lambda/5 from the radiating source.

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Database of bio-effects from non-ionizing radiation

Leach V, Weller S, Redmayne M. A novel database of bio-effects from non-ionizing radiation. Rev Environ Health. 2018 Jun 6. pii: /j/reveh.ahead-of-print/reveh-2018-0017/reveh-2018-0017.xml.

Abstract

A significant amount of electromagnetic field/electromagnetic radiation (EMF/EMR) research is available that examines biological and disease associated endpoints. The quantity, variety and changing parameters in the available research can be challenging when undertaking a literature review, meta-analysis, preparing a study design, building reference lists or comparing findings between relevant scientific papers. The Oceania Radiofrequency Scientific Advisory Association (ORSAA) has created a comprehensive, non-biased, multi-categorized, searchable database of papers on non-ionizing EMF/EMR to help address these challenges. It is regularly added to, freely accessible online and designed to allow data to be easily retrieved, sorted and analyzed. This paper demonstrates the content and search flexibility of the ORSAA database. Demonstration searches are presented by Effect/No Effect; frequency-band/s; in vitro; in vivo; biological effects; study type; and funding source.

As of September 15, 2017, the clear majority of 2653 papers captured in the database examine outcomes in the 300 MHz-3 GHz range. There are 3 times more biological "Effect" than "No Effect" papers; nearly a third of papers provide no funding statement; industry-funded studies more often than not find "No Effect", while institutional funding commonly reveal "Effects". Country of origin where the study is conducted/funded also appears to have a dramatic influence on the likely result outcome.

> The Oceania Radiofrequency Science Advisory Association
>
> The Oceania Radiofrequency Science Advisory Association (ORSAA) Database is a searchable database on peer-reviewed scientific studies and articles on bioeffect research of electromagnetic fields. The database is designed to enable detailed independent searches invaluable to researchers and scientists. It requires some training on how to use it most effectively. http://www.orsaa.org/orsaa-database.html

Discussion and Conclusions

ORSAA's new database provides a highly flexible way of searching a wide, and increasing, range of the EMF literature. It can be used to search for papers according to frequency range, power, SAR, tested endpoints, reported outcomes and study type, amongst others. Furthermore, the data can be exported to create graphs to identify trends in research as well as biological effect outcomes based on frequency and/or exposure duration.

Our method of selecting papers for inclusion is intended to minimize bias and we anticipate that the resulting library is representative of the spread of peer-reviewed papers being published.

Nearly a third of the studies do not declare research funding in the papers so they are marked as funding source unknown in the ORSAA database. Maisch discusses this problem [5]. It may be that these are generally funded by the institution or department where the work was performed, but without a declaration the reader cannot know. Although we have not included NESS studies in the funding chart (Figure 2), it should be borne in mind that the choice of papers selected for reviews and meta-analyses may be related to the funding source and may ultimately affect the paper conclusions. ORSAA considers funding declarations are of critical importance to ensure transparency and to help identify potential biases. ORSAA also encourages all journals to insist on providing this, even when there is no specific funder to declare. Requiring full disclosure of income affiliations is vital, especially in the latter circumstance.

Although animal studies cannot provide direct evidence of human biological effects, animal models can provide a strong indication of likely risks to humans. The ORSAA database can be used to enumerate and compare the many instances where both animal and human studies have found the same biological effect outcomes.

Our demonstration tables also indicate that although there are studies that report no effect on the tested parameters, there are in many cases significantly more that do find an effect. Closer examination suggests that this inconsistency can be explained in large part by the lack of replication between studies.

The evolving database cannot be used as a sole source of reference for a systematic review on any particular end-point, and can only reflect the status quo with reference to the included papers. However, it provides many benefits to the general public and researchers alike.

https://www.ncbi.nlm.nih.gov/pubmed/29874195

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Genomic effects of cell phone exposure on the reproductive system

Yahyazadeh A, Deniz OG, Kaplan AA, Altun G, Yurt KK, Davis D. The genomic effects of cell phone exposure on the reproductive system. Environmental Research. Available online 5 June 2018.

Abstract

Humans are exposed to increasing levels of electromagnetic fields (EMF) at various frequencies as technology advances. In this context, improving understanding of the biological effects of EMF remains an important, high priority issue. Although a number of studies in this issue and elsewhere have focused on the mechanisms of the oxidative stress caused by EMF, the precise understanding of the processes involved remains to be elucidated. Due to unclear results among the studies, the issue of EMF exposure in the literature should be evaluated at the genomic level on the reproductive system. Based on this requirement, a detail review of recently published studies is necessary. The main objectives of this study are to show differences between negative and positive effect of EMF on the reproductive system of animal and human. Extensive review of literature has been made based on well known data bases like Web of Science, PubMed, MEDLINE, Google Scholar, Science Direct, Scopus. This paper reviews the current literature and is intended to contribute to a better understanding of the genotoxic effects of EMF emitted from mobile phones and wireless systems on the human reproductive system, especially on fertility. The current literature reveals that mobile phones can affect cellular functions via non-thermal effects. Although the cellular targets of global system for mobile communications (GSM)-modulated EMF are associated with the cell membrane, the subject is still controversial. Studies regarding the genotoxic effects of EMF have generally focused on DNA damage. Possible mechanisms are related to ROS formation due to oxidative stress. EMF increases ROS production by enhancing the activity of nicotinamide adenine dinucleotide (NADH) oxidase in the cell membrane. Further

detailed studies are needed to elucidate DNA damage mechanisms and apoptotic pathways during oogenesis and spermatogenesis in germ cells exposed to EMF.

Conclusion

This paper reviews the current literature and is intended to contribute to a better understanding of the genotoxic effects of EMF emitted from mobile phones and wireless systems on the human reproductive system, especially on fertility. The current literature reveals that mobile phones can affect cellular functions via non-thermal effects (Diem et al., 2005; Hanci et al., 2013 ; Odaci et al., 2016a). Although the cellular targets of GSM-modulated EMF are associated with the cell membrane, the subject is still controversial (Eberhardt et al., 2008). Studies regarding the genotoxic effects of EMF have generally focused on DNA damage (Mortelmans and Rupa, 2004; Young, 2002; Zeiger, 2004; Panagopoulos, 2012 ; Turedi et al., 2016). Possible mechanisms are related to ROS formation due to oxidative stress (Moustafa et al., 2004; Hanukoglu et al., 2006). EMF increases ROS production by enhancing the activity of NADH oxidase in the cell membrane (Friedman et al., 2007b). In this context, EMF affected spermatozoa may have a high degree rate of infertilization. It seems that previous genomic studies do not show definitive evidence regarding EMF affected cells in the fertilization. Although we evaluated broadly the genomic effects of cell phone exposure on the reproductive system using both animal and human studies, one of the weaknesses of this work is insufficient review of human studies. This may come from limited number of EMF based human studies in the literature. Further detailed studies are needed to elucidate DNA damage mechanisms and apoptotic pathways during oogenesis and spermatogenesis in germ cells that are exposed to EMF.

https://www.sciencedirect.com/science/article/pii/S0013935118302639

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Effects of mobile phone exposure on metabolomics in the male and female reproductive systems

Altun G, Deniz OG, Yurt KK, Davis D, Kaplan S. Effects of mobile phone exposure on metabolomics in the male and female reproductive systems. Environmental Research. Available online 5 June 2018.

Highlights

• Long-term exposure to EMF decreases sperm motility and fertilization.
• Effects of EMF emitted from mobile phones are related to protein synthesis.
• Oxidative stress based EMF exposure modulates nitric oxide level in the germ cells.
• Oxidative stress based EMF exposure inhibits antioxidant mechanisms in the germ cells.

Abstract

With current advances in technology, a number of epidemiological and experimental studies have reported a broad range of adverse effects of electromagnetic fields (EMF) on human health. Multiple cellular mechanisms have been proposed as direct causes or contributors to these biological effects. EMF-induced alterations in cellular levels can activate voltage-gated calcium channels and lead to the formation of free radicals, protein misfolding and DNA damage. Because rapidly dividing germ cells go through meiosis and mitosis, they are more sensitive to EMF in contrast to other slower-growing cell types. In this review, possible mechanistic pathways of the effects of EMF exposure on fertilization, oogenesis and spermatogenesis are discussed. In addition, the present review also evaluates metabolomic effects of GSM-modulated EMFs on the male and female reproductive systems in recent human and animal studies. In this context, experimental and

epidemiological studies which examine the impact of mobile phone radiation on the processes of oogenesis and spermatogenesis are examined in line with current approaches.

Conclusion

EMF emitted by mobile phones has a number of well-documented adverse metabolomic effects on the male and female reproductive systems and can lead to infertility by increasing ROS production and reducing GSH and other antioxidants. The primary target of the EMF emitted by mobile phones may be the cell membrane (Pall in press, this volume). This then results in accelerated activity of membrane NADH oxidase and, consequently, greater rates of ROS formation that cannot be easily conjugated or detoxified. Although many studies have reported morphological and functional deteriorations in testis and ovary following EMF exposures, as well both structural and functional deficits in reproductive health, the underlying mechanisms have not been fully elucidated. To assist in further clarification of these processes and mechanisms, Table 1 summarizes key studies on the metabolomic effects of EMF on reproductive systems. Future studies will benefit greatly from standardized exposure protocols and evaluations of key metabolomic indicators.

https://www.sciencedirect.com/science/article/pii/S0013935118300999

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Effect of cell-phone RF on angiogenesis and cell invasion in human head and neck cancer cells

Alahmad YM, Aljaber M, Saleh AI, Yalcin HC, Aboulkassim T, Yasmeen A, Batist G, Moustafa AA**.** Effect of cell-phone radiofrequency on angiogenesis and cell invasion in human head and neck cancer cells. Head Neck. 2018 May 13. doi: 10.1002/hed.25210.

Abstract

BACKGROUND: Today, the cell phone is the most widespread technology globally. However, the outcome of cell-phone radiofrequency on head and neck cancer progression has not yet been explored.

METHODS: The chorioallantoic membrane (CAM) and human head and neck cancer cell lines, FaDu and SCC25, were used to explore the outcome of cell-phone radiofrequency on angiogenesis, cell invasion, and colony formation of head and neck cancer cells, respectively. Western blot analysis was used to investigate the impact of the cell phone on the regulation of E-cadherin and Erk1/Erk2 genes.

RESULTS: Our data revealed that cell-phone radiofrequency promotes angiogenesis of the CAM. In addition, the cell phone enhances cell invasion and colony formation of human head and neck cancer cells; this is accompanied by a downregulation of E-cadherin expression. More significantly, we found that the cell phone can activate Erk1/Erk2 in our experimental models.

CONCLUSION: Our investigation reveals that cell-phone radiofrequency could enhance head and neck cancer by stimulating angiogenesis and cell invasion via Erk1/Erk2 activation.

https://www.ncbi.nlm.nih.gov/pubmed/29756334

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Cancers of the brain and CNS: Global patterns and trends in incidence

Mortazavi SMJ, Mortazavi SAR,, Paknahad M. Cancers of the brain and CNS: Global patterns and trends in incidence. J Biomed Phys Eng. 2018 Mar 1;8(1):151-152.

Abstract

Miranda-Filho et al. in their recently published paper entitled "Cancers of the brain and CNS: global patterns and trends in incidence" provided a global status report of the geographic and temporal variations in the incidence of brain and CNS cancers in different countries across continents worldwide. While the authors confirm the role of genetic risk factors and ionizing radiation exposures, they claimed that no firm conclusion could be drawn about the role of exposure to non-ionizing radiation. The paper authored by Miranda-Filho et al. not only addresses a challenging issue, it can be considered as a good contribution in the field of brain and CNS cancers. However, our correspondence addresses a basic shortcoming of this paper about the role of electromagnetic fields and cancers and provides evidence showing that exposure to radiofrequency electromagnetic fields (RF-EMFs), at least at high levels and long durations, can increases the risk of cancer.

Open access letter: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5928307/

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Wireless radiation absorption in child vs adult brain & eye from cell phone conversation or virtual reality

Fernandez C, de Salles AA, Sears ME, Morris RD, Davis DL. Absorption of wireless radiation in the child versus adult brain and eye from cell phone conversation or virtual reality. Environmental Research. Jun 5, 2018. https://doi.org/10.1016/j.envres.2018.05.013

Highlights

• More cell phone radiation is absorbed by children's inner brain tissues than adults'.
• Children's radiofrequency radiation exposure should be reduced.
• Further research to evaluate the risks to the eye from use of VR is urgently needed.
• It is biologically relevant and feasible to reduce the standards' averaging volume.
• Current methods to determine wireless device compliance should be revised.

Abstract

Children's brains are more susceptible to hazardous exposures, and are thought to absorb higher doses of radiation from cell phones in some regions of the brain. Globally the numbers and applications of wireless devices are increasing rapidly, but since 1997 safety testing has relied on a large, homogenous, adult male head phantom to simulate exposures; the "Standard Anthropomorphic Mannequin" (SAM) is used to estimate only whether tissue temperature will be increased by more than 1 Celsius degree in the periphery. The present work employs anatomically based modeling currently used to set standards for surgical and medical devices, that incorporates heterogeneous characteristics of age and anatomy. Modeling of a cell phone held to the ear, or of virtual reality devices in front of the eyes, reveals that young eyes and brains absorb substantially higher local radiation doses than adults'. Age-specific simulations indicate the need to apply refined methods for regulatory compliance testing; and for public education regarding manufacturers' advice to keep phones off the body, and prudent use to limit exposures, particularly to protect the young.

Excerpts

In summary, compared with adult models, children experience two- to three-fold higher RF doses to: 1) localized areas of the brain when a cell phone is positioned next to the ear; and 2) the eyes and frontal lobe when a cell phone is used to view virtual reality. These findings raise serious questions about the current approach to certify cell phones; particularly the use of the SAM.

Our modeling demonstrates clearly that localized psSAR varies significantly for critical components of the brain. Younger models absorb proportionally more radiation in the eyes and brain – grey matter, cerebellum and hippocampus—and the local dose rate varies inversely with age. This reflects the fact that the head is not homogeneous. Indeed, localized heating up to 5 Centigrade degrees has been detected as a result of mobile phone radiation studied *ex vivo* in cow brain using Nuclear Magnetic Resonance thermometry (Gultekin and Moeller, 2013).

Our findings support reexamination of methods to determine regulatory compliance for wireless devices, and highlight the importance of precautionary advice such as that of American Academy of Pediatrics (2016). The Academy recommends that younger children should not use cell phones, and that prudent measures should be taken to eliminate exposure (e.g. using devices for amusement or education only when all wireless features are turned off – in “airplane mode”) or to minimize exposure (e.g. texting or using speakerphone), and that cell phones should not be kept next to the body. Use of wires/cables in schools and homes circumvents needless exposures of children to radiation from both devices and Wi-Fi routers. There is also an urgent need for research to evaluate the risks to the eye from use of cell phones in virtual reality applications.

https://www.sciencedirect.com/science/article/pii/S0013935118302561

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Children's exposure assessment of radiofrequency fields: Comparison between spot and personal measurements

Gallastegi M, Huss A, Santa-Marina L, Aurrekoetxea JJ, Guxens M, Birks LE, Ibarluzea J, Guerra D, Röösli M. Children's exposure assessment of radiofrequency fields: Comparison between spot and personal measurements. Environment International. 118:60-69. Sep 2018.

Highlights

• Children's radiofrequency field levels and contribution of sources were assessed.
• We contrasted exposure assessment based on spot and personal measurements.
• Median exposures range: 29.73–236.31 μW/m2; broadcast and downlink contributed most.
• Proportional bias between assessment based on spot and personal measurements.
• No systematic differences when classifying subjects in exposure-dependent groups.

Abstract

Introduction Radiofrequency (RF) fields are widely used and, while it is still unknown whether children are more vulnerable to this type of exposure, it is essential to explore their level of exposure in order to conduct adequate epidemiological studies. Personal measurements provide individualized information, but they are costly in terms of time and resources, especially in large epidemiological studies. Other approaches, such as estimation of time-weighted averages (TWAs) based on spot measurements could simplify the work.

Objectives The aims of this study were to assess RF exposure in the Spanish INMA birth cohort by spot measurements and by personal measurements in the settings where children tend to spend most of their time,

i.e., homes, schools and parks; to identify the settings and sources that contribute most to that exposure; and to explore if exposure assessment based on spot measurements is a valid proxy for personal exposure.

Methods When children were 8 years old, spot measurements were conducted in the principal settings of 104 participants: homes (104), schools and their playgrounds (26) and parks (79). At the same time, personal measurements were taken for a subsample of 50 children during 3 days. Exposure assessment based on personal and on spot measurements were compared both in terms of mean exposures and in exposure-dependent categories by means of Bland-Altman plots, Cohen's kappa and McNemar test.

Results Median exposure levels ranged from 29.73 (in children's bedrooms) to 200.10 μW/m2 (in school playgrounds) for spot measurements and were higher outdoors than indoors. Median personal exposure was 52.13 μW/m2 and median levels of assessments based on spot measurements ranged from 25.46 to 123.21 μW/m2. Based on spot measurements, the sources that contributed most to the exposure were FM radio, mobile phone downlink and Digital Video Broadcasting-Terrestrial, while indoor and personal sources contributed very little (altogether <20%). Similar distribution was observed with personal measurements.

There was a bias proportional to power density between personal measurements and estimates based on spot measurements, with the latter providing higher exposure estimates. Nevertheless, there were no systematic differences between those methodologies when classifying subjects into exposure categories. Personal measurements of total RF exposure showed low to moderate agreement with home and bedroom spot measurements and agreed better, though moderately, with TWA based on spot measurements in the main settings where children spend time (homes, schools and parks; Kappa = 0.46).

Conclusions Exposure assessment based on spot measurements could be a feasible proxy to rank personal RF exposure in children population, providing that all relevant locations are being measured.

https://www.sciencedirect.com/science/article/pii/S0160412017319724

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Exposure to radiation from single or combined radio frequencies provokes macrophage dysfunction in the RAW 264.7 cell line

López-Furelos A, Salas-Sánchez AA, Ares-Pena FJ, Leiro-Vidal JM, López-Martín E. Exposure to radiation from single or combined radio frequencies provokes macrophage dysfunction in the RAW 264.7 cell line. Int J Radiat Biol. 2018 Apr 30:1-12. doi: 10.1080/09553002.2018.1465610.

Abstract

PURPOSE: The aim of this study was to determine whether exposure to radiation from single or multiple radio-frequency (RF) signals at 900 and 2450 MHz would induce effects in the RAW 264.7 cell line.

MATERIALS AND METHODS: Cell cultures were exposed to single or combined RF for 4, 24, 48, or 72 h in a GTEM electromagnetic test chamber. At the end of the radiation exposure time, viability and cell growth were analyzed by flow cytometry, nitric oxide (NO) production was measured by colorimetry, the expression of HSP70 and TNF-α was ascertained by qPCR, and the phagocytic activity was observed by microscopy.

RESULTS: NO production increased after 48 h exposure at 2450 MHz, compared with controls. The group

subjected to the combined interaction of two RFs showed an increase of HSP70 after 48 h exposure and a significant increase of NO and TNF-α after 72 h. The phagocytic activity of macrophages decreased in all groups as exposure time increased.

CONCLUSIONS: Our results indicated a decrease in phagocytic activity and an increase in inflammatory, cytoprotective, and cytotoxic responses in macrophages after continuous and combined exposure of multiple RF signals. Multiple RF interact in everyday life, the immune response in humans is unknown.

https://www.ncbi.nlm.nih.gov/pubmed/29659305

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Cellular stress & caspase-3 resulting from combined two-frequency signal in brains of Sprague-Dawley rats

López-Furelos A, Leiro-Vidal JM, Salas-Sánchez AÁ, Ares-Pena FJ, López-Martín ME. Evidence of cellular stress and caspase-3 resulting from a combined two-frequency signal in the cerebrum and cerebellum of sprague-dawley rats. Oncotarget. 2016 Oct 4;7(40):64674-64689. doi: 10.18632/oncotarget.11753.

Abstract

Multiple simultaneous exposures to electromagnetic signals induced adjustments in mammal nervous systems. In this study, we investigated the non-thermal SAR (Specific Absorption Rate) in the cerebral or cerebellar hemispheres of rats exposed in vivo to combined electromagnetic field (EMF) signals at 900 and 2450 MHz.Forty rats divided into four groups of 10 were individually exposed or not exposed to radiation in a GTEM chamber for one or two hours. After radiation, we used the Chemiluminescent Enzyme-Linked Immunosorbent Assay (ChELISA) technique to measure cellular stress levels, indicated by the presence of heat shock proteins (HSP) 90 and 70, as well as caspase-3-dependent pre-apoptotic activity in left and right cerebral and cerebellar hemispheres of Sprague Dawley rats.Twenty-four hours after exposure to combined or single radiation, significant differences were evident in HSP 90 and 70 but not in caspase 3 levels between the hemispheres of the cerebral cortex at high SAR levels. In the cerebellar hemispheres, groups exposed to a single radiofrequency (RF) and high SAR showed significant differences in HSP 90, 70 and caspase-3 levels compared to control animals. The absorbed energy and/or biological effects of combined signals were not additive, suggesting that multiple signals act on nervous tissue by a different mechanism.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5323107/

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Biological effects of cell-phone radiofrequency waves exposure on fertilization in mice; an in vivo and in vitro study

Fatehi D, Anjomshoa M, Mohammadi M, Seify M, Rostamzadeh A. Biological effects of cell-phone radiofrequency waves exposure on fertilization in mice; an in vivo and in vitro study. Middle East Fertility Society Journal, 23(2):148-153. June 2018.

Abstract

Increasing use of cell-phone is one of the most important risk factors for population health. We designed an experimental study aimed at evaluating the effects of cell-phone radiofrequency (RF) waves exposure

on fertilization in mice. Two hundred male and female NMRI-mice were used. One hundred males divided in five groups (n = 20) as control and exposed groups. Those irradiated with cell-phone RF in “Standby-mode” 1, 5 and 10 h daily named groups II, III and IV; respectively. Group V irradiated with cell-phone on “Active-mode” one hour daily. After 30 days irradiation, 50 males and 50 females were kept 24 h to assess their embryos. Fifty males were scarified to evaluate both in vitro and in vivo parameters, and 50 females received PMSG & HCG for both quantitative and qualitative evaluation. Comparing groups III, IV and V with control-group showed significantly decreased in the number of two-cell embryos (p = .000); however, a significant increase was found in the number of dead embryos (p = .000). Furthermore, 5 h daily irradiation significantly decreased grade-A embryos (p = .015); while, it significantly increased grade-B, C and D embryos (p-values = 0.026, 0.007, 0.006; respectively). Moreover, comparing groups IV and V to control-group, significant increase was found in pregnancy duration (p = .005, p = .009; respectively). However, in the mentioned groups a significant decrease was seen in number of newborn mice (p = .001, p = .004; respectively). In conclusion our findings showed that the cell-phone radiation can affect development of embryos as well as the number of newborn and pregnancy duration in NMRI-mouse, which might be a significant cause of reproductive failure.

Open access paper: https://www.sciencedirect.com/science/article/pii/S1110569017301875

The applied frequency of the waves was 900 MHz irradiated from a Nokia cell-phone (Nokia 1100, Finland). In case of irradiation, the distance between cell-phone and mouse was 10 cm.

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Proximity to overhead power lines and childhood leukaemia: an international pooled analysis

Amoon AT, Crespi CM, Ahlbom A, Bhatnagar M, Bray I, Bunch KJ, Clavel J, Feychting M, Hémon D, Johansen C, Kreis C, Malagoli C, Marquant F, Pedersen C, Raaschou-Nielsen O, Röösli M, Spycher BD, Sudan M, Swanson J, Tittarelli A, Tuck DM, Tynes T, Vergara X, Vinceti M, Wünsch-Filho V, Kheifets L. Proximity to overhead power lines and childhood leukaemia: an international pooled analysis. Br J Cancer. 2018 May 29. doi: 10.1038/s41416-018-0097-7.

Abstract

BACKGROUND: Although studies have consistently found an association between childhood leukaemia risk and magnetic fields, the associations between childhood leukaemia and distance to overhead power lines have been inconsistent. We pooled data from multiple studies to assess the association with distance and evaluate whether it is due to magnetic fields or other factors associated with distance from lines.

METHODS: We present a pooled analysis combining individual-level data (29,049 cases and 68,231 controls) from 11 record-based studies.

RESULTS: There was no material association between childhood leukaemia and distance to nearest overhead power line of any voltage. Among children living < 50 m from 200 + kV power lines, the adjusted odds ratio for childhood leukaemia was 1.33 (95% CI: 0.92-1.93). The odds ratio was higher among children diagnosed before age 5 years. There was no association with calculated magnetic fields. Odds ratios remained unchanged with adjustment for potential confounders.

CONCLUSIONS: In this first comprehensive pooled analysis of childhood leukaemia and distance to power lines, we found a small and imprecise risk for residences < 50 m of 200 + kV lines that was not explained by

high magnetic fields. Reasons for the increased risk, found in this and many other studies, remains to be elucidated.

https://www.ncbi.nlm.nih.gov/pubmed/29808013

In conclusion, we found a small, imprecise association between childhood leukaemia and residence located within 50 m of 200 + kV lines, which was stronger for younger children, in our individual-data pooled analysis of 11 studies. This association was not explained by exposure to high MF levels or by other measured confounders. We found no evidence for bias as a potential explanation and in particular, we only included record-based studies, making selection bias unlikely. Although exposure misclassification is likely to be present, the risk of bias due to distance misclassification is quite small. The previous UK findings of risk estimates for distances beyond 200 m are not supported by the pooled data from other countries. The decrease in effect over time are not clearly supported by the pooled data from other countries, although numbers of exposed cases and controls for the earlier time period are small for both the United Kingdom and for other countries combined. Although pooled analysis is a powerful approach to integrating data, it is only as good as the underlying data. Reasons for the small yet fairly consistent increase in the risk of childhood leukaemia in relation to proximity to power lines found in many studies remain to be elucidated.

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Measurement and analysis of power-frequency magnetic fields in residences: Results from a pilot study

Halgamuge MN, McLean L.Measurement and analysis of power-frequency magnetic fields in residences: Results from a pilot study. Measurement. 125:415-424. Sep 2018.
https://doi.org/10.1016/j.measurement.2018.05.007

Highlights
• Exposure to high magnetic fields in residential situations occurs in proximity to appliances.
• Emissions from some appliances exceeded the general public exposure levels of the ICNIRP limits.
• Taking precautions, such as reducing distance from sources can significantly reduce exposures.
• Collected data can be useful as an additional data base for future epidemiological studies.

Abstract

Aim Extremely low-frequency magnetic fields (ELF-MFs) are emitted by electrical household appliances, wiring, meter boxes, conductive plumbing, power lines and transformers. Some of the studies investigating the link between ELF-MFs and health problems have not adequately characterized the magnetic field exposure of subjects, as they did not always measure residential magnetic fields or measure in locations where residents are most exposed. Considering this, there is a need for good quality assessments of residential ELF-MFs in different geographical regions to collect general public exposure data and to identify high sources of magnetic fields. Such studies have the potential to add significant scientific knowledge about residential exposure and appropriate precautions to reduce exposure, improve the quality of life and substantially reduce health care costs.

Subject and methods In this work, we analyzed the ELF-MFs from 3163 datasets collected from 100 houses in Australia. Measurements were carried out in different geographical locations and were assessed for compliance with the International Commission on Non-Ionizing Radiation Protection (ICNIRP) Guidelines. Then we compared our measurements with another twenty-three peer-reviewed studies, published 1987–2015,

reporting magnetic field measurements in residences.

Results The observed average (geometric mean) magnetic field values were; bed 0.85, bedroom 1.39 mG, baby cot 0.39 mG, children's play area 0.47 mG, and family room 0.30 mG. Our results show considerable variation in the fields to which residents are typically exposed, particularly in beds (21.83%) and bedrooms (33.33%) where the percentage of measurements greater than 4 mG was considerable. Some emissions exceeded the general public exposure levels of the ICNIRP Guidelines, with the potential for residents to be exposed above these levels. However, away from electrical appliances, the average field in all rooms was 0.30–1.39 mG. We show that simple precautions can be applied to reduce exposure to ELF-MFs in residences and thereby minimize potential risks to health and wellbeing.

Conclusion Our investigation provides a new data collection model for future surveys, which could be conducted with larger samples to verify our observations. Additionally, this data could be useful as a reference for researchers and those members of the general public who do not have access to the necessary measuring equipment.

Excerpts

The fields most likely to impact residents are those near beds, where people spend long periods of time daily. In our study, these included fields from clock radios, meter boxes, wiring and conductive plumbing.

In most cases, the kitchen appliance with the highest magnetic field was the microwave oven, whether or not it was operating, indicating that especial care needs to be taken when positioning it. Our study considered only the magnetic fields from the microwave oven and not the microwave radiation that it also emits. Many other kitchen appliances also had high magnetic fields – including ovens, cook tops, range hoods, kettles, dishwashers and toasters.

Magnetic fields varied from 2.9 to 167 mG for washing machines and 0.3 to 373 mG for clothes dryers, however, residents do not usually spend long periods of time close to these machines while they are operating. We measured highest magnetic fields from irons during the period when they were heating up to the desired setting and observed that, once they had done so, magnetic fields at the handle were generally less than 0.01 mG. A surprise finding was the very high magnetic fields from hairdryers, which are used in close proximity to the body.

https://www.sciencedirect.com/science/article/pii/S0263224118303920

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Magnetocarcinogenesis: is there a mechanism for carcinogenic effects of weak magnetic fields?

Juutilainen J, Herrala M, Luukkonen J, Naarala J, Hore PJ. Magnetocarcinogenesis: is there a mechanism for carcinogenic effects of weak magnetic fields? Proceedings of the Royal Society B: Biological Sciences. May 23, 2018.

Abstract

Extremely low-frequency (ELF) magnetic fields have been classified as possibly carcinogenic, mainly based on rather consistent epidemiological findings suggesting a link between childhood leukaemia and 50–60 Hz magnetic fields from power lines. However, causality is not the only possible explanation for the epidemiological associations, as animal and in vitro experiments have provided only limited support for

carcinogenic effects of ELF magnetic fields. Importantly, there is no generally accepted biophysical mechanism that could explain such effects. In this review, we discuss the possibility that carcinogenic effects are based on the radical pair mechanism (RPM), which seems to be involved in magnetoreception in birds and certain other animals, allowing navigation in the geomagnetic field. We review the current understanding of the RPM in magnetoreception, and discuss cryptochromes as the putative magnetosensitive molecules and their possible links to cancer-relevant biological processes. We then propose a hypothesis for explaining the link between ELF fields and childhood leukaemia, discuss the strengths and weaknesses of the current evidence, and make proposals for further research.

http://rspb.royalsocietypublishing.org/content/285/1879/20180590

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Cytotoxicity of carboplatin on human glioblastoma cells is reduced by exposure to ELF EMF (50 Hz, 70 G)

Amiri M, Basiri M, Eskandary H, Akbarnejad Z, Esmaeeli M, Masoumi-Ardakani Y, Ahmadi-Zeidabadi M. Cytotoxicity of carboplatin on human glioblastoma cells is reduced by the concomitant exposure to an extremely low-frequency electromagnetic field (50 Hz, 70 G). Electromagn Biol Med. 2018 May 30:1-8. doi: 10.1080/15368378.2018.1477052.

Abstract

Glioblastoma multiforme (GBM) is a malignant brain cancer that causes high mortality in patients. GBM responds weakly to the common cancer treatments such as chemotherapy and radiotherapy and even surgery. Carboplatin is an alkylating agent widely used to treat cancer. However, resistance to this drug is a common problem in its use in cancer treatment. Concomitant exposure to extremely low-frequency electromagnetic fields (ELF-EMFs) and carboplatin is one unexplored possibility for overcoming this resistance. Indeed, many lines of evidence show that EMF affects cancer cells and drug action. In this study, we evaluated the effect of concomitant administration of carboplatin and EMF (50 Hz, 70 G) and also concomitant administration of carboplatin and static magnetic field (SMF) (70 G) on human glioma cell line (U-87). The results showed that cotreatment reduced the efficiency of carboplatin in U-87 cells, by decreasing caspase-3 in comparison to drug groups. Overall, EMF reduced the apoptotic effect of carboplatin, possibly through a redox regulation mechanism. Therefore, we have to avoid coadministration of magnetic field (MF) and carboplatin in tumor area, because the MF decreased the toxicity of the drug. However, further studies are needed to reveal the action mechanism of this combination therapeutic method.

https://www.ncbi.nlm.nih.gov/pubmed/29846098

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Reanalysis of risks of childhood leukemia with distance from overhead power lines in the UK

Swanson J, Bunch K. Reanalysis of risks of childhood leukaemia with distance from overhead power lines in the UK. J Radiol Prot. 2018 May 30. doi: 10.1088/1361-6498/aac89a.

Abstract

Our previous study of childhood leukaemia and distance to high-voltage overhead power lines in the UK has

been included in an international pooled analysis. That pooled analysis used different distance categories to us, which has focussed attention on the effect of that choice. We re-analyse our previous subjects, using finer distance categories. In the 1960s and 1970s, when we principally found an elevated risk, the risk did not fall monotonically with distance from the power line but had a maximum at 100-200 m. This weakens the evidence that any elevated risks are related to magnetic fields, and slightly strengthens the evidence for a possible effect involving residential mobility or other socioeconomic factors.

https://www.ncbi.nlm.nih.gov/pubmed/29844249

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Radiofrequency Radiation

Spatial and temporal variability of personal environmental exposure to RF EMF in children in Europe

Birks LE, Struchen B, Eeftens M, van Wel L, Huss A, Gajšek P, Kheifets L, Gallastegi M, Dalmau-Bueno A, Estarlich M, Fernandez MF, Meder IK, Ferrero A, Jiménez-Zabala A, Torrent M, Vrijkotte TGM, Cardis E, Olsen J, Valič B, Vermeulen R, Vrijheid M, Röösli M, Guxens M. Spatial and temporal variability of personal environmental exposure to radio frequency electromagnetic fields in children in Europe. Environ Int. 117:204-214. 2018 May 10.

Highlights

• We describe personal environmental RF-EMF exposure from mobile communication in European children.
• 529 children carried personal exposure meters for up to 3 days during 2014–2016.
• Median personal environmental RF-EMF exposure was 75.5 μW/m2.
• Downlink was largest contributor to total environmental exposure (median 27.2 μW/m2).
• Urban environment was most important determinant of total environmental exposure.

Abstract

BACKGROUND: Exposure to radiofrequency electromagnetic fields (RF-EMF) has rapidly increased and little is known about exposure levels in children. This study describes personal RF-EMF environmental exposure levels from handheld devices and fixed site transmitters in European children, the determinants of this, and the day-to-day and year-to-year repeatability of these exposure levels.

METHODS: Personal environmental RF-EMF exposure (μW/m2, power flux density) was measured in 529 children (ages 8-18 years) in Denmark, the Netherlands, Slovenia, Switzerland, and Spain using personal portable exposure meters for a period of up to three days between 2014 and 2016, and repeated in a subsample of 28 children one year later. The meters captured 16 frequency bands every 4 seconds and incorporated a GPS. Activity diaries and questionnaires were used to collect children's location, use of handheld devices, and presence of indoor RF-EMF sources. Six general frequency bands were defined: total, digital enhanced cordless telecommunications (DECT), television and radio antennas (broadcast), mobile phones (uplink), mobile phone base stations (downlink), and Wireless Fidelity (WiFi). We used adjusted mixed effects models with region random effects to estimate associations of handheld device use habits and indoor RF-EMF sources with personal RF-EMF exposure. Day-to-day and year-to-year repeatability of personal RF-EMF exposure were calculated through intraclass correlations (ICC).

RESULTS: Median total personal RF-EMF exposure was 75.5 μW/m2. Downlink was the largest contributor to total exposure (median: 27.2 μW/m2) followed by broadcast (9.9 μW/m2). Exposure from uplink (4.7 μW/m2) was lower. WiFi and DECT contributed very little to exposure levels. Exposure was higher during day (94.2 μW/m2) than night (23.0 μW/m2), and slightly higher during weekends than weekdays, although varying across regions. Median exposures were highest while children were outside (157.0 μW/m2) or traveling (171.3 μW/m2), and much lower at home (33.0 μW/m2) or in school (35.1 μW/m2). Children living in urban

environments had higher exposure than children in rural environments. Older children and users of mobile phones had higher uplink exposure but not total exposure, compared to younger children and those that did not use mobile phones. Day-to-day repeatability was moderate to high for most of the general frequency bands (ICCs between 0.43 and 0.85), as well as for total, broadcast, and downlink for the year-to-year repeatability (ICCs between 0.49 and 0.80) in a small subsample.

CONCLUSION: The largest contributors to total personal environmental RF-EMF exposure were downlink and broadcast, and these exposures showed high repeatability. Urbanicity was the most important determinant of total exposure and mobile phone use was the most important determinant of uplink exposure. It is important to continue evaluating RF-EMF exposure in children as device use habits, exposure levels, and main contributing sources may change.

https://www.ncbi.nlm.nih.gov/pubmed/29754001

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Radiofrequency radiation from nearby base stations gives high levels in an apartment in Stockholm, Sweden: A case report.

Hardell L, Carlberg M, Hedendahl LK. Radiofrequency radiation from nearby base stations gives high levels in an apartment in Stockholm, Sweden: A case report. Oncol Lett. 15(5):7871-7883. 2018 May. doi: 10.3892/ol.2018.8285.

Abstract

Exposure to radiofrequency (RF) radiation was classified in 2011 as a possible human carcinogen, Group 2B, by the International Agency for Research on Cancer of the World Health Organisation. Evidence of the risk of cancer risk has since strengthened. Exposure is changing due to the rapid development of technology resulting in increased ambient radiation. RF radiation of sufficient intensity heats tissues, but the energy is insufficient to cause ionization, hence it is called non-ionizing radiation. These non-thermal exposure levels have resulted in biological effects in humans, animals and cells, including an increased cancer risk. In the present study, the levels of RF radiation were measured in an apartment close to two groups of mobile phone base stations on the roof. A total of 74,531 measurements were made corresponding to ~83 h of recording. The total mean RF radiation level was 3,811 μW/m2 (range 15.2-112,318 μW/m2) for the measurement of the whole apartment, including balconies. Particularly high levels were measured on three balconies and 3 of 4 bedrooms. The total mean RF radiation level decreased by 98% when the measured down-links from the base stations for 2, 3 and 4 G were disregarded. The results are discussed in relation to the detrimental health effects of non-thermal RF radiation. Due to the current high RF radiation, the apartment is not suitable for long-term living, particularly for children who may be more sensitive than adults. For a definitive conclusion regarding the effect of RF radiation from nearby base stations, one option would be to turn them off and repeat the measurements. However, the simplest and safest solution would be to turn them off and dismantle them.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5920374/

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Characteristics of perceived electromagnetic hypersensitivity in the general population

Gruber MJ, Palmquist E, Nordin S. Characteristics of perceived electromagnetic hypersensitivity in the general population. Scand J Psychol. 2018 May 9. doi: 10.1111/sjop.12449.

Abstract

Health problems evoked in the presence of electrical equipment is a concern, calling for better understanding

for characteristics of electromagnetic hypersensitivity (EHS) in the general population. The present study investigated demographics, lifestyle factors, frequency and duration, coping strategies, proportion meeting clinical criteria for intolerance attributed to electromagnetic fields (EMF) and comorbidity. Using data from a large-scale population-based questionnaire study, we investigated persons with self-reported (n = 91) EHS in comparison to referents (n = 3,250). Middle age, female sex and poor perceived health was found to be associated with EHS. More than 50% in the EHS group reported having EMF-related symptoms more often than once a week, and the mean number of years experiencing EHS was 10.5. More than half of the EHS group reported that their symptoms started after a high-dose or long-term EMF exposure, that they actively tried to avoid EMF sources and that they mostly could affect the EMF environment. A minority of the EHS group had sought medical attention, been diagnosed by a physician or received treatment. Exhaustion syndrome, anxiety disorder, back/joint/muscle disorder, depression, functional somatic syndrome and migraine were comorbid with EHS. The results provide ground for future study of these characteristic features being risk factors for development of EHS and or consequences of EHS.

https://www.ncbi.nlm.nih.gov/pubmed/29741795

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Is MRI imaging in pediatric age totally safe? A critical reprisal.

Salerno S, Granata C, Trapenese M, Cannata V, Curione D, Rossi Espagnet MC, Magistrelli A, Tomà P. Is MRI imaging in pediatric age totally safe? A critical reprisal. Radiol Med. 2018 May 3. doi: 10.1007/s11547-018-0896-1.

Abstract

Current radiological literature is strongly focussed on radiation imaging risks. Indeed, given there is a small but actual augment in cancer risk from exposure to ionizing radiation in children, it is important to understand what the risk of alternative techniques could be. We retrospectively review literature data concerning possible MR imaging risks, focussing on the biological effects of MR, sedation and gadolinium compound risks when dealing with infant patients. The main concerns can be summarized in: (1) Biological effects of non-ionizing electromagnetic fields (EMF) employed-whose mechanisms of interaction with human tissues are polarization, induced current, and thermal heating, respectively. (2) Risks associated with noises produced during MRI examinations. (3) Hazards from ferromagnetic external and/or implanted devices-whose risk of being unintentionally brought inside MR room is higher in children than in adults. (4) Risks associated with sedation or general anaesthesia, essential problem in performing MR in very young patients, due to the exam long-lasting. (5) Risks related to gadolinium-based contrast agents, especially considering the newly reported brain deposition.

https://www.ncbi.nlm.nih.gov/pubmed/29725913

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RF EMF Risk Perception Revisited: Is the Focus on Concern Sufficient for Risk Perception Studies?

Wiedemann PM, Freudenstein F, Böhmert C, Wiart J, Croft RJ. RF EMF Risk Perception Revisited: Is the Focus on Concern Sufficient for Risk Perception Studies? Int J Environ Res Public Health. 2017 Jun 8;14(6). pii: E620. doi: 10.3390/ijerph14060620.

Abstract

An implicit assumption of risk perception studies is that concerns expressed in questionnaires reflect concerns in everyday life. The aim of the present study is to check this assumption, i.e., the extrapolability of risk perceptions expressed in a survey, to risk perceptions in everyday life. To that end, risk perceptions were

measured by a multidimensional approach. In addition to the traditional focus on measuring the magnitude of risk perceptions, the thematic relevance (how often people think about a risk issue) and the discursive relevance (how often people think about or discuss a risk issue) of risk perceptions were also collected. Taking into account this extended view of risk perception, an online survey was conducted in six European countries with 2454 respondents, referring to radio frequency electromagnetic field (RF EMF) risk potentials from base stations, and access points, such as WiFi routers and cell phones. The findings reveal that the present study's multidimensional approach to measuring risk perception provides a more differentiated understanding of RF EMF risk perception. High levels of concerns expressed in questionnaires do not automatically imply that these concerns are thematically relevant in everyday life. We use thematic relevance to distinguish between enduringly concerned (high concern according to both questionnaire and thematic relevance) and not enduringly concerned participants (high concern according to questionnaire but no thematic relevance). Furthermore, we provide data for the empirical value of this distinction: Compared to other participants, enduringly concerned subjects consider radio frequency electromagnetic field exposure to a greater extent as a moral and affective issue. They also see themselves as highly exposed to radio frequency electromagnetic fields. However, despite these differences, subjects with high levels of thematic relevance are nevertheless sensitive to exposure reduction as a means for improving the acceptance of base stations in their neighborhood. This underlines the value of exposure reduction for the acceptance of radio frequency electromagnetic field communication technologies.

https://www.ncbi.nlm.nih.gov/pubmed/28594366

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Effective Analysis of Human Exposure Conditions with Body-worn Dosimeters in the 2.4 GHz Band

de Miguel-Bilbao S, Blas J, Ramos V. Effective Analysis of Human Exposure Conditions with Body-worn Dosimeters in the 2.4 GHz Band. J Vis Exp. 2018 May 2;(135). doi: 10.3791/56525.

Abstract

A well-defined experimental procedure is put forward to evaluate maximum exposure conditions in a worst-case scenario whilst avoiding the uncertainties caused by the use of personal exposimeters (PEMs) as measuring devices: the body shadow effect (BSE), the limited sensitivity range, and the non-identification of the radiation source. An upper bound for exposure levels to EMF in several indoor enclosures has been measured and simulated. The frequency used for the study is 2.4 GHz, as it is the most commonly used band in indoor communications. Although recorded values are well below the International Commission for Non-Ionizing Radiation Protection (ICNIRP) reference levels, there is a particular need to provide reliable exposure levels within particularly sensitive environments. In terms of electromagnetic field (EMF) exposure, limits established in national and international standards for health protection have been set for unperturbed exposure conditions; that is, for real and objective exposure data that have not been altered in any way.

https://www.ncbi.nlm.nih.gov/pubmed/29781983

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Hippocampal alterations triggered by acute exposure of mice to GSM 1800 MHz mobile phone radiation

Fragopoulou AF, Polyzos A, Papadopoulou MD, Sansone A, Manta AK, Balafas E, Kostomitsopoulos N, Skouroliakou A, Chatgilialoglu C, Georgakilas A, Stravopodis DJ, Ferreri C, Thanos D, Margaritis LH. Hippocampal lipidome and transcriptome profile alterations triggered by acute exposure of mice to GSM 1800 MHz mobile phone radiation: An exploratory study. Brain Behav. 2018 May 22.

Abstract

BACKGROUND: The widespread use of wireless devices during the last decades is raising concerns about adverse health effects of the radiofrequency electromagnetic radiation (RF-EMR) emitted from these devices. Recent research is focusing on unraveling the underlying mechanisms of RF-EMR and potential cellular targets. The "omics" high-throughput approaches are powerful tools to investigate the global effects of RF-EMR on cellular physiology.

METHODS: In this work, C57BL/6 adult male mice were whole-body exposed (nExp = 8) for 2 hr to GSM 1800 MHz mobile phone radiation at an average electric field intensity range of 4.3-17.5 V/m or sham-exposed (nSE = 8), and the RF-EMR effects on the hippocampal lipidome and transcriptome profiles were assessed 6 hr later.

RESULTS: The data analysis of the phospholipid fatty acid residues revealed that the levels of four fatty acids [16:0, 16:1 (6c + 7c), 18:1 9c, eicosapentaenoic acid omega-3 (EPA, 20:5 ω3)] and the two fatty acid sums of saturated and monounsaturated fatty acids (SFA and MUFA) were significantly altered ($p < 0.05$) in the exposed group. The observed changes indicate a membrane remodeling response of the tissue phospholipids after nonionizing radiation exposure, reducing SFA and EPA, while increasing MUFA residues. The microarray data analysis demonstrated that the expression of 178 genes changed significantly ($p < 0.05$) between the two groups, revealing an impact on genes involved in critical biological processes, such as cell cycle, DNA replication and repair, cell death, cell signaling, nervous system development and function, immune system response, lipid metabolism, and carcinogenesis.

CONCLUSIONS: This study provides preliminary evidence that mobile phone radiation induces hippocampal lipidome and transcriptome changes that may explain the brain proteome changes and memory deficits previously shown by our group.

https://www.ncbi.nlm.nih.gov/pubmed/29786969

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2450 MHz EMR exposure causes cognition deficit with mitochondrial dysfunction & activation of intrinsic pathway of apoptosis in rats

Gupta SK, Mesharam MK, Krishnamurthy S. Electromagnetic radiation 2450 MHz exposure causes cognition deficit with mitochondrial dysfunction and activation of intrinsic pathway of apoptosis in rats. Journal of Biosciences. 43(2):263-276. June 2018.

Abstract

Electromagnetic radiation (EMR) can induce or modulate several neurobehavioral disorders. Duration and frequency of exposure of EMR is critical to develop cognitive disorders. Even though EMR-2450 is widely used, its effects on cognition in relation to mitochondrial function and apoptosis would provide better understanding of its pathophysiological effects. Therefore, a comparative study of different frequencies of EMR exposure would give valuable information on effects of discrete frequencies of EMR on cognition. Male rats were exposed to EMR (900, 1800 and 2450 MHz) every day for 1 h for 28 consecutive days. The cognitive behavior in terms of novel arm entries in Y-maze paradigm was evaluated every week after 1 h to last EMR exposure. Animals exposed to EMR-2450 MHz exhibited significant cognitive deficits. EMR-2450 MHz caused loss of mitochondrial function and integrity, an increase in amyloid beta expression. There was release of cytochrome-c and activation of apoptotic factors such as caspase-9 and -3 in the hippocampus. Further, there was decrease in levels of acetylcholine, and increase in activity of acetyl cholinesterase, indicating impairment of cholinergic system. Therefore, exposure of EMR-2450 in rats caused cognitive deficit with related pathophysiological changes in mitochondrial and cholinergic function, and amyloidogenesis.

Excerpts

The horn antenna was connected to the generator, which emitted continuous radiofrequency (RF) signals of 900, 1800 and 2450 MHz.

The rats were kept inside the cage and positioned at distance of 8, 11 and 15 cm from the antenna for exposure to 900, 1800 and 2450 MHz respectively to maintain the required power density, which is described in the following section.

The animals after being exposed to 900, 1800 and 2450 MHz EMR, the average power density was found to be 0.1227 W/m2. While the overall value of whole body average SAR was found to be approximately, 0.0227, 0.030 and 0.0616 W/kg for 900, 1800 and 2450 MHz respectively.

In summary, EMR at 2450 MHz induced cognitive behavioral deficit with concomitant loss in mitochondrial function. Alteration in the activity of mitochondrial complex enzyme systems caused oxidative stress and decrease in MMP, which ultimately lead to loss of mitochondrial integrity. Further, mitochondrial stress as observed from increases in cytochrome-c activated the expression of caspase-9 and caspase-3, indicating mitochondrial-linked apoptosis. Furthermore, exposure with EMR-2450 increased expression of hippocampal Aβ and decreased cholinergic neurotransmission in the hippocampus, which are considered to be important factors for development of cognitive dysfunction.

https://link.springer.com/article/10.1007/s12038-018-9744-7

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Measurement of 100 MHz EMF radiation in vivo effects on zebrafish embryonic development

Piccinetti CC, De Leo A, Cosoli G, Scalise L, Randazzo B, Cerri B. Olivotto I. Measurement of the 100 MHz EMF radiation in vivo effects on zebrafish D. rerio embryonic development: A multidisciplinary study. Ecotoxicology and Environmental Safety. 154:268-279. June 2018.
https://doi.org/10.1016/j.ecoenv.2018.02.053

Highlights

• Setting up of an EMF exposure protocol for the unequivocal interpretation of results.
• Assessment of biological effects arising from RF-EMF exposure during zebrafish embryonic development.
• Zebrafish as a useful experimental model in electromagnetic pollution studies.

Abstract

The augmented exposure of both environment and human being to electromagnetic waves and the concomitant lack of an unequivocal knowledge about biological consequences of these radiations, raised public interest on electromagnetic pollution. In this context, the present study aims to evaluate the biological effects on zebrafish (ZF) embryos of 100 MHz radiofrequency electromagnetic field (RF-EMF) exposure through a multidisciplinary protocol.

Because of the shared synteny between human and ZF genomes that validated its use in biomedical research, toxicology and developmental biology studies, ZF was here selected as experimental model and a measurement protocol and biological analyses have been set up to clearly discriminate between RF-EMF biological and thermal effects.

The results showed that a 100 MHz EMF was able to affect ZF embryonic development, from 24 to 72 h post fertilization (hpf) in all the analyzed pathways. Particularly, at the 48 hpf stage, a reduced growth, an increased transcription of oxidative stress genes, the onset of apoptotic/autophagic processes and a modification in cholesterol metabolism were detected. ZF embryos faced stress induced by EMF radiation by triggering

detoxification mechanisms and at 72 hpf they partially recovered from stress reaching the hatching time in a comparable way respect to the control group.

Data here obtained showed unequivocally the in vivo effects of RF-EMF on an animal model, excluding thermal outcomes and thus represents the starting point for more comprehensive studies on dose response effects of electromagnetic fields radiations consequences.

https://www.sciencedirect.com/science/article/pii/S0147651318301489

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Oxidative stress & an animal neurotransmitter synthesizing enzyme in wild growing myrtle leaves after GSM radiation exposure

Aikaterina L, Stefi AL, Vassilacopoulou D, Margaritis LH, Christodoulakis NS. Oxidative stress and an animal neurotransmitter synthesizing enzyme in the leaves of wild growing myrtle after exposure to GSM radiation. Flora. 243:67-76. June 2018. https://doi.org/10.1016/j.flora.2018.04.006

Highlights

• Mature myrtle plants were exposed to GSM radiation for 30 min, at 48 h intervals, for 50 days.
• Secondary metabolite accumulation was observed in the exposed leaves.
• Photosynthetic pigment content decreased in the exposed leaves.
• The oxidative stress (ROS) increased in the exposed leaves.
• Significant rise of the DDC level was recorded only in the exposed leaves.

Abstract

Mobile phones turned to be the most common form of public communication. Therefore, life on our planet continues wrapped in a “cloud” of non-ionizing radiations. Myrtus communis L. is an evergreen shrub, common in Mediterranean formations, exposed and adapted to two seasonally separated and qualitatively different environmental stresses. Thus, we considered it important to investigate the response of this tolerant species to emitted GSM non-ionizing radiations and compare it to already available data from thoroughly investigated plant species. Although the leaves of the exposed plants present unaffected tissue arrangement, their mesophyll cells accumulate large amounts of secondary metabolites, their photosynthetic pigments are dramatically reduced, the ROS counted are significantly increased and the presence of DDC, which cannot be detected in the leaves of the control plants, is recorded in high levels. The exposed leaves seem to experience a severe oxidative stress which probably induces DDC expression and the biosynthesis of the neurotransmitter dopamine, the activation of the shikimate pathway and, eventually, the accumulation of secondary metabolites.

https://www.sciencedirect.com/science/article/pii/S0367253018301208

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Selenium supplementation ameliorates electromagnetic field-induced oxidative stress in HEK293 cells

Özsobacı NP, Ergün DD, Durmuş S, Tunçdemir M, Uzun H, Gelişgen R, Özçelik D.Selenium supplementation ameliorates electromagnetic field-induced oxidative stress in the HEK293 cells. Journal of Trace Elements in Medicine and Biology. Available online 13 April 2018

There is a widespread use of 2.4 GHz electromagnetic radiation emitting devices especially in communication and education. Recent studies show the adverse effects of electromagnetic fields (EMF) such as oxidative stress, cellular damage and apoptosis on tissues. Selenium (Se) has an antioxidant properties by inhibiting oxidative damage being within the structure of antioxidant enzymes like glutathione peroxidase (GSH-Px) and it has also regulatory function for cell cycle and apoptosis. The aim of this study was to investigate the effect of

Se on 2.4 GHz frequency EMF exposed human embryonic kidney cells (HEK293) by means of alterations in apoptotic and oxidative stress parameters.

Our study was planned as control, EMF, 100 nM Se+EMF, 200 nM Se+EMF groups. EMF groups were exposed to 2.4 GHz EMF for 1 hour, element groups were incubated with two different doses of Se added cell culture medium for 48 hour before EMF exposure.

MDA levels were significantly higher whereas SOD and GSH-Px activities were significantly lower in EMF compared to control. 100 and 200 nM Se + EMF application decreased MDA levels, increased SOD and GSH-Px activities than EMF. Apoptosis and caspase-3 were statistically significantly higher but bcl-2 was lower in EMF than control. Apoptosis and caspase-3 were lower in 100 and 200 nM Se + EMF, although bcl-2 were higher than EMF.

In conclusion, Se has protective effects against 2.4 GHz EMF-induced oxidative stress by reducing lipid peroxidation, regulating SOD and GSH-Px activity. Also, Se has inhibitory effect on 2.4 GHz EMF induced apoptosis by increasing the expression of anti-apoptotic protein bcl-2 and suppressing apoptosis regulatory protein caspase-3.

https://www.sciencedirect.com/science/article/pii/S0946672X17309768/pdfft?md5=8b8434bd54416111b883a00e4a6edfba&pid=1-s2.0-S0946672X17309768-main.pdf

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Extremely Low Frequency Fields

Residential magnetic fields exposure and childhood leukemia: a population-based case-control study in California

Thomas DC. Re: Kheifets et al. (2017): Residential magnetic fields exposure and childhood leukemia: a population-based case-control study in California. Cancer Causes Control 2018. doi:10.1007/s10552-018-1037-9

No abstract

Excerpts
In contrast, our LA County study reported OR 2.19 (95% CI 1.12–4.31; *p* for trend = .007) in our highest exposure category (MF > 0.125 μT) ...,

Finally, our wiring-based model found an association between residential MF and childhood leukemia when measurements alone did not [2], supporting the hypothesis that the temporal stability of distribution and transmission lines makes their wiring characteristics a better predictor of long-term residential MF exposures.

Discussion of possible mechanisms that could account for our reported effects as lower levels is beyond the scope of this comparison with previous literature, but a brief summary is provided in the Supplementary Comments. These findings suggest that innovations in ELF-MF exposure assessment may lead to more informative studies of the childhood leukemia association than the HVTL-only approach.

https://link.springer.com/article/10.1007%2Fs10552-018-1037-9

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ELF EMF impair the Cognitive and Motor Abilities of Honey Bees

Shepherd S, Lima MAP, Oliveira EE, Sharkh SM, Jackson CW, Newland PL. Extremely Low Frequency

Electromagnetic Fields impair the Cognitive and Motor Abilities of Honey Bees. Sci Rep. 2018 May 21;8(1):7932. doi: 10.1038/s41598-018-26185-y.

Abstract

Extremely low frequency electromagnetic field (ELF EMF) pollution from overhead powerlines is known to cause biological effects across many phyla, but these effects are poorly understood. Honey bees are important pollinators across the globe and due to their foraging flights are exposed to relatively high levels of ELF EMF in proximity to powerlines. Here we ask how acute exposure to 50 Hz ELF EMFs at levels ranging from 20-100 μT, found at ground level below powerline conductors, to 1000-7000 μT, found within 1 m of the conductors, affects honey bee olfactory learning, flight, foraging activity and feeding. ELF EMF exposure was found to reduce learning, alter flight dynamics, reduce the success of foraging flights towards food sources, and feeding. The results suggest that 50 Hz ELF EMFs emitted from powerlines may represent a prominent environmental stressor for honey bees, with the potential to impact on their cognitive and motor abilities, which could in turn reduce their ability to pollinate crops.

https://www.ncbi.nlm.nih.gov/pubmed/29785039

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ELF EMF exposure and restraint stress induce changes on the brain lipid profile of Wistar rats

Martínez-Sámano J, Flores-Poblano A, Verdugo-Díaz L, Juárez-Oropeza MA, Torres-Durán PV. Extremely low frequency electromagnetic field exposure and restraint stress induce changes on the brain lipid profile of Wistar rats. BMC Neurosci. 2018 May 21; 19(1):31. doi: 10.1186/s12868-018-0432-1.

Abstract

BACKGROUND: Exposure to electromagnetic fields can affect human health, damaging tissues and cell homeostasis. Stress modulates neuronal responses and composition of brain lipids. The aim of this study was to evaluate the effects of chronic extremely low frequency electromagnetic field (ELF-EMF) exposure, restraint stress (RS) or both (RS + ELF-EMF) on lipid profile and lipid peroxidation in Wistar rat brain.

METHODS: Twenty-four young male Wistar rats were allocated into four groups: control, RS, ELF-EMF exposure, and RS + ELF-EMF for 21 days. After treatment, rats were euthanized, the blood was obtained for quantitate plasma corticosterone concentration and their brains were dissected in cortex, cerebellum and subcortical structures for cholesterol, triacylglycerols, total free fatty acids, and thiobarbituric acid reactive substances (TBARS) analysis. In addition, fatty acid methyl esters (FAMEs) were identified by gas chromatography.

RESULTS: Increased values of plasma corticosterone were found in RS and ELF-EMF exposed groups ($p < 0.05$), this effect was higher in RS + ELF-EMF group ($p < 0.05$, vs. control group). Chronic ELF-EMF exposure increased total lipids in cerebellum, and total cholesterol in cortex, but decreased polar lipids in cortex. In subcortical structures, increased concentrations of non-esterified fatty acids were observed in RS + ELF-EMF group. FAMEs analysis revealed a decrease of polyunsaturated fatty acids of cerebellum and increases of subcortical structures in the ELF-EMF exposed rats. TBARS concentration in lipids was increased in all treated groups compared to control group, particularly in cortex and cerebellum regions.

CONCLUSIONS: These findings suggest that chronic exposure to ELF-EMF is similar to physiological stress, and induce changes on brain lipid profile.

https://www.ncbi.nlm.nih.gov/pubmed/29783956

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Effect of weak static & ELF alternating magnetic fields on memory & brain amyloid-β in two animal models of Alzheimer's disease

Bobkova NV, Novikov VV. Medvinskaya NI, Aleksandrova IY, Nesterova IV, Fesenko EE. Effect of weak combined static and extremely low-frequency alternating magnetic fields on spatial memory and brain amyloid-β in two animal models of Alzheimer's disease. Electromagnetic Biol Med. May 2018.

Abstract

Subchronic effect of a weak combined magnetic field (MF), produced by superimposing a constant component, 42 μT and an alternating MF of 0.08 μT, which was the sum of two frequencies of 4.38 and 4.88 Hz, was studied in olfactory bulbectomized (OBE) and transgenic Tg (APPswe, PSEN1) mice, which were used as animal models of sporadic and heritable Alzheimer's disease (AD) accordingly. Spatial memory was tested in a Morris water maze on the following day after completion of training trials with the hidden platform removed. The amyloid-β (Aβ) level was determined in extracts of the cortex and hippocampus of mice using a specific DOT analysis while the number and dimensions of amyloid plaques were detected after their staining with thioflavin S in transgenic animals. Exposure to the MFs (4 h/day for 10 days) induced the decrease of Aβ level in brain of OBE mice and reduced the number of Aβ plaques in the cortex and hippocampus of Tg animals. However, memory improvement was revealed in Tg mice only, but not in the OBE animals. Here, we suggest that in order to prevent the Aβ accumulation, MFs could be used at early stage of neuronal degeneration in case of AD and other diseases with amyloid protein deposition in other tissues.

https://www.tandfonline.com/doi/full/10.1080/15368378.2018.1471700

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Radiofrequency Radiation

Numerical evaluation of human exposure to WiMax patch antenna in tablet or laptop

Siervo B, Morelli MS, Landini L, Hartwig V. Numerical evaluation of human exposure to WiMax patch antenna in tablet or laptop. Bioelectromagnetics. 2018 Apr 30. doi: 10.1002/bem.22128.

Abstract

The use of wireless communication devices, such as tablets or laptops, is increasing among children. Only a few studies assess specific energy absorption rate (SAR) due to exposure from wireless-enabled tablets and laptops, in particular with Worldwide Interoperability for Microwave Access (WiMax) technology. This paper reports the estimation of the interaction between an E-shaped patch antenna (3.5 GHz) and human models, by means of finite-difference time-domain (FDTD) method. Specifically, four different human models (young adult male, young adult female, pre-teenager female, male child) in different exposure conditions (antenna at different distances from the human model, in different positions, and orientations) were considered and whole-body, 10 and 1 g local SAR and magnetic field value (Bmax) were evaluated. From our results, in some worst-case scenarios involving male and female children's exposure, the maximum radiofrequency energy absorption (hot spots) is located in more sensitive organs such as eye, genitals, and breast.

Excerpts

Worldwide Interoperability for Microwave Access (WiMax) is a communication system based on IEEE 802.16 [2004], belonging to fourth generation (4G) technology with well-known Long-term Evolution (LTE).

In conclusion, the results of our study show the importance of simulating exposure taking into account the antenna-body mutual position for the exact localization of maximum SAR values ("hot spots"). Although the

average SAR values do not exceed the recommended limits for all simulated exposure conditions except one, the maximum SAR values in some scenarios are located in more sensitive organs, which are the eyes, genitals, and breast. This is particularly important for children. Their entire organism is in a process of development and it is not possible to predict long-lasting problems that might occur as a result of exposure to EM fields at an early age. Nevertheless, recently Barnes and Greenenbaum [2016] presented possible theoretical mechanisms and experimental data concerning long-term exposures to RF magnetic fields, speculating that they can be responsible for changing in radical concentrations. Moreover, the values for the SAR reported here are expected to be in a range that could change the concentration of reactive oxygen species, and long-term exposures may be significant for some health effects [De Iuliis et al., 2009; Kang et al., 2014; Wang and Zhang, 2017].

Hence, until a more exhaustive monitoring of the potential risk of exposure from wireless-enabled devices is available, exposures of the young should be As Low As Reasonably Achievable (ALARA). To prevent any potential hazard and damage from the use of wireless devices, some simple rules, such as keeping the device as far away as possible from the eyes, genitals, and breast, should be established.

https://www.ncbi.nlm.nih.gov/pubmed/29709072

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Representativeness and repeatability of microenvironmental personal and head exposures to RF EMF

Thielens A, Van den Bossche M, Brzozek C, Bhatt CR, Abramson MJ, Benke G, Martens L, Joseph W. Representativeness and repeatability of microenvironmental personal and head exposures to radio-frequency electromagnetic fields. Environ Res. 2018 Apr;162:81-96. doi: 10.1016/j.envres.2017.12.017.

Highlights

• First time assessment of head exposure to RF-EMF in uncontrolled environments, in 15 microenvironments in Melbourne, Australia.

• We show that our measurement protocol is repeatable over time.

• We show that the paths selected in our protocol are representative for the larger areas in which they are defined.

• Exposure to RF-EMF is higher in more dense urban areas than in less populated suburban areas in the outskirts of the city.

Abstract

The aims of this study were to: i) investigate the repeatability and representativeness of personal radio frequency-electromagnetic fields (RF-EMFs) exposure measurements, across different microenvironments, ii) perform simultaneous evaluations of personal RF-EMF exposures for the whole body and the head, iii) validate the data obtained with a head-worn personal distributed exposimeter (PDE) against those obtained with an on-body worn personal exposimeter (PEM). Data on personal and head RF-EMF exposures were collected by performing measurements across 15 microenvironments in Melbourne, Australia. A body-worn PEM and a head-worn PDE were used for measuring body and head exposures, respectively. The summary statistics obtained for total RF-EMF exposure showed a high representativeness (r2 > 0.66 for two paths in the same area) and a high repeatability over time (r2 > 0.87 for repetitions of the same path). The median head exposure in the 900MHz downlink band ranged between 0.06V/m and 0.31V/m. The results obtained during

simultaneous measurements using the two devices showed high correlations (0.42 < r2 < 0.94). The highest mean total RF-EMF exposure was measured in Melbourne's central business district (0.89V/m), whereas the lowest mean total exposure was measured in a suburban residential area (0.05V/m). This study shows that personal RF-EMF microenvironmental measurements in multiple microenvironments have high representativeness and repeatability over time. The personal RF-EMF exposure levels (i.e. body and head exposures) demonstrated moderate to high correlations.

https://www.ncbi.nlm.nih.gov/pubmed/29289859

Also see: Cell Phone Towers are Largest Contributor to Environmental Radiofrequency Radiation

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Spatial and temporal variability of personal exposure to RF EMF in children in Europe

Birks LE, Struchen B, Eeftens M, Huss A, Gajšek P, Kheifets L, Gallastegi M, van Wel L, Dalmau-Bueno A, Estarlich M, Fernandez M, Meder IK, Ferrero A, Jiménez-Zabala A, Torrent M, Vrijkotte TGM, Cardis E, Olsen J, Valič B, Vermeulen R, Vrijheid M, Röösli M, Guxens M. OP VI – 5 Spatial and temporal variability of personal exposure to radio frequency electromagnetic fields in children in europe. Occupational and Environmental Medicine 75(Suppl 1):A13.1-A13. March 2018. DOI: 10.1136/oemed-2018-ISEEabstracts.31

Conference: ISEE Young 2018, Early Career Researchers Conference on Environmental Epidemiology – Together for a Healthy Environment, 19–20 March 2018, Freising, Germany

Abstract

Background/aim Exposure to radiofrequency electromagnetic fields (RF-EMF) has rapidly increased and little is known about exposure levels in children. This study aims to describe personal RF-EMF environmental exposure levels from handheld devices and fixed site transmitters in European children and its day-to-day and year-to-year repeatability.

Methods Environmental RF-EMF exposure (μW/m²) was measured in 529 children (ages 8–18) in Denmark, the Netherlands, Slovenia, Switzerland, and Spain using personal portable exposure metres over 3 days in 2014–2016, and repeated in 28 children one year later. Metres captured exposure every 4 s. Activity diaries collected children's location and use of mobile devices. Six general frequency bands were defined: total, digital enhanced cordless telecommunications (DECT), television and radio antennas (broadcast), mobile phones (uplink), mobile phone base stations (downlink), and WiFi. We used mixed effects models with region random effects to estimate associations between mobile device use and exposure. Day-to-day and year-to-year repeatability was calculated through Spearman correlations.

Results Median total exposure was 75.5 μW/m². Downlink was the largest contributor to total exposure (27.2 μW/m²) followed by broadcast (9.9 μW/m²). Exposure from uplink was lower (4.7 μW/m²). WiFi and DECT contributed very little to exposure levels. Exposure was higher during day (94.2 μW/m²) than night (23.0 μW/m²), and slightly higher during weekends than weekdays, although varying across regions. Exposure was generally highest while children were travelling (171.3 μW/m²) and outside (157.0 μW/m²). Children living in urban environments had higher exposure. Older children, girls, and users of mobile phones had higher uplink exposure but not total exposure. Repeatability was high for total, downlink, and broadcast in the year-to-year repeatability (rho between 0.54 and 0.66).

Conclusion Largest contributors to total RF-EMF exposure were downlink and broadcast, which was consistent one year later. Location of home (region and urbanicity) was associated with higher exposure. More frequent mobile phone use was associated with higher uplink exposure. It is important to continue evaluating RF-EMF exposure in children as mobile devices, use habits, and technologies continue to evolve.

http://oem.bmj.com/content/75/Suppl_1/A13.1

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Wireless Phone Use and Risk of Adult Glioma: Evidence from Meta-analysis

Wang P, Hou C, Li Y, Zhou D. Wireless Phone Use and Risk of Adult Glioma: Evidence from Meta-analysis. World Neurosurgery. Available online 28 April 2018.

Objective Wireless phone use has been increasing rapidly and is associated with the risk of glioma. Many studies have been conducted on this association, but did not reach an agreement. The aim of this meta-analysis was to determine the possible association between wireless phone use and the risk of adult glioma.

Methods Eligible studies were identified by searching Pubmed and Embase till July 2017. The random- or fixed-effects model was used to combine the results depending on the heterogeneity of the analysis. Publication bias was evaluated using Begg's funnel plot and Egger's regression asymmetry test. Subgroup analysis was performed to evaluate the possible influence of these variables.

Results A total of 10 studies about the association of wireless phone use and the risk of glioma were included in this meta-analysis. The combined odd's ratio (OR) of adult glioma associated with ever use of wireless phone was 1.03 (95% CI=0.92–1.16) with high heterogeneity (I2=54.2%, P=0.013). In the subgroup analyses, no significant association was found among tumor location in the temporal lobe and adult glioma risk, with ORs of 1.26 (95% CI=0.87–1.84), 0.93 (95%CI=0.69–1.24), 1.61 (95%CI=0.78–3.33), respectively. Significant association was found in long-term users (≥10 years) with OR 1.33 (95%CI =1.05–1.67) and risk of glioma.

Conclusions Our analysis suggested that ever use of wireless phone was not significantly associated with the risk of adult glioma, but could increase the risk in long-term users.

https://www.sciencedirect.com/science/article/pii/S1878875018308428

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Recall of mobile phone usage and laterality in young people: The multinational Mobi-Expo study

Goedhart G, van Wel L, Langer CE, de Llobet Viladoms P, Wiart J, Hours M, Kromhout H, Benke G, Bouka E, Bruchim R, Choi KH, Eng A, Ha M, Huss A, Kiyohara K, Kojimahara N, Krewski D, Lacour B, 't Mannetje A, Maule M, Migliore E, Mohipp C, Momoli F, Petridou ET, Radon K, Remen T, Sadetzki S, Sim M, Weinmann T, Cardis E, Vrijheid M, Vermeulen R. Recall of mobile phone usage and laterality in young people: The multinational Mobi-Expo study. Environ Res. 2018 Apr 25;165:150-157. doi: 10.1016/j.envres.2018.04.018.

Abstract

OBJECTIVE: To study recall of mobile phone usage, including laterality and hands-free use, in young people.

METHODS: Actual mobile phone use was recorded among volunteers aged between 10 and 24 years from 12 countries by the software application XMobiSense and was compared with self-reported mobile phone use at 6 and 18 months after using the application. The application recorded number and duration of voice calls, number of text messages, amount of data transfer, laterality (% of call time the phone was near the right or left side of the head, or neither), and hands-free usage. After data cleaning, 466 participants were available for the main analyses (recorded vs. self-reported phone use after 6 months).

RESULTS: Participants were on average 18.6 years old (IQR 15.2-21.8 years). The Spearman correlation coefficients between recorded and self-reported (after 6 months) number and duration of voice calls were 0.68 and 0.65, respectively. Number of calls was on average underestimated by the participants (adjusted geometric mean ratio (GMR) self-report/recorded = 0.52, 95% CI = 0.47-0.58), while duration of calls was overestimated (GMR=1.32, 95%, CI = 1.15-1.52). The ratios significantly differed by country, age, maternal educational level, and level of reported phone use, but not by time of the interview (6 vs. 18 months). Individuals who reported low mobile phone use underestimated their use, while individuals who reported the highest level of phone use were more likely to overestimate their use. Individuals who reported using the phone mainly on the right side of the head used it more on the right (71.1%) than the left (28.9%) side. Self-reported left side users, however, used the phone only slightly more on the left (53.3%) than the right (46.7%) side. Recorded percentage hands-free use (headset, speaker mode, Bluetooth) increased with increasing self-reported frequency of hands-free device usage. Frequent (≥50% of call time) reported headset or speaker mode use corresponded with 17.1% and 17.2% of total call time, respectively, that was recorded as hands-free use.

DISCUSSION: These results indicate that young people can recall phone use moderately well, with recall depending on the amount of phone use and participants' characteristics. The obtained information can be used to calibrate self-reported mobile use to improve estimation of radiofrequency exposure from mobile phones.

https://www.ncbi.nlm.nih.gov/pubmed/29704776

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Mobile phone EMF induced DNA damage in human ear canal hair follicle cells

Akdag M, Dasdag S, Canturk F, Akdag MZ. Exposure to non-ionizing electromagnetic fields emitted from mobile phones induced DNA damage in human ear canal hair follicle cells. Electromagn Biol Med. 2018 Apr 18:1-10. doi: 10.1080/15368378.2018.1463246.

Abstract

The aim of this study was to investigate effect of radiofrequency radiation (RFR) emitted from mobile phones on DNA damage in follicle cells of hair in the ear canal. The study was carried out on 56 men (age range: 30-60 years old) in four treatment groups with n = 14 in each group. The groups were defined as follows: people who did not use a mobile phone (Control), people use mobile phones for 0-30 min/day (second group), people use mobile phones for 30-60 min/day (third group) and people use mobile phones for more than 60 min/day (fourth group). Ear canal hair follicle cells taken from the subjects were analyzed by the Comet Assay to

determine DNA damages. The Comet Assay parameters measured were head length, tail length, comet length, percentage of head DNA, tail DNA percentage, tail moment, and Olive tail moment. Results of the study showed that DNA damage indicators were higher in the RFR exposure groups than in the control subjects. In addition, DNA damage increased with the daily duration of exposure. In conclusion, RFR emitted from mobile phones has a potential to produce DNA damage in follicle cells of hair in the ear canal. Therefore, mobile phone users have to pay more attention when using wireless phones.

https://www.ncbi.nlm.nih.gov/pubmed/29667447

Excerpts

Participants using smart phones with similar SAR values, were used. The head peak SAR values of the smart phones used by the participants, ranged between 0.45–0.97 W/kg.

Comet Assay was performed by researchers who were unaware of which group the hair samples were from.

In conclusion, the findings of the present study indicated that exposure to radiation from mobile phones can lead to DNA single-strand breaks, therefore, to DNA damage. The results of this study indicated a positive correlation between duration of exposure and DNA damage. We consider that the result of this study might be important in terms of the balance involved in DNA damage and repair mechanisms.

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Temperature induced in human organs due to near-field and far-field electromagnetic exposure effects

Wessapan T, Rattanadech P. Temperature induced in human organs due to near-field and far-field electromagnetic exposure effects. International Journal of Heat and Mass Transfer. 119:65-76. April 2018.

Highlights

• The field radiation pattern and the operating frequency significantly influence the temperature distribution in each organ.
• The testis temperature increases are lower than the thresholds for the induction of infertility for both 900 and 1800 MHz.
• For distances less than 2 m, the SAR values are higher than the general public exposure limit of ICNIRP.

Abstract

The main biological effect from exposure to electromagnetic (EM) radiation is a temperature rise in the human body and its sensitive organs, which results from absorbing electromagnetic field (EMF) power. EM near-field and far-field sources, which have different operating frequencies and exposure distances, result in different EMF distribution patterns and EMF power absorptions by the human body. Actually, the severity of the physiological effect can occur with small temperature increases in the sensitive organs. However, the EM absorption characteristics and the temperature increase distribution resulting from different field radiation patterns from EM sources are not well established. To adequately explain the biological effects that are associated with the EMF energy absorption, a systematic study of different EMF distribution patterns and how they interact with body tissue is needed. This study considers the computationally determined specific

absorption rate (SAR) and the heat transfer in a heterogeneous human torso model with internal organs exposed to near-field and far-field EM radiations at different frequencies. The electric field, SAR, and the temperature distributions in various organs during exposure to EMFs are obtained through the numerical simulation of EM wave propagation and an unsteady bioheat transfer model. The findings indicate that the field radiation pattern and the operating frequency of an EM source significantly influence the electric field, the SAR, and the temperature distribution in each organ. Moreover, the tissue's dielectric properties also affect the temperature distribution patterns within the body tissue. These findings enable researchers to more accurately determine the exposure limits for the power output of wireless transmitters, and the distance that they should remain from the humans.

https://www.sciencedirect.com/science/article/pii/S0017931017342709

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Does acute RF EMF exposure affect visual event-related potentials in healthy adults?

Dalecki A, Loughran SP, Verrender A, Burdon CA, Taylor NAS, Croft RJ. Does acute radio-frequency electromagnetic field exposure affect visual event-related potentials in healthy adults? Clinical Neurophysiology. 129(5):901-908. May 2018.

Abstract

Objective To use improved methods to address the question of whether acute exposure to radio-frequency (RF) electromagnetic fields (RF-EMF) affects early (80–200 ms) sensory and later (180–600 ms) cognitive processes as indexed by event-related potentials (ERPs).

Methods Thirty-six healthy subjects completed a visual discrimination task during concurrent exposure to a Global System for Mobile Communications (GSM)-like, 920 MHz signal with peak-spatial specific absorption rate for 10 g of tissue of 0 W/kg of body mass (Sham), 1 W/kg (Low RF) and 2 W/kg (High RF). A fully randomised, counterbalanced, double-blind design was used.

Results P1 amplitude was reduced ($p = .02$) and anterior N1 latency was increased ($p = .04$) during Exposure compared to Sham. There were no effects on any other ERP latencies or amplitudes.

Conclusions RF-EMF exposure may affect early perceptual (P1) and preparatory motor (anterior N1) processes. However, only two ERP indices, out of 56 comparisons, were observed to differ between RF-EMF exposure and Sham, suggesting that these observations may be due to chance.

Excerpts

It should be noted that the RF-EMF exposure in the present study was a simulated GSM signal, delivered via planar antenna (Murbach et al., 2012). This planar antenna delivers a relatively homogenous SAR distribution to brain structures in the exposed hemisphere (Murbach et al., 2012).... We note that, in contrast to the homogenous SAR distribution produced by the planar antenna used in the present study, exposures from individual mobile phones are far more localised, such that SARs in brain regions more distant from the mobile phone are markedly smaller than those more proximal to the phone (Boutry et al., 2008; Loughran et al., 2008). Therefore, given the lack of effects on central nervous system function under conditions where the maximal SAR is delivered to the entire hemisphere, it is unlikely that a markedly smaller, localised SAR exposure, such

as that which might be present during mobile phone use, would affect the processes assessed in the present study.

This study was funded by the National Health and Medical Research Council of Australia [Grant 1042464] and the **Electric Power Research Institute** [Grant 00-10003301].

Conflict of interest statement: None.

https://www.sciencedirect.com/science/article/pii/S1388245718301044

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Commentary: Geographic Variations in Incidence of Glioblastoma & Prognostic Factors Predictive of Overall Survival in US Adults from 2004–2013

Mortazavi SMJ. Commentary: Geographic Variations in the Incidence of Glioblastoma and Prognostic Factors Predictive of Overall Survival in US Adults from 2004–2013. Front Aging Neurosci. 2018; 10: 105. Published online 2018 Apr 12. doi: 10.3389/fnagi.2018.00105.

No abstract

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5906709/

See the article "Geographic Variations in the Incidence of Glioblastoma and Prognostic Factors Predictive of Overall Survival in US Adults from 2004–2013" in volume 9, 352. Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5681990/

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Tumor-treating fields as a fourth treating modality for glioblastoma: a meta-analysis

Magouliotis DE, Asprodini EK, Svokos KA, Tasiopoulou VS, Svokos AA, Toms SA. Tumor-treating fields as a fourth treating modality for glioblastoma: a meta-analysis. Acta Neurochir (Wien). 2018 Apr 25. doi: 10.1007/s00701-018-3536-6. [Epub ahead of print]

Abstract

BACKGROUND: We aim to review the available literature on patients suffering from glioblastoma treated with tumor-treating fields (TTFields) plus radio chemotherapy or conventional radio chemotherapy alone, to compare the efficacy and safety of the two methods.

METHODS: A systematic literature search was performed in PubMed, Cochrane library, and Scopus databases, in accordance with the PRISMA guidelines. Six studies met the inclusion criteria incorporating 1806 patients for the qualitative analysis and 1769 for the quantitative analysis.

RESULTS: This study reveals increased median overall survival (weighted mean difference (WMD) 3.29 [95% confidence interval (CI) 2.37, 4.21]; $p < 0.00001$), survival at 1 year (odds ratio (OR) 1.81 [95% CI 1.41, 2.32]; $p < 0.00001$) and 2 years (OR 2.33 [95% CI 1.73, 3.14]; $p < 0.00001$), and median progression-free survival

(WMD 2.35 [95% CI 1.76, 2.93]; p < 0.00001) along with progression-free survival at 6 months (WMD 6.86 [95% CI 5.91, 7.81]; p < 0.00001) for the patients treated with TTFields. Survival at 3 years was comparable between the two groups. TTFields were associated with fewer adverse events compared to chemotherapy along with similar incidence of skin irritation.

CONCLUSIONS: TTFields are a safe and efficient novel treatment modality. More randomized controlled studies, with longer follow-up, are necessary to further assess the clinical outcomes of TTFields.

https://www.ncbi.nlm.nih.gov/pubmed/29696502

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Electronics in fluorescent bulbs & LEDs cause malignant melanoma in indoor office workers & tanning bed users

Milham S, Stetzer D. The electronics in fluorescent bulbs and light emitting diodes (LED), rather than ultraviolet radiation, cause increased malignant melanoma incidence in indoor office workers and tanning bed users. Medical Hypotheses. 116:33-39. Jul 2018.

Abstract

The epidemiology of cutaneous malignant melanoma (CMM) has a number of facets that do not fit with sunlight and ultraviolet light as the primary etiologic agents. Indoor workers have higher incidence and mortality rates of CMM than outdoor workers; CMM occurs in body locations never exposed to sunlight; CMM incidence is increasing in spite of use of UV blocking agents and small changes in solar radiation.

Installation of two new fluorescent lights in the milking parlor holding area of a Minnesota dairy farm in 2015 caused an immediate drop in milk production. This lead to measurement of body amperage in humans exposed to modern non-incandescent lighting. People exposed to old and new fluorescent lights, light emitting diodes (LED) and compact fluorescent lights (CFL) had body amperage levels above those considered carcinogenic. We hypothesize that modern electric lighting is a significant health hazard, a carcinogen, and is causing increasing CMM incidence in indoor office workers and tanning bed users. These lights generate dirty electricity (high frequency voltage transients), radio frequency (RF) radiation, and increase body amperage, all of which have been shown to be carcinogenic. This could explain the failure of ultraviolet blockers to stem the malignant melanoma pandemic. Tanning beds and non-incandescent lighting could be made safe by incorporating a grounded Faraday cage which allows passage of ultraviolet and visible light frequencies and blocks other frequencies. Modern electric lighting should be fabricated to be electrically clean.

https://www.medical-hypotheses.com/article/S0306-9877(18)30116-6/abstract

Evaluation of hypothesis

To test this hypothesis, tanning beds with and without grounded Faraday cages which allow passage of UV light and block other electromagnetic frequencies should be tested with a body amperage meter and with animal malignant melanoma models. Incandescent (no internal or external electronics) and fluorescent tanning bulbs of the same UV frequency (wavelength) and intensity should also be tested similarly. Modern non-incandescent lighting of all types should be tested and compared to incandescent lights and lights fabricated to

be electrically clean. Case/control and cohort studies of CMM cases focused on lighting exposures should be undertaken.

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A proposed explanation for thunderstorm asthma and leukemia risk near high-voltage power lines: a supported hypothesis

Redmayne M. A proposed explanation for thunderstorm asthma and leukemia risk near high-voltage power lines: a supported hypothesis
Electromagnetic Biology and Medicine. Published online 30 Apr 2018.

Abstract

Thunderstorm asthma and increased childhood leukemia risk near high-voltage power lines (HVPL) are occurrences whose mechanism of effect is not fully understood.

This paper proposes and discusses a key similarity: both thunderstorms and HVPL generate a high enough electrical field in the environment to ionize nearby air and air-borne particles.

I argue that the repeatedly demonstrated acute asthma response to pollen-laden air during thunderstorms is largely due to ionization of air-borne allergens, which adhere more readily and in greater quantity in the lungs than non-ionized particles. If these bind to mucous or phagocytic cells, it would enhance immune response. A rapid temperature drop and high ozone also seem to be drivers of thunderstorm asthma.

This causal nexus provides strong support for the parallel situation of prolonged exposure to ionized particles near HVPL and an increased rate of childhood leukemia. Here, it is proposed that upwind carcinogens are ionized when passing HVPL and then residential and business areas. Published evidence for most steps are presented, but have not previously been published as a coherent whole, nor has it been suggested that the inhaled ionized micro-particle explanation for acute asthma may also explain development of childhood leukemia over time.

The demonstrated series of events leading to increased deposition and retention of ionized particles in airways provides support for explaining both adverse health outcomes: acute thunderstorm asthma and increased risk of childhood leukemia near HVPL. Further support for this explanation of both outcomes is provided by effects of on-going proximity to highways.

https://doi.org/10.1080/15368378.2018.1466309

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Alteration of adaptive behaviors of progeny after maternal mobile phone exposure

Petitdant N, Lecomte A, Robidel F, Gamez, C, Blazy K, Villégier A-S. Alteration of adaptive behaviors of progeny after maternal mobile phone exposure. Environmental Science and Pollution Research. 25(11):10894-10903. Apr 2018.

Exposure of pregnant women to radiofrequency (RF) devices raises questions on their possible health consequences for their progeny. We examined the hazard threshold of gestational RF on the progeny's glial homeostasis, sensory-motor gating, emotionality, and novelty seeking and tested whether maternal immune activation would increase RF toxicity. Pregnant dams were daily restrained with loop antennas adjoining the abdomen (fetus body specific absorption rates (SAR): 0, 0.7, or 2.6 W/kg) and received three lipopolysaccharide (LPS) intra-peritoneal injections (0 or 80 mu g/kg). Scores in the prepulse startle inhibition, fear conditioning, open field, and elevated plus maze were assessed at adolescence and adulthood. Glial fibrillary acidic protein (GFAP) and interleukines-1 beta (ILs) were quantified. LPS induced a SAR-dependent reduction of the prepulse startle inhibition in adults. Activity in the open field was reduced at 2.6 W/kg at adolescence. GFAP and ILs, emotional memory, and anxiety-related behaviors were not modified. These data support the hypothesis that maternal immune activation increased the developmental RF exposure-induced long-term neurobiological impairments. These data support the fact that fetuses who receive combined environmental exposures with RF need special attention for protection.

https://www.ncbi.nlm.nih.gov/pubmed/29397508

Excerpts

GD 1 dams were randomly assigned to one RF-EMF emission power group (0 (sham), 1 or 4 W) or to the cage control group (no daily restraint). Half of each RF-EMF group was randomly assigned to receive vehicle (saline) or LPS intraperitoneal injections (80 µg/ml/kg, *E. coli*, serotype 055:B5, phenol extraction Sigma-Aldrich, MO) at GD 15, 17 and 19 ($n = 6–9$/group). At birth, the number of pups per litter was recorded. At post-natal day (PND) 3, litters were adjusted to four males by reduction or adoption.

According to the finite difference time domain calculations, numerical dosimetry indicated 20 GD-averaged fetus whole body SAR of 0.7 +/− 1.5 W/kg for 1 W and 2,6 +/− 6 W/kg for 4 W emitting power.

To conclude, our study is the first to highlight gestational inflammation-induced vulnerability towards RF-EMF exposure on the ability to filtrate sensory information. Cerebral impairments were SAR-dependent supporting the causal relationship between EMF-RF exposure and deficits. RF-EMF levels tested in this study may surround the possible toxic threshold for gestational RF-EMF. These data with those of other studies support the fact that special attention should be devoted to the protection of embryos and fetuses that can be co-exposed to environmental factors and EMFs at diverse frequencies and intensities.

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Effects of 1.8 GHz radiofrequency field on microstructure and bone metabolism of femur in mice

Guo L, Zhang JP, Zhang KY, Wang HB, Wang H, An GZ, Zhou Y, Meng GL, Ding DR. Effects of 1.8 GHz radiofrequency field on microstructure and bone metabolism of femur in mice. Bioelectromagnetics. Published online Apr 30, 2018.

Abstract

To investigate the effects of 1.8 GHz radiofrequency (RF) field on bone microstructure and metabolism of femur in mice, C57BL/6 mice (male, age 4 weeks) were whole-body exposed or sham exposed to 1.8 GHz RF field. Specific absorption rates of whole body and bone were approximately 2.70 and 1.14 W/kg (6 h/day for 28

days). After exposure, microstructure and morphology of femur were observed by microcomputed tomography (micro-CT), Hematoxylin and Eosin (HE) and Masson staining. Subsequently, bone parameters were calculated directly from the reconstructed images, including structure model index, bone mineral density, trabecular bone volume/total volume, connectivity density, trabecular number, trabecular thickness, and trabecular separation. Biomarkers that reflect bone metabolism, such as serum total alkaline phosphatase (ALP), bone-specific alkaline phosphatase (BALP), and tartrate-resistant acid phosphatase 5b (TRACP-5b), were determined by biochemical assay methods. Micro-CT and histology results showed that there was no significant change in bone microstructure and the above parameters in RF group, compared with sham group. The activity of serum ALP and BALP increased 29.47% and 16.82%, respectively, in RF group, compared with sham group ($P < 0.05$). In addition, there were no significant differences in the activity of serum TRACP-5b between RF group and sham group. In brief, under present experimental conditions, we did not find support for an effect of 1.8 GHz RF field on bone microstructure; however, it might promote metabolic function of osteoblasts in mice.

https://doi.org/10.1002/bem.22125

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835 MHz RF-EMF decreases expression of calcium channels, inhibits apoptosis, but induces autophagy in mouse hippocampus

Kim JH, Sohn UD, Kim HG, Kim HR. Exposure to 835 MHz RF-EMF decreases the expression of calcium channels, inhibits apoptosis, but induces autophagy in the mouse hippocampus. Korean J Physiol Pharmacol. 2018 May;22(3):277-289. doi: 10.4196/kjpp.2018.22.3.277.

Abstract

The exponential increase in the use of mobile communication has triggered public concerns about the potential adverse effects of radiofrequency electromagnetic fields (RF-EMF) emitted by mobile phones on the central nervous system (CNS). In this study, we explored the relationship between calcium channels and apoptosis or autophagy in the hippocampus of C57BL/6 mice after RF-EMF exposure with a specific absorption rate (SAR) of 4.0 W/kg for 4 weeks. Firstly, the expression level of voltage-gated calcium channels (VGCCs), a key regulator of the entry of calcium ions into the cell, was confirmed by immunoblots. We investigated and confirmed that pan-calcium channel expression in hippocampal neurons were significantly decreased after exposure to RF-EMF. With the observed accumulation of autolysosomes in hippocampal neurons via TEM, the expressions of autophagy-related genes and proteins (e.g., LC3B-II) had significantly increased. However, down-regulation of the apoptotic pathway may contribute to the decrease in calcium channel expression, and thus lower levels of calcium in hippocampal neurons. These results suggested that exposure of RF-EMF could alter intracellular calcium homeostasis by decreasing calcium channel expression in the hippocampus; presumably by activating the autophagy pathway, while inhibiting apoptotic regulation as an adaptation process for 835 MHz RF-EMF exposure.

Open access paper: http://pdf.medrang.co.kr/paper/pdf/Kjpp/Kjpp022-03-06.pdf

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Extremely Low Frequency Fields

Electric cars and EMI with cardiac implantable electronic devices: A cross-sectional evaluation

Lennerz C, O'Connor M, Horlbeck L, Michel J, Weigand S, Grebmer C, Blazek P, Brkic A, Semmler V, Haller B, Reents T, Hessling G, Deisenhofer I, Whittaker P, Lienkamp M, Kolb C. Letter: Electric cars and electromagnetic interference with cardiac implantable electronic devices: A cross-sectional evaluation. *Annals of Internal Medicine*. Apr 24, 2018.

No abstract

See Hybrid & Electric Cars: Electromagnetic Radiation Risks for excerpts and link to paper.

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Antitumor effect of static and ELF MF against nephroblastoma and neuroblastoma

Yuan LQ, Wang C, Zhu K, Li HM, Gu WZ, Zhou DM, Lai JQ, Zhou D, Lv Y, Tofani S, Chen X. The antitumor effect of static and extremely low frequency magnetic fields against nephroblastoma and neuroblastoma. Bioelectromagnetics. 2018 May 2. doi: 10.1002/bem.22124.

Abstract

Certain magnetic fields (MF) have potential therapeutic antitumor effect whereas the underlying mechanism remains undefined. In this study, a well-characterized MF was applied to two common childhood malignancies, nephroblastoma and neuroblastoma. This MF has a time-averaged total intensity of 5.1 militesla (mT), and was generated as a superimposition of a static and an extremely low frequency (ELF) MF in 50 Hertz (Hz). In nephroblastoma and neuroblastoma cell lines including G401, CHLA255, and N2a, after MF exposure of 2 h per day, the cell viability decreased significantly after 2 days. After 3 days, inhibition rates of 17-22% were achieved in these cell lines. Furthermore, the inhibition rate was positively associated with exposure time. On the other hand, when using static MF only while maintaining the same time-averaged intensity of 5.1 mT, the inhibition rate was decreased. Thus, both time and combination of ELF field were positively associated with the inhibitory effect of this MF. Exposure to the field decreased cell proliferation and induced apoptosis. Combinational use of MF together with chemotherapeutics cisplatin (DDP) was performed in both in vitro and in vivo experiments. In cell lines, combinational treatment further increased the inhibition rate compared with single use of either DDP or MF. In G401 nephroblastoma tumor model in nude mice, combination of MF and DDP resulted in significant decrease of tumor mass, and the side effect was limited in mild liver injury. MF exposure by itself did not hamper liver or kidney functions. In summary, the antitumor effect of an established MF against neuroblastoma and nephroblastoma is reported, and this field has the potential to be used in combination with DDP to achieve increased efficacy and reduce side effects in these two childhood malignancies.

https://www.ncbi.nlm.nih.gov/pubmed/29719057

Radio Frequency Radiation

5G wireless telecommunications expansion: Public health and environmental implications

Russell CL. 5G wireless telecommunications expansion: Public health and environmental implications. Environmental Research. Available online 11 April 2018. in press. https://doi.org/10.1016/j.envres.2018.01.016

Abstract

The popularity, widespread use and increasing dependency on wireless technologies has spawned a telecommunications industrial revolution with increasing public exposure to broader and higher frequencies of the electromagnetic spectrum to transmit data through a variety of devices and infrastructure. On the horizon, a new generation of even shorter high frequency 5G wavelengths is being proposed to power the Internet of Things (IoT). The IoT promises us convenient and easy lifestyles with a massive 5G interconnected telecommunications network, however, the expansion of broadband with shorter wavelength radiofrequency radiation highlights the concern that health and safety issues remain unknown. Controversy continues with regards to harm from current 2G, 3G and 4G wireless technologies. 5G technologies are far less studied for human or environmental effects.

It is argued that the addition of this added high frequency 5G radiation to an already complex mix of lower frequencies, will contribute to a negative public health outcome both from both physical and mental health perspectives.

Radiofrequency radiation (RF) is increasingly being recognized as a new form of environmental pollution. Like other common toxic exposures, the effects of radiofrequency electromagnetic radiation (RF EMR) will be problematic if not impossible to sort out epidemiologically as there no longer remains an unexposed control group. This is especially important considering these effects are likely magnified by synergistic toxic exposures and other common health risk behaviors. Effects can also be non-linear. Because this is the first generation to have cradle-to-grave lifespan exposure to this level of man-made microwave (RF EMR) radiofrequencies, it will be years or decades before the true health consequences are known. Precaution in the roll out of this new technology is strongly indicated.

This article will review relevant electromagnetic frequencies, exposure standards and current scientific literature on the health implications of 2G, 3G, 4G exposure, including some of the available literature on 5G frequencies. The question of what constitutes a public health issue will be raised, as well as the need for a precautionary approach in advancing new wireless technologies.

Conclusion

Although 5G technology may have many unimagined uses and benefits, it is also increasingly clear that significant negative consequences to human health and ecosystems could occur if it is widely adopted. Current radiofrequency radiation wavelengths we are exposed to appear to act as a toxin to biological systems. A moratorium on the deployment of 5G is warranted, along with development of independent health and environmental advisory boards that include independent scientists who research biological effects and exposure levels of radiofrequency radiation. Sound regulatory policy regarding current and future telecommunications initiative will require more careful assessment of risks to human health, environmental health, public safety, privacy, security and social consequences. Public health regulations need to be updated to match appropriate independent science with the adoption of biologically based exposure standards prior to further deployment of 4G or 5G technology.

Considering the current science, lack of relevant exposure standards based on known biological effects and data gaps in research, we need to reduce our exposure to RF EMR where ever technically feasible. Laws or policies which restrict the full integrity of science and the scientific community with regards to health and environmental effects of wireless technologies or other toxic exposures should be changed to enable unbiased, objective and precautionary science to drive necessary public policies and regulation. Climate change, fracking, toxic emissions and microwave radiation from wireless devices all have something in common with smoking. There is much denial and confusion about health and environmental risks, along with industry insistence for absolute proof before regulatory action occurs (Frentzel-Beyme, 1994; Michaels 2008). There are many lessons we have not learned with the introduction of novel substances, which later became precarious environmental pollutants by not heeding warning signs from scientists (Gee, 2009). The threats of these common pollutants continue to weigh heavily on the health and wellbeing of our nation. We now accept them as the price of progress. If we do not take precautions but wait for unquestioned proof of harm will it be too late at that point for some or all of us?

https://www.sciencedirect.com/science/article/pii/S0013935118300161

More information about 5G:

Physicians for Safe Technology
Scientists and Doctors Demand Moratorium on 5G

5G Wireless Technology: Is 5G Harmful to Our Health?
5G Wireless Technology: Millimeter Wave Health Effects

5G Wireless Technology: Cutting Through the Hype

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Human Exposure to RF Fields in 5G Downlink

Nasim I, Kim S. Human Exposure to RF Fields in 5G Downlink. Submitted on 10 Nov 2017 to IEEE International Communications Conference. arXiv:1711.03683v1.

Abstract

While cellular communications in millimeter wave (mmW) bands have been attracting significant research interest, their potential harmful impacts on human health are not as significantly studied. Prior research on human exposure to radio frequency (RF) fields in a cellular communications system has been focused on uplink only due to the closer physical contact of a transmitter to a human body. However, this paper claims the necessity of thorough investigation on human exposure to downlink RF fields, as cellular systems deployed in mmW bands will entail (i) deployment of more transmitters due to smaller cell size and (ii) higher concentration of RF energy using a highly directional antenna. In this paper, we present human RF exposure levels in downlink of a Fifth Generation Wireless Systems (5G). Our results show that 5G downlink RF fields generate significantly higher power density (PD) and specific absorption rate (SAR) than a current cellular system. This paper also shows that SAR should also be taken into account for determining human RF exposure in the mmW downlink.

Open access paper: https://arxiv.org/abs/1711.03683

Note: Although this is not a peer-reviewed paper, this may be the first study to explore potential RF exposures under 5G.

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Intensity-time dependence dosing criterion in the EMF exposure guidelines in Russia

Rubtsova N, Paltsev Y, Perov S, Bogacheva E. Intensity-time dependence dosing criterion in the EMF exposure guidelines in Russia. Electromagn Biol Med. 2018;37(1):43-49. doi: 10.1080/15368378.2017.1414056. Epub 2018 Mar 1.

Abstract

Major approaches of the Russian Federation in setting of exposure guidelines to electromagnetic fields (EMF) in occupational and public environments are discussed in this paper. EMF exposure guidelines in Russia are based on the results of hygienic, clinical, physiological, epidemiological and experimental studies and are frequency-dependent. The concept of a threshold principle of occupational and environmental factors due to hazardous exposure effects has been used to set permissible exposure levels of different EMF frequency ranges. The data of experimental studies showed hazardous threshold levels of EMF effects. The main criteria of EMF hazardous exposure evaluated in the experimental study concerned both estimation of threshold levels of chronic (long-term) and acute exposure. Also, this paper contains some recent experimental study data on correlation of long-term radiofrequency and power-frequency EMF exposure effects with regard to time duration, the so-called time-dependence approach. It enables identification of the value of permissible EMF exposure levels depending on exposure duration. This approach is used in occupational exposure guideline setting and requires the introduction of "power exposition" (PE) and "maximal permissible level" (MPL). In general, EMF exposure guidelines are established with regard to possible duration of exposure per day.

https://www.ncbi.nlm.nih.gov/pubmed/29493302

Excerpts

Threshold hazardous effect, as mentioned above, is the EMF level that causes significant functional changes of body compensatory systems at the boundary of physiologically normal and abnormal state.

Today, the sphere of interests lies in radiofrequency exposure guideline standardization. Currently, the “dosing-time-dependence approach” is used for EMF frequency range from 30 kHz to 300 GHz. This approach specifies values of EMF-exposure permissible levels depending on exposure duration per work day which helps to provide more adequate evaluation of personnel exposure measurements such as “power exposition” (PE) and “maximal permissible level” (MPL), where MPL is the maximum exposure EMF level for very short time per work day (<10 minutes) (Table 1) (Ministry of Health of the Russian Federation, 2016). PE is calculated by multiplying the values of electric field or magnetic field by the square value of exposure duration per 8-hr work day, or by multiplying power density value and the value of exposure duration per work day.

An example of EMF Russian hygienic norms for cellular phones is 0.1 mW/cm2 (Rospotrebnadzor of the Russian Federation, 2003). The study directed to
EMF rating of cellular phones included examination of cardiovascular and nervous systems of cellular phone users before and after a short-term call of 30 min. The study was also meant to find out intensity-time

correlation of EMF biological effects with NMT and GSM systems that were studied at 450, 900 and 1800 MHz carrier frequencies with modulations. Also, comput ersimulation of EMF absorption in biological objects (rats) was performed.

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Mobile phone use during pregnancy with birth weight: Kumamoto of Japan Environment and Children's Study

Lu X, Oda M, Ohba T, Mitsubuchi H, Masuda S, Katoh T. Association of excessive mobile phone use during pregnancy with birth weight: an adjunct study in Kumamoto of Japan Environment and Children's Study. Environ Health Prev Med. 2017 Jun 8;22(1):52. doi: 10.1186/s12199-017-0656-1.

Abstract

BACKGROUND: Low birth weight has been shown to be closely associated with neonatal mortality and morbidity, inhibited growth, poor cognitive development, and chronic diseases later in life. Some studies have also shown that excessive mobile phone use in the postnatal period may lead to behavioral complications in the children during their growing years; however, the relationship between mobile phone use during pregnancy and neonatal birth weight is not clear. The aim of the present study was to determine the associations of excessive mobile phone use with neonatal birth weight and infant hea lth status.

METHODS: A sample of 461 mother and child pairs participated in a survey on maternal characteristics, infant characteristics, and maternal mobile phone usage information during pregnancy.

RESULTS: Our results showed that pregnant women tend to excessively use mobile phones in Japan. The mean infant birth weight was lower in the excessive use group than in the ordinary use group, and the frequency of infant emergency transport was significantly higher in the excessive use group than in the ordinary use group.

CONCLUSIONS: Excessive mobile phone use during pregnancy may be a risk factor for lower birth weight and a high rate of infant emergency transport.

Open access paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5664573/

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RF exposure assessment of baby surveillance devices in the frequency range 400 MHz-2.45 GHz

Vermeeren G, Joseph W, Martens L. Radiofrequency exposure assessment of baby surveillance devices in the frequency range 400 MHz-2.45 GHz. Bioelectromagnetics. 2018 Apr;39(3):244-248. doi: 10.1002/bem.22113.

No abstract

Excerpts

We investigated the exposure, in terms of both the peak spatial-averaged specific absorption rate (SAR) in 10 g of tissue and the time-averaged root-mean-squared (RMS) electric (E) field, induced by baby monitors

operating in a frequency range between 400 MHz and 2.45 GHz. We selected nine commercially available baby monitors ...

Considering all investigated devices, the peak spatial SAR in 10 g ranged from 0.09 to 0.37 W/kg, which is 22.3–5.4 times below the ICNIRP basic restriction.

In summary, we measured the induced time-averaged root-mean-square electric field strength and the peak spatial-averaged specific absorption rate from the baby unit of nine commercially available devices and compared both with the ICNIRP guidelines. The communication technologies implemented in the baby monitors were: PMR446, continuous transmission at 864 MHz, DECT, and communication in the ISM band at 2450 MHz. The electric field was measured at a distance of 50 cm from the baby unit of the baby monitor. We measured the SAR in a flat phantom filled with head tissue simulating liquid and the baby unit touching the flat phantom. The maximum time-averaged root-mean-square electric field value closest to the ICNIRP reference level over all investigated devices was 1.51 V/m (for modern-electronics DBS 3), which is 19.4 times below the ICNIRP reference level at 466 MHz. The peak spatial-averaged SAR in 10 g of tissue was 0.37 W/kg in head simulating tissue (for Alecto-DBX-82), which is 5.4 times below the basic restriction of 2 W/kg as specified by ICNIRP.

https://www.ncbi.nlm.nih.gov/pubmed/29492985

Note: The ICNIRP guidelines were designed to protect users only from short-term thermal effects.

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Heart rate variability affected by RF EMF in adolescent students

Misek J, Belyaev I, Jakusova V, Tonhajzerova I, Barabas J, Jakus J. Heart rate variability affected by radiofrequency electromagnetic field in adolescent students. Bioelectromagnetics. 2018 Feb 22. doi: 10.1002/bem.22115.

Abstract

This study examines the possible effect of radiofrequency (RF) electromagnetic fields (EMF) on the autonomic nervous system (ANS). The effect of RF EMF on ANS activity was studied by measuring heart rate variability (HRV) during ortho-clinostatic test (i.e., transition from lying to standing and back) in 46 healthy grammar school students. A 1788 MHz pulsed wave with intensity of 54 ± 1.6 V/m was applied intermittently for 18 min in each trial. Maximum specific absorption rate (SAR10) value was determined to 0.405 W/kg. We also measured the respiration rate and estimated a subjective perception of EMF exposure. RF exposure decreased heart rate of subjects in a lying position, while no such change was seen in standing students. After exposure while lying, a rise in high frequency band of HRV and root Mean Square of the Successive Differences was observed, which indicated an increase in parasympathetic nerve activity. Tympanic temperature and skin temperature were measured showing no heating under RF exposure. No RF effect on respiration rate was observed. None of the tested subjects were able to distinguish real exposure from sham exposure when queried at the end of the trial. In conclusion, short-term RF EMF exposure of students in a lying position during the ortho-clinostatic test affected ANS with significant increase in parasympathetic nerve activity compared to sham exposed group.

https://www.ncbi.nlm.nih.gov/pubmed/29469164

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Estimates of Environmental Exposure to RF EMF and Risk of Lymphoma Subtypes

G. Satta, N. Mascia, T. Serra, A. Salis, L. Saba, S. Sanna, M. G. Zucca, E. Angelucci, A. Gabbas, F. Culurgioni, P. Pili, E. Mura, M. Cappai, M. G. Ennas, and P. Cocco (2018) Estimates of Environmental Exposure to Radiofrequency Electromagnetic Fields and Risk of Lymphoma Subtypes. Radiation Research In-Press. https://doi.org/10.1667/RR14952.1

We investigated the association between environmental exposure to radiofrequency electromagnetic fields (RF-EMF) and risk of lymphoma subtypes in a case-control study comprised of 322 patients and 444 individuals serving as controls in Sardinia, Italy in 1998–2004. Questionnaire information included the self-reported distance of the three longest held residential addresses from fixed radio-television transmitters and mobile phone base stations. We georeferenced the residential addresses of all study subjects and obtained the spatial coordinates of mobile phone base stations. For each address within a 500-meter radius from a mobile phone base station, we estimated the RF-EMF intensity using predictions from spatial models, and we performed RF-EMF measurements at the door in the subset of the longest held addresses within a 250-meter radius. We calculated risk of lymphoma and its major subtypes associated with the RF-EMF exposure metrics with unconditional logistic regression, adjusting by age, gender and years of education. In the analysis of self-reported data, risk associated with residence in proximity (within 50 meters) to fixed radio-television transmitters was likewise elevated for lymphoma overall [odds ratio = 2.7, 95% confidence interval = 1.5–4.6], and for the major lymphoma subtypes. With reference to mobile phone base stations, we did not observe an association with either the self-reported, or the geocoded distance from mobile phone base stations. RF-EMF measurements did not vary by case-control status. By comparing the self-reports to the geocoded data, we discovered that the cases tended to underestimate the distance from mobile phone base stations differentially from the controls (P = 0.073). The interpretation of our findings is compromised by the limited study size, particularly in the analysis of the individual lymphoma subtypes, and the unavailability of the spatial coordinates of radio-television transmitters. Nonetheless, our results do not support the hypothesis of a link between environmental exposure to RF-EMF from mobile phone base stations and risk of lymphoma subtypes.

https://www.ncbi.nlm.nih.gov/pubmed/29547352

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Analysis of ear side of mobile phone use in the general population of Japan

Sato Y, Kojimahara N, Taki M, Yamaguchi N. Analysis of ear side of mobile phone use in the general population of Japan.Bioelectromagnetics. 2018 Jan;39(1):53-59. doi: 10.1002/bem.22098.

Abstract

This study aimed to clarify the distribution of the ear side of mobile phone use in the general population of Japan and clarify what factors are associated with the ear side of mobile phone use. Children at elementary and junior high schools (n = 2,518) and adults aged ≥20 years (n = 1,529) completed an Internet-based survey. Data were subjected to a logistic regression analysis. In children, due to the tendency to use the dominant hand, we analyzed the factors associated with the use of right ear in right-handed people. Statistically significant differences were observed only in talk time per call (odds ratio (OR) = 2.17; 95% confidence interval

(CI): 1.22-3.99). In adults, due to the tendency to use the left ear, we analyzed factors associated with the use of left ear in right-handed people. Significant differences were observed in those aged 30-39 years (OR = 2.55; 95% CI: 1.79-3.68), those aged 40-49 years (OR = 3.08; 95% CI: 2.15-4.43), those aged >50 years (OR = 1.85; 95% CI: 1.20-2.85), and in those with a percentage of total talk time when using mobile phones at work of 51-100% (OR = 1.75; 95% CI: 1.21-2.55). We believe that future epidemiological studies on mobile phone use can be improved by considering the trends in mobile phone use identified in this study

https://www.ncbi.nlm.nih.gov/pubmed/29171064

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Mathematical Structure for EMF that May Reflect Pilot Waves of Bohm's Implicate Order

Geesink, H.J.H. and Meijer, D.K.F. Mathematical Structure for Electromagnetic Frequencies that May Reflect Pilot Waves of Bohm's Implicate Order. Journal of Modern Physics, 9, 851-897. 2018.

Abstract

The mathematical basis for the earlier reported spectrum of discrete electromagnetic field (EMF) frequencies that were shown to affect health and disease is substantiated and generalized in the present paper. The particular EMF pattern was revealed by a meta-analysis of, now, more than 500 biomedical publications that reported life-sustaining as well as life-decaying EMF frequencies. These discrete eigenfrequency values can be related to supposed bio-resonance of solitons or polaron quasi particles in life systems. Bio-solitons are conceived as self-reinforcing solitary waves that are constituting local fields, being involved in intracellular geometric ordering and patterning, as well as in intra- and inter-cellular signalling. Literature search, revealed very similar frequency patterns for wave resonances of nucleotides in aqueous so-lution, for a candidate RNA-catalyst, as well as for sound-induced vibrations evoked in thin vibrating membranes. This collective evidence points at a gen-eralized biophysical algorithm underlying complexity in nature, evidently manifest in both animate and non-animate modalities. The detected EMF eigenfrequencies could be arithmetically scaled according to an adapted Pythagorean tuning. The mathematical analysis shows that the derived arithmetical scale exhibits a sequence of unique products of integer powers of 2, 3 and a factor 2. This generalized semi-harmonic frequency spectrum may reflect a discrete pilot-wave structure that can be interpreted as a, so called, hidden variable in Bohm's causal interpretation of quantum field theory.

https://doi.org/10.4236/jmp.2018.95055

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RF EMR and Memory Performance: Sources of Uncertainty in Epidemiological Cohort Studies

Brzozek C, Benke KK, Zeleke BM, Abramson MJ, Benke G.Radiofrequency Electromagnetic Radiation and Memory Performance: Sources of Uncertainty in Epidemiological Cohort Studies. Int J Environ Res Public Health. 2018 Mar 26;15(4). pii: E592. doi: 10.3390/ijerph15040592.

Abstract

Uncertainty in experimental studies of exposure to radiation from mobile phones has in the past only been

framed within the context of statistical variability. It is now becoming more apparent to researchers that epistemic or reducible uncertainties can also affect the total error in results. These uncertainties are derived from a wide range of sources including human error, such as data transcription, model structure, measurement and linguistic errors in communication. The issue of epistemic uncertainty is reviewed and interpreted in the context of the MoRPhEUS, ExPOSURE and HERMES cohort studies which investigate the effect of radiofrequency electromagnetic radiation from mobile phones on memory performance. Research into this field has found inconsistent results due to limitations from a range of epistemic sources. Potential analytic approaches are suggested based on quantification of epistemic error using Monte Carlo simulation. It is recommended that future studies investigating the relationship between radiofrequency electromagnetic radiation and memory performance pay more attention to treatment of epistemic uncertainties as well as further research into improving exposure assessment. Use of directed acyclic graphs is also encouraged to display the assumed covariate relationship.

Open access paper: http://www.mdpi.com/1660-4601/15/4/592/htm

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Mobile phone specific EMF induce transient DNA damage and nucleotide excision repair in serum-deprived human glioblastoma cells

Halh Al-Serori, Franziska Ferk, Michael Kundi, Andrea Bileck, Christopher Gerner, Miroslav Mišík, Armen Nersesyan, Monika Waldherr, Manuel Murbach, Tamara T. Lah, Christel Herold-Mende, Andrew R. Collins, Siegfried Knasmülle. Mobile phone specific electromagnetic fields induce transient DNA damage and nucleotide excision repair in serum-deprived human glioblastoma cells. PLOS One. April 12, 2018. https://doi.org/10.1371/journal.pone.0193677

Abstract

Some epidemiological studies indicate that the use of mobile phones causes cancer in humans (in particular glioblastomas). It is known that DNA damage plays a key role in malignant transformation; therefore, we investigated the impact of the UMTS signal which is widely used in mobile telecommunications, on DNA stability in ten different human cell lines (six brain derived cell lines, lymphocytes, fibroblasts, liver and buccal tissue derived cells) under conditions relevant for users (SAR 0.25 to 1.00 W/kg). We found no evidence for induction of damage in single cell gel electrophoresis assays when the cells were cultivated with serum. However, clear positive effects were seen in a p53 proficient glioblastoma line (U87) when the cells were grown under serum free conditions, while no effects were found in p53 deficient glioblastoma cells (U251). Further experiments showed that the damage disappears rapidly in U87 and that exposure induced nucleotide excision repair (NER) and does not cause double strand breaks (DSBs). The observation of NER induction is supported by results of a proteome analysis indicating that several proteins involved in NER are up-regulated after exposure to UMTS; additionally, we found limited evidence for the activation of the γ-interferon pathway. The present findings show that the signal causes transient genetic instability in glioma derived cells and activates cellular defense systems.

Open access paper: http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0193677#sec027

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Effect of electromagnetic waves from mobile phones on spermatogenesis in the era of 4G-LTE

Oh JJ, Byun S, Lee SE, Choe G, Hong SK. Effect of electromagnetic waves from mobile phones on spermatogenesis in the era of 4G-LTE. BioMed Research International. Vol 2018 (2018), Article ID 1801798.

Abstract

Objective. To investigate the effect of long duration exposure to electromagnetic field from mobile phones on spermatogenesis in rats using 4G-LTE.

Methods. Twenty Sprague-Dawley male rats were placed into 4 groups according to the intensity and exposure duration: Group 1 (sham procedure), Group 2 (3 cm distance + 6 h exposure daily), Group 3 (10 cm distance + 18 h exposure daily), and Group 4 (3 cm distance + 18 h exposure daily). After 1 month, we compared sperm parameters and histopathological findings of the testis.

Results.The mean spermatid count (×106/ml) was 398.6 in Group 1, 365.40 in Group 2, 354.60 in Group 3, and 298.60in Group 4 (p = 0.041). In the second review, the mean count of spermatogonia in Group 4 (43.00) was significantly lower than in Group 1 (57.00) and Group 2 (53.40) (p < 0.001 and p = 0.010, resp.). The sum of the germ cell counts was decreased in Group 4 compared to Groups 1, 2, and 3 (p = 0.032). The mean Leydig cell count was significantly decreased in Group 4 (p < 0.001).

Conclusions.The longer exposure duration of electromagnetic field decreased the spermatogenesis. Our findings warrant further investigations on the potential effects of EMF from mobile phones on male fertility.

https://www.hindawi.com/journals/bmri/2018/1801798/

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1800 MHz mobile phone radiation induced oxidative and nitrosative stress leads to p53 dependent Bax mediated testicular apoptosis in mice

Shahin S, Singh SP, Chaturvedi CM. 1800 MHz mobile phone irradiation induced oxidative and nitrosative stress leads to p53 dependent Bax mediated testicular apoptosis in mice, Mus musculus. J Cell Physiol. 2018 Apr 10. doi: 10.1002/jcp.26558.

Abstract

Present study was carried out to investigate the effect of long-term mobile phone radiation exposure in different operative modes (Dialing, Receiving, and Stand-by) on immature male mice. Three-week old male mice were exposed to mobile phone (1800 MHz) radiation for 3 hr/day for 120 days in different operative modes. To check the changes/alteration in testicular histoarchitecture and serum testosterone level, HE staining and ELISA was performed respectively. Further, we have checked the redox status (ROS, NO, MDA level, and antioxidant enzymes: SOD, CAT, and GPx) by biochemical estimation, alteration in the expression of pro-apoptotic proteins (p53 and Bax), active executioner caspase-3, full length/uncleaved PARP-1 (DNA repair enzyme), anti-apoptotic proteins (Bcl-2 and Bcl-xL) in testes by immunofluorescence and cytosolic cytochrome-c by Western blot. Decreased seminiferous tubule diameter, sperm count, and viability along with increased germ cells apoptosis and decreased serum testosterone level, was observed in the testes of all the mobile phone

exposed mice compared with control. We also observed that, mobile phone radiation exposure in all the three different operative modes alters the testicular redox status via increasing ROS, NO, and MDA level, and decreasing antioxidant enzymes levels leading to enhanced apoptosis of testicular cells by increasing the expression of pro-apoptotic and apoptotic proteins along with decreasing the expression of anti-apoptotic protein. On the basis of results, it is concluded that long-term mobile phone radiation exposure induced oxidative stress leads to apoptosis of testicular cells and thus impairs testicular function.

https://www.ncbi.nlm.nih.gov/pubmed/29637556

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Oxidative stress and an animal neurotransmitter synthesizing enzyme in the leaves of wild growing myrtle after exposure to GSM radiation

Stefi AL, Copoulou DV, Margaritis LH, Christodoulakis NS. Oxidative stress and an animal neurotransmitter synthesizing enzyme in the leaves of wild growing myrtle after exposure to GSM radiation. Flora. Available online 16 April 2018. https://doi.org/10.1016/j.flora.2018.04.006

Highlights

• Mature myrtle plants were exposed to GSM radiation for 30 min, at 48 h intervals, for 50 days.
• Secondary metabolite accumulation was observed in the exposed leaves.
• Photosynthetic pigment content decreased in the exposed leaves.
• The oxidative stress (ROS) increased in the exposed leaves.
• Significant rise of the DDC level was recorded only in the exposed leaves.

Abstract

Mobile phones turned to be the most common form of public communication. Therefore, life on our planet continues wrapped in a “cloud” of non-ionizing radiations. Myrtus communis L. is an evergreen shrub, common in Mediterranean formations, exposed and adapted to two seasonally separated and qualitatively different environmental stresses. Thus, we considered it important to investigate the response of this tolerant species to emitted GSM non-ionizing radiations and compare it to already available data from thoroughly investigated plant species. Although the leaves of the exposed plants present unaffected tissue arrangement, their mesophyll cells accumulate large amounts of secondary metabolites, their photosynthetic pigments are dramatically reduced, the ROS counted are significantly increased and the presence of DDC, which cannot be detected in the leaves of the control plants, is recorded in high levels. The exposed leaves seem to experience a severe oxidative stress which probably induces DDC expression and the biosynthesis of the neurotransmitter dopamine, the activation of the shikimate pathway and, eventually, the accumulation of secondary metabolites.

https://www.sciencedirect.com/science/article/pii/S0367253018301208

Extremely Low Frequency Fields

Evaluating ELF magnetic fields in the rear seats of electric vehicles

Lin J, Lu M, Wu T, Yang L, Wu T. Evaluating extremely low frequency magnetic fields in the rear seats of the

electric vehicles. Radiat Prot Dosimetry. 2018 Mar 23. doi: 10.1093/rpd/ncy048.

Abstract

In the electric vehicles (EVs), children can sit on a safety seat installed in the rear seats. Owing to their smaller physical dimensions, their heads, generally, are closer to the underfloor electrical systems where the magnetic field (MF) exposure is the greatest. In this study, the magnetic flux density (B) was measured in the rear seats of 10 different EVs, for different driving sessions. We used the measurement results from different heights corresponding to the locations of the heads of an adult and an infant to calculate the induced electric field (E-field) strength using anatomical human models. The results revealed that measured B fields in the rear seats were far below the reference levels by the International Commission on Non-Ionizing Radiation Protection. Although small children may be exposed to higher MF strength, induced E-field strengths were much lower than that of adults due to their particular physical dimensions.

https://www.ncbi.nlm.nih.gov/pubmed/29584925

Excerpts

Small children and infants sitting in a safety seat at the rear part of the vehicle is a common occurrence. Children have smaller physical dimensions and, thus, their heads are generally much closer to the car floor, where the MF strength has been reported to be higher due to tire magnetization and the operation of the underfloor electrical systems (6, 7). The matter of children being potentially subject to greater magnetic field exposure may be relevant as leukemia is the most common type of childhood cancer (8). In particular, Ahlbom et al. (9) and Greenland et al. (10) indicated that the exposure to 50 and 60 Hz MF exceeding 0.3–0.4 μT may result in an increased risk for childhood leukemia although a satisfactory causal relationship has not yet been reliably demonstrated. Also, it was reported that a combination of weak, steady and alternating MF could modify the radical concentration, which had the potential to lead to biologically significant changes (11).

... the *B* field values measured at location #4 (floor in from of rear seat) were the highest, followed by values from location #3 (rear seat cushion), #2 (child's head position) and #1 (adult's head position) ($p < 0.012$, $\alpha = 0.05/3 = 0.017$). There was a significant difference between the driving scenarios ($F(3, 117) = 3.72$, $p = 0.013$). The acceleration and deceleration scenarios generated higher *B* fields compared with the stationary and the 40 km/h driving scenarios ($p < 0.01$, $\alpha = 0.05/3 = 0.017$) while no difference was identified between acceleration and deceleration ($p = 0.16$).

... The results demonstrate that the induced *E*-field strength was lower for the infant model compared with that of the adult in terms of both the head and body as a whole.

The infant was reported to have higher electrical conductivity [29] but there was no database dedicated to the infant. Furthermore, below 1 MHz, the database was hard to be measured and the uncertainty was large [30]. Therefore, we would not include the issue in the study.

Although several SCs on higher frequencies have been observed (can spread to 1.24 kHz), the spectral analysis revealed that the SCs concentrated on bands below 1000 Hz. The EVs under test used aluminum alloy wheel rims, which have low magnetic permeability. However, the steel wire in the reinforcing belts of radial tires pick up magnetic fields from the terrestrial MF. When the tires spin, the magnetized steel wire in the reinforcing belts generates ELF MF usually below 20 Hz, that can exceed 2.0 μT at seat level in the passenger compartment[6]. The measurement did not identify the ELF MF by different sources because the purpose of the study was to investigate the realistic exposure scenario for the occupants. To note, degaussing the tires or

using the fiberglass belted tires can eliminate this effect and provide the MF results solely introduced by the operation of the electrified system.

ICNIRP proposed guidelines to evaluate the compliance of the non-sinusoidal signal exposure[3]. The measurements rendered the maximal *B* field at the level of one-tenth to several μT, far below the reference level of the guidelines (e.g. 200 μT for 20–400 Hz). The similar non-sinusoidal MF signal magnitudes can only account for 6–10% of the reference levels according to the previous reports[32]. However, as noted in the Introduction, '… 50 and 60 Hz MF exceeding 0.3–0.4 μT may result in an increased risk for childhood leukemia'. Therefore, it is necessary to measure the MF in the EVs to limit the exposure and for the purpose of epidemiological studies.

In this study, we measured ELF MF in the rear seats of ten types of EVs. The measurements were performed for four different driving scenarios. The measurement results were analyzed to determine the worst-case scenario and those values were used for simulations. We made numerical simulations to compare the induced E-field strength due to the physical difference between children and adults using detailed anatomical models. The results support the contention that the MF in the EVs that we tested was far below the reference levels of the ICNIRP guidelines. Furthermore, our findings show that children would not be more highly exposed compared to adults when taking into consideration of their physical differences. However, the measurement results indicated that further studies should be performed to elucidate the concerns on the incidence of the childhood leukemia for infant and child occupants.

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Occupational ELF-MF exposure and hematolymphopoietic cancers - Swiss National Cohort analysis and updated meta-analysis

Huss A, Spoerri A, Egger M, Kromhout H, Vermeulen R; Swiss National Cohort. Occupational extremely low frequency magnetic fields (ELF-MF) exposure and hematolymphopoietic cancers - Swiss National Cohort analysis and updated meta-analysis. Environ Res. 2018 Mar 24;164:467-474. doi: 10.1016/j.envres.2018.03.022.

Highlights

• ELF-MF exposure may affect specific hematolymphopoietic malignancies rather than "all leukaemia".
• We evaluated effects of occupational ELF-MF exposure on different types of hematolymphopoietic malignancies.
• We observed increased risks of AML if workers were exposed to higher levels and for a longer period of time.
• Risks were in line with meta-analysed findings of previous studies.

Abstract

PURPOSE: Previous studies have examined risks of leukaemia and selected lymphoid malignancies in workers exposed to extremely low frequency magnetic fields (ELF-MF). Most studies evaluated hematolymphopoietic malignancies as a combined category, but some analyses suggested that effects may be contained to some specific leukaemia or lymphoma subtypes, with inconsistent results.

METHODS: We examined exposure to ELF-MF and mortality 1990-2008 from different types of hematolymphopoietic cancers in the Swiss National Cohort, using a job exposure matrix for occupations recorded at censuses 1990 and 2000. We analysed 3.1 million workers exposed at different levels to ELF-MF:

ever-high, only-medium, only-low exposure using Cox proportional hazard models. We evaluated risk of death from acute myeloid leukaemia (AML), chronic myeloid leukaemia, lymphoid leukaemia, diffuse large B-cell lymphomas, follicular lymphoma, Waldenström's macroglobulinemia, multiple myeloma and Hodgkin lymphoma.

RESULTS: Mortality from hematolymphopoietic cancers was not associated with exposure to ELF-MF with the exception of an increase in ever-high exposed men of myeloid leukaemias (HR 1.31, 95% CI 1.02-1.67), and AML (HR 1.26, 95%CI 0.93-1.70). If workers had been high exposed during their vocational training and at both censuses, these HR increased to 2.24 (95%CI 0.91-5.53) and 2.75 (95%CI 1.11-6.83), respectively.

CONCLUSIONS:Our analysis provided no convincing evidence for an increased risk of death from a range of hematolymphopoietic cancers in workers exposed to high or medium levels of ELF magnetic fields. However, we observed an increased risk of acute myeloid leukaemia in workers exposed to high levels for a longer duration. Observed risks are in line with meta-analysed previous reports on ELF-MF exposure and AML risk, with a summary relative risk of 1.21 (95%CI 1.08-1.37).

https://www.ncbi.nlm.nih.gov/pubmed/29587222

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Residential mobility and childhood leukemia

Amoon AT, Oksuzyan S, Crespi CM, Arah OA, Cockburn M, Vergara X, Kheifets L. Residential mobility and childhood leukemia. Environ Res. 2018 Mar 22;164:459-466. doi: 10.1016/j.envres.2018.03.016.

Highlights

• Children who moved were older, had younger mothers, and lower SES.
• Non-movers showed stronger associations with EMF exposures and childhood leukemia.
• Adjustment for variables predicting mobility, save dwelling, did not alter results.
• Mobility does not appear to explain observed links between EMF and leukemia.

Abstract

AIMS: Studies of environmental exposures and childhood leukemia studies do not usually account for residential mobility. Yet, in addition to being a potential risk factor, mobility can induce selection bias, confounding, or measurement error in such studies. Using data collected for California Powerline Study (CAPS), we attempt to disentangle the effect of mobility.

METHODS: We analyzed data from a population-based case-control study of childhood leukemia using cases who were born in California and diagnosed between 1988 and 2008 and birth certificate controls. We used stratified logistic regression, case-only analysis, and propensity-score adjustments to assess predictors of residential mobility between birth and diagnosis, and account for potential confounding due to residential mobility.

RESULTS: Children who moved tended to be older, lived in housing other than single-family homes, had younger mothers and fewer siblings, and were of lower socioeconomic status. Odds ratios for leukemia among

non-movers living <50 meters (m) from a 200+ kilovolt line (OR: 1.62; 95% CI: 0.72-3.65) and for calculated fields ≥ 0.4 microTesla (OR: 1.71; 95% CI: 0.65-4.52) were slightly higher than previously reported overall results. Adjustments for propensity scores based on all variables predictive of mobility, including dwelling type, increased odds ratios for leukemia to 2.61 (95% CI: 1.76-3.86) for living < 50 m from a 200 + kilovolt line and to 1.98 (1.11-3.52) for calculated fields. Individual or propensity-score adjustments for all variables, except dwelling type, did not materially change the estimates of power line exposures on childhood leukemia.

CONCLUSION: The residential mobility of childhood leukemia cases varied by several sociodemographic characteristics, but not by the distance to the nearest power line or calculated magnetic fields. Mobility appears to be an unlikely explanation for the associations observed between power lines exposure and childhood leukemia.

Funding: This work was supported by the Electric Power Research Institute. Crespi was also partially supported by the National Cancer Institute at the National Institutes of Health (grant P30 CA16042). Vergara is an employee of the Electric Power Research Institute.

https://www.ncbi.nlm.nih.gov/pubmed/29574256

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Reactive oxygen species mediates 50-Hz magnetic field-induced EGF receptor clustering via acid sphingomyelinase activation

Sun L, Chen L, Bai L, Xia Y, Yang X, Jiang W, Sun W. Reactive oxygen species mediates 50-Hz magnetic field-induced EGF receptor clustering via acid sphingomyelinase activation. Int J Radiat Biol. 2018 Apr 16:1-19. doi: 10.1080/09553002.2018.1466208.

Abstract

PURPOSE: Exposure to extremely low frequency electromagnetic fields (ELF-MFs) could elicit biological effects including carcinogenesis. However, the detailed mechanisms by which these ELF-MFs interact with biological system are currently unclear. Previously, we found that a 50-Hz magnetic field (MF) exposure could induce epidermal growth factor receptor (EGFR) clustering and phosphorylation on cell membranes. In the present experiment, the possible roles of reactive oxygen species (ROS) in MF-induced EGFR clustering were investigated.

MATERIALS AND METHODS: Human amnion epithelial (FL) cells were exposed to a 50-Hz MF with or without N-acetyl-L-cysteine (NAC) or pyrrolidine dithiocarbamate (PDTC). EGFR clustering on cellular membrane surface was analyzed using confocal microscopy after indirect immunofluorescence staining. The intracellular ROS level and acid sphingomyelinase (ASMase) activity were detected using a reactive oxygen species assay kit and an Amplex® Red Sphingomyelinase Assay Kit, respectively.

RESULTS: Results showed that exposure of FL cells to a 50-Hz MF at 0.4 mT for 15 min significantly enhanced the ROS level, induced EGFR clustering and increased ASMase activity. However, pretreatment with NAC or PDTC, the scavenger of ROS, not only counteracted the effects of a 50-Hz MF on ROS level and AMS activity, but also inhibited the EGFR clustering induced by MF exposure.

CONCLUSION: Based on present and previous data, it suggests that ROS mediates the MF-induced EGFR clustering via ASMase activation.

https://www.ncbi.nlm.nih.gov/pubmed/29659325

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Final results regarding brain & heart tumors in rats exposed from prenatal life until natural death to mobile phone RF (1.8 GHz GSM base station environmental emission)

Falcioni et al (2018). Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission. Environmental Research. 2018 Mar 7. pii: S0013-9351(18)30036-7. doi: 10.1016/j.envres.2018.01.037.

Abstract

Background: In 2011, IARC classified radiofrequency radiation (RFR) as possible human carcinogen (Group 2B). According to IARC, animals studies, as well as epidemiological ones, showed limited evidence of carcinogenicity. In 2016, the NTP published the first results of its long-term bioassays on near field RFR, reporting increased incidence of malignant glial tumors of the brain and heart Schwannoma in rats exposed to GSM – and CDMA –modulated cell phone RFR. The tumors observed in the NTP study are of the type similar to the ones observed in some epidemiological studies of cell phone users.

Objectives: The Ramazzini Institute (RI) performed a life-span carcinogenic study on Sprague-Dawley rats to evaluate the carcinogenic effects of RFR in the situation of far field, reproducing the environmental exposure to RFR generated by 1.8 GHz GSM antenna of the radio base stations of mobile phone. This is the largest long-term study ever performed in rats on the health effects of RFR, including 2448 animals. In this article, we reported the final results regarding brain and heart tumors.

Methods: Male and female Sprague-Dawley rats were exposed from prenatal life until natural death to a 1.8 GHz GSM far field of 0, 5, 25, 50 V/m with a whole-body exposure for 19 h/day.

Results: A statistically significant increase in the incidence of heart Schwannomas was observed in treated male rats at the highest dose (50 V/m). Furthermore, an increase in the incidence of heart Schwann cells hyperplasia was observed in treated male and female rats at the highest dose (50 V/m), although this was not statistically significant. An increase in the incidence of malignant glial tumors was observed in treated female rats at the highest dose (50 V/m), although not statistically significant.

Conclusions: The RI findings on far field exposure to RFR are consistent with and reinforce the results of the NTP study on near field exposure, as both reported an increase in the incidence of tumors of the brain and heart in RFR-exposed Sprague-Dawley rats. These tumors are of the same histotype of those observed in some epidemiological studies on cell phone users. These experimental studies provide sufficient evidence to call for the reevaluation of IARC conclusions regarding the carcinogenic potential of RFR in humans.

Among male rats, the incidence of heart schwannoma and hyperplasia was 0.7% (3 of 412) in the control group, 1.2% (5/401) in the 5 volts/meter (V/m) group, 1.0% (2/209) in the 25 V/m group, and 3.9% (8/207) in the 50 V/m group. The 50 V/m group had significantly greater incidence than the control group ($p < .02$).

Among male rats, the incidence of glioma and glial cell hyperplasia in the control group was 0.0% (0 of 412), 0.7% (3/401) in the 5 volts/meter (V/m) group, 1.4% (3/209) in the 25 V/m group, and 0.0% (0/207) in the 50 V/m group.

https://www.ncbi.nlm.nih.gov/pubmed/29530389

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Brain tumors: rise in Glioblastoma incidence in England 1995–2015 suggests adverse environmental or lifestyle factor

Alasdair Philips, Denis L. Henshaw, Graham Lamburn, and Michael O'Carroll. Brain tumours: rise in Glioblastoma Multiforme incidence in England 1995–2015 suggests an adverse environmental or lifestyle factor. Journal of Environmental and Public Health, in press.

Highlights

• A clear description of the changing pattern in incidence of brain tumour types
• The study used extensive data from an official and recognised quality source
• The study included histological and morphological information
• The study identified a significant and concerning incidence time trend
• Some evidence is provided to help guide future research into causal mechanisms

Abstract

Objective To investigate detailed trends in malignant brain tumour incidence over a recent time period.

Methods UK Office of National Statistics (ONS) data covering 81,135 ICD10 C71 brain tumours diagnosed in England (1995–2015) were used to calculate incidence rates (ASR) per 100k person–years, age–standardised to the European Standard Population (ESP–2013).

Results We report a sustained and highly statistically significant ASR rise in glioblastoma multiforme (GBM) across all ages. The ASR for GBM more than doubled from 2.4 to 5.0, with annual case numbers rising from 983 to 2531. Overall, this rise is mostly hidden in the overall data by a reduced incidence of lower grade tumours.

Conclusions The rise is of importance for clinical resources and brain tumour aetiology. The rise cannot be fully accounted for by promotion of lower–grade tumours, random chance or improvement in diagnostic techniques as it affects specific areas of the brain and only one type of brain tumour. Despite the large variation in case numbers by age, the percentage rise is similar across the age groups which suggests widespread environmental or lifestyle factors may be responsible.

http://downloads.hindawi.com/journals/jeph/aip/7910754.pdf

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Wi-Fi is an important threat to human health

Pall M.L. Wi-Fi is an important threat to human health. Environmental Research. 164:405-416. 2018.

Abstract

Repeated Wi-Fi studies show that Wi-Fi causes oxidative stress, sperm/testicular damage, neuropsychiatric effects including EEG changes, apoptosis, cellular DNA damage, endocrine changes, and calcium overload. Each of these effects are also caused by exposures to other microwave frequency EMFs, with each such effect being documented in from 10 to 16 reviews. Therefore, each of these seven EMF effects are established effects of Wi-Fi and of other microwave frequency EMFs. Each of these seven is also produced by downstream effects of the main action of such EMFs, voltage-gated calcium channel (VGCC) activation. While VGCC activation via EMF interaction with the VGCC voltage sensor seems to be the predominant mechanism

of action of EMFs, other mechanisms appear to have minor roles. Minor roles include activation of other voltage-gated ion channels, calcium cyclotron resonance and the geomagnetic magnetoreception mechanism.

Five properties of non-thermal EMF effects are discussed. These are that pulsed EMFs are, in most cases, more active than are non-pulsed EMFs; artificial EMFs are polarized and such polarized EMFs are much more active than non-polarized EMFs; dose-response curves are non-linear and non-monotone; EMF effects are often cumulative; and EMFs may impact young people more than adults.

These general findings and data presented earlier on Wi-Fi effects were used to assess the Foster and Moulder (F&M) review of Wi-Fi. The F&M study claimed that there were seven important studies of Wi-Fi that each showed no effect. However, none of these were Wi-Fi studies, with each differing from genuine Wi-Fi in three distinct ways. F&M could, at most conclude that there was no statistically significant evidence of an effect. The tiny numbers studied in each of these seven F&M-linked studies show that each of them lack power to make any substantive conclusions.

In conclusion, there are seven repeatedly found Wi-Fi effects which have also been shown to be caused by other similar EMF exposures. Each of the seven should be considered, therefore, as established effects of Wi-Fi.

https://doi.org/10.1016/j.envres.2018.01.035

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Favorable and Unfavorable EMF Frequency Patterns in Cancer: Perspectives for Improved Therapy and Prevention

Meijer DKF, Geesink HJH. Favourable and Unfavourable EMF Frequency Patterns in Cancer: Perspectives for Improved Therapy and Prevention. Journal Cancer Therapy. 9(3):188-230. 2018.

Carcinogenesis fits in a frequency pattern of electromagnetic field (EMF) waves, in which a gradual loss of cellular organization occurs. Such generation of cancer features can be inhibited by adequate exposure to coherent electromagnetic frequencies. However, cancer can also be initiated and promoted at other distinct frequencies of electromagnetic waves. Both observations were revealed by analyzing 100 different EMF frequency data reported in a meta-analyses of 123 different, earlier published, biomedical studies. The studied EM frequencies showed a fractal pattern of 12 beneficial (anti-cancer) frequencies, and 12 detrimental (cancer promoting) frequencies, that form the central pattern of a much wider self-similar EMF spectrum of cancer inhibiting or promoting activities. Inhibiting of the cancer process, and even curing of the disease, can thus be considered through exposure to the coherent type of EM fields. Stabilization of the disease can be understood by constructive resonance of macromolecules in the cancer cell with the externally appied coherent EMF field frequencies, called solitons/polarons. The latter, for instance, have been shown earlier to induce repair in DNA/RNA conformation and/or epigenetic changes. The field of EMF treatment of cancer disorders is rapidly expanding and our studies may invite further experimental and clinical studies in which systematically various potential EMF treatment protocols could be applied, with combined and modulated frequencies, to obtain even more efficient EMF anti-cancer therapies.

Open access paper: http://www.scirp.org/journal/PaperInformation.aspx?paperID=82944

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Fatal collision? Are wireless headsets a risk in treating patients?

Cindy Sage & Lennart Hardell (2018): Fatal collision? Are wireless headsets a risk in treating patients?, Electromagnetic Biology and Medicine. Published online Feb 5, 2018. DOI: 10.1080/15368378.2017.1422261

Abstract

Wireless-enabled headsets that connect to the internet can provide remote transcribing of patient examination notes. Audio and video can be captured and transmitted by wireless signals sent from the computer screen in the frame of the glasses. But using wireless glass-type devices can expose the user to a specific absorption rates (SAR) of 1.11–1.46 W/kg of radiofrequency radiation. That RF intensity is as high as or higher than RF emissions of some cell phones. Prolonged use of cell phones used ipsilaterally at the head has been associated with statistically significant increased risk of glioma and acoustic neuroma. Using wireless glasses for extended periods to teach, to perform surgery, or conduct patient exams will expose the medical professional to similar RF exposures which may impair brain performance, cognition and judgment, concentration and attention and increase the risk for brain tumors. The quality of medical care may be compromised by extended use of wireless-embedded devices in health care settings. Both medical professionals and their patients should know the risks of such devices and have a choice about allowing their use during patient exams. Transmission of sensitive patient data over wireless networks may increase the risk of hacking and security breaches leading to losses of private patient medical and financial data that are strictly protected under HIPPA health information privacy laws

http://www.tandfonline.com/doi/full/10.1080/15368378.2017.1422261

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Meeting the imperative to accelerate environmental bioelectromagnetics research

McKee L. Meeting the imperative to accelerate environmental bioelectromagnetics research. Environ Res. 2018 Feb 23;164:100-108. doi: 10.1016/j.envres.2018.01.036

Highlights

Concerns mount about adverse health effects of low-level radiofrequency (RF) radiation.
Bioelectronics and environmental RF effects research both need an omics platform.
Standard bioelectromagnetic data models would advance dosimetry and omics work.
Steps toward developing standards and a shared research platform are proposed.

Abstract

In this article, the author draws on his experience in the world of geospatial information technology standards to suggest a path toward acceleration of bioelectromagnetics science. Many studies show biological effects of extremely low frequency (ELF) and radiofrequency (RF) radiation despite that fact that the radiation is too weak to cause temperature changes in biological features. Considered together in worst case scenarios, such effects, many of which appear to have long latencies, could have potentially disastrous consequences for the health and safety of humans and wildlife. Other studies show no such effects, and in both cases, often there are significant research quality deficits that make it difficult to draw firm conclusions from the data. The progress of bioelectromagnetics science is retarded by a lack of standard data models and experimental protocols that could improve the overall quality of research and make it easier for researchers to benefit from omics-related bioinformatics resources. "Certainty of safety" of wireless devices used in digital communications and remote sensing (radar) is impossible without dosimetry standards that reflect the effects of non-thermal exposures. Electrical signaling in biological systems, a poorly funded research domain, is as biologically important as chemical signaling, a richly funded research domain, and these two types of signaling are inextricably connected. Entreprenuerial scientists pursuing bioelectronic innovations have begun to attract new funding. With appropriate institutional coordination, this new funding could equally benefit those investigating environmental effects of ELF and RF radiation. The author proposes a concerted effort among both bioelectronics technology stakeholders and environmental bioelectromagnetics science researchers to collaborate in developing institutional arrangements and standard data models that would give the science a

stronger bioinformatics platform and give researchers better access to omics data. What is proposed here is essentially a bioelectromagnetics omics initiative.

https://www.ncbi.nlm.nih.gov/pubmed/29482182

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The human skin as a sub-THz receiver - Does 5G pose a danger to it or not?

Betzalel N, Ben Ishai P, Feldman Y. The human skin as a sub-THz receiver - Does 5G pose a danger to it or not? Environ Res. 2018 May;163:208-216. doi: 10.1016/j.envres.2018.01.032.

Highlights

• The sweat duct is regarded as a helical antenna in the sub-THz band, reflectance depends on perspiration.
• We outline the background for non-thermal effects based on the structure of sweat ducts.
• We have introduced a realistic skin EM model and found the expected SAR for the 5G standard.

Abstract

In the interaction of microwave radiation and human beings, the skin is traditionally considered as just an absorbing sponge stratum filled with water. In previous works, we showed that this view is flawed when we demonstrated that the coiled portion of the sweat duct in upper skin layer is regarded as a helical antenna in the sub-THz band. Experimentally we showed that the reflectance of the human skin in the sub-THz region depends on the intensity of perspiration, i.e. sweat duct's conductivity, and correlates with levels of human stress (physical, mental and emotional). Later on, we detected circular dichroism in the reflectance from the skin, a signature of the axial mode of a helical antenna. The full ramifications of what these findings represent in the human condition are still unclear. We also revealed correlation of electrocardiography (ECG) parameters to the sub-THz reflection coefficient of human skin. In a recent work, we developed a unique simulation tool of human skin, taking into account the skin multi-layer structure together with the helical segment of the sweat duct embedded in it. The presence of the sweat duct led to a high specific absorption rate (SAR) of the skin in extremely high frequency band. In this paper, we summarize the physical evidence for this phenomenon and consider its implication for the future exploitation of the electromagnetic spectrum by wireless communication. Starting from July 2016 the US Federal Communications Commission (FCC) has adopted new rules for wireless broadband operations above 24 GHz (5 G). This trend of exploitation is predicted to expand to higher frequencies in the sub-THz region. One must consider the implications of human immersion in the electromagnetic noise, caused by devices working at the very same frequencies as those, to which the sweat duct (as a helical antenna) is most attuned. We are raising a warning flag against the unrestricted use of sub-THz technologies for communication, before the possible consequences for public health are explored.

https://www.ncbi.nlm.nih.gov/pubmed/29459303

Excerpt

The need for high data transmission rates, coupled with advances in semiconductor technology, is pushing the communications industry towards the sub-THz frequency spectrum. While the promises of a glorious future, resplendent with semi-infinite data streaming, may be attractive, there is a price to pay for such luxury. We shall find our cities, workspace and homes awash with 5 G base stations and we shall live though an unprecedented EM smog. The benefits to our society of becoming so wired cannot ignore possible health concerns, as yet unexplored. There is enough evidence to suggest that the combination of the helical sweat duct and wavelengths approaching the dimensions of skin layers could lead to non-thermal biological effects. Such fears should be investigated and these concerns should also effect the definition of standards for the application of 5G communications.

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Effect of cell phone RFR on body temperature in rodents: Pilot studies of NTP's reverberation chamber exposure system

Wyde ME, Horn TL, Capstick MH, Ladbury JM, Koepke G, Wilson PF, Kissling GE, Stout MD, Kuster N, Melnick RL, Gauger J, Bucher JR, McCormick DL. Effect of cell phone radiofrequency radiation on body temperature in rodents: Pilot studies of the National Toxicology Program's reverberation chamber exposure system. Bioelectromagnetics. 2018 Apr;39(3):190-199. doi: 10.1002/bem.22116.

Abstract

Radiofrequency radiation (RFR) causes heating, which can lead to detrimental biological effects. To characterize the effects of RFR exposure on body temperature in relation to animal size and pregnancy, a series of short-term toxicity studies was conducted in a unique RFR exposure system. Young and old B6C3F1 mice and young, old, and pregnant Harlan Sprague-Dawley rats were exposed to Global System for Mobile Communication (GSM) or Code Division Multiple Access (CDMA) RFR (rats = 900 MHz, mice = 1,900 MHz) at specific absorption rates (SARs) up to 12 W/kg for approximately 9 h a day for 5 days. In general, fewer and less severe increases in body temperature were observed in young than in older rats. SAR-dependent increases in subcutaneous body temperatures were observed at exposures ≥6 W/kg in both modulations. Exposures of ≥10 W/kg GSM or CDMA RFR induced excessive increases in body temperature, leading to mortality. There was also a significant increase in the number of resorptions in pregnant rats at 12 W/kg GSM RFR. In mice, only sporadic increases in body temperature were observed regardless of sex or age when exposed to GSM or CDMA RFR up to 12 W/kg. These results identified SARs at which measurable RFR-mediated thermal effects occur, and were used in the selection of exposures for subsequent toxicology and carcinogenicity studies.

https://www.ncbi.nlm.nih.gov/pubmed/29537695

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Rats exposed to 2.45 GHz of non-ionizing radiation exhibit behavioral changes with increased brain expression of apoptotic caspase 3

Rini Varghese, Anuradha Majumdar, Girish Kumar, Amit Shukla. Rats exposed to 2.45 GHz of non-ionizing radiation exhibit behavioral changes with increased brain expression of apoptotic caspase 3. Pathophysiology. 25(1):19-30. March 2018. https://doi.org/10.1016/j.pathophys.2017.11.001

Highlights

• The exposure to non-ionizing radiation of 2.45 GHz caused detrimental changes in rat brain leading to learning and memory decline and expression of anxiety behavior.
• The exposure to radiation induced oxidative stress and fall in brain antioxidants.
• The exposure triggered the gene expression of caspase 3.

Abstract

In recent years there has been a tremendous increase in use of Wi-Fi devices along with mobile phones, globally. Wi-Fi devices make use of 2.4 GHz frequency. The present study evaluated the impact of 2.45 GHz radiation exposure for 4 h/day for 45 days on behavioral and oxidative stress parameters in female Sprague Dawley rats. Behavioral tests of anxiety, learning and memory were started from day 38. Oxidative stress parameters were estimated in brain homogenates after sacrificing the rats on day 45. In morris water maze, elevated plus maze and light dark box test, the 2.45 GHz radiation exposed rats elicited memory decline and

anxiety behavior. Exposure decreased activities of super oxide dismutase, catalase and reduced glutathione levels whereas increased levels of brain lipid peroxidation was encountered in the radiation exposed rats, showing compromised anti-oxidant defense. Expression of caspase 3 gene in brain samples were quantified which unraveled notable increase in the apoptotic marker caspase 3 in 2.45 GHz radiation exposed group as compared to sham exposed group. No significant changes were observed in histopathological examinations and brain levels of TNF-α. Analysis of dendritic arborization of neurons showcased reduction in number of dendritic branching and intersections which corresponds to alteration in dendritic structure of neurons, affecting neuronal signaling. The study clearly indicates that exposure of rats to microwave radiation of 2.45 GHz leads to detrimental changes in brain leading to lowering of learning and memory and expression of anxiety behavior in rats along with fall in brain antioxidant enzyme systems.

Excerpts

The animals of group 2 were exposed to the 2.45 GHz radiation for 4 h/day for 45 days between 10 am to 6 pm, at a power density of 7.88 W/m^2.

... the radiated power absorbed by the body of rat was calculated to be 0.04728 W.

Conclusion

The study was an attempt to draw attention towards the adverse effects of non-ionizing electromagnetic radiations (NI-EMR) in the frequency that is used widely in the field of telecommunication. Many studies have captured the impact of the 900 MHz and 1800 MHz frequencies, however the frequency of radiation in Wi-Fi range has not been much explored. Along with the use of cell phones there is a growing concern with the use of Wi-Fi devices which continuously emit radiations in the frequency of 2.4 GHz. Hence we thought it prudent to investigate the impact of radiation of the frequency of 2.45 GHz. It can be concluded that the exposure to non-ionizing radiation of 2.45 GHz caused detrimental changes in rat brain leading to learning and memory decline and expression of anxiety behavior along with fall in brain antioxidants. The exposure triggered the gene expression of caspase 3 which plays a major role in the apoptotic pathway. The chronic impact of non-ionizing radiation needs to be thoroughly evaluated in humans so that combative steps can be taken.

https://www.sciencedirect.com/science/article/pii/S0928468017300524

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Intensity-time dependence dosing criterion in the EMF exposure guidelines in Russia

Rubtsova N, Paltsev Y, Perov S, Bogacheva E. Intensity-time dependence dosing criterion in the EMF exposure guidelines in Russia. Electromagn Biol Med. 2018 Mar 1:1-7. doi: 10.1080/15368378.2017.1414056.

Abstract

Major approaches of the Russian Federation in setting of exposure guidelines to electromagnetic fields (EMF) in occupational and public environments are discussed in this paper. EMF exposure guidelines in Russia are based on the results of hygienic, clinical, physiological, epidemiological and experimental studies and are frequency-dependent. The concept of a threshold principle of occupational and environmental factors due to hazardous exposure effects has been used to set permissible exposure levels of different EMF frequency ranges. The data of experimental studies showed hazardous threshold levels of EMF effects. The main criteria of EMF hazardous exposure evaluated in the experimental study concerned both estimation of threshold levels of chronic (long-term) and acute exposure. Also, this paper contains some recent experimental study data on correlation of long-term radiofrequency and power-frequency EMF exposure effects with regard to time duration, the so-called time-dependence approach. It enables identification of the value of permissible EMF exposure levels depending on exposure duration. This approach is used in occupational exposure guideline setting and requires the introduction of "power exposition" (PE) and "maximal permissible level" (MPL). In

general, EMF exposure guidelines are established with regard to possible duration of exposure per day.

https://www.ncbi.nlm.nih.gov/pubmed/29493302

Excerpt

The most important unknown effect is that of concomitant exposure to EMF from different sources.

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Radiofrequency radiation from nearby base stations gives high levels in an apartment in Stockholm, Sweden: A case report

Lennart Hardell, Michael Carlberg, Lena K. Hedendahl. Radiofrequency radiation from nearby base stations gives high levels in an apartment in Stockholm, Sweden: A case report. Oncology Letters. Published online on: March 16, 2018 https://doi.org/10.3892/ol.2018.8285

Abstract

Exposure to radiofrequency (RF) radiation was classified in 2011 as a possible human carcinogen, Group 2B, by the International Agency for Research on Cancer of the World Health Organisation. Evidence of the risk of cancer risk has since strengthened. Exposure is changing due to the rapid development of technology resulting in increased ambient radiation. RF radiation of sufficient intensity heats tissues, but the energy is insufficient to cause ionization, hence it is called non-ionizing radiation. These non-thermal exposure levels have resulted in biological effects in humans, animals and cells, including an increased cancer risk. In the present study, the levels of RF radiation were measured in an apartment close to two groups of mobile phone base stations on the roof. A total of 74,531 measurements were made corresponding to ~83 h of recording. The total mean RF radiation level was 3,811 μW/m2 (range 15.2-112,318 μW/m2) for the measurement of the whole apartment, including balconies. Particularly high levels were measured on three balconies and 3 of 4 bedrooms. The total mean RF radiation level decreased by 98% when the measured down-links from the base stations for 2, 3 and 4 G were disregarded. The results are discussed in relation to the detrimental health effects of non-thermal RF radiation. Due to the current high RF radiation, the apartment is not suitable for long-term living, particularly for children who may be more sensitive than adults. For a definitive conclusion regarding the effect of RF radiation from nearby base stations, one option would be to turn them off and repeat the measurements. However, the simplest and safest solution would be to turn them off and dismantle them.

Open Access Paper: https://www.spandidos-publications.com/10.3892/ol.2018.8285/abstract

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The effects of microwave radiation on rabbit's retina

Mohammad R. Talebnejad MR,Sadeghi-Sarvestani A, Hossein Nowroozzadeh M, Mortazavi SMJ, Khalili MR.The effects of microwave radiation on rabbit's retina. Journal of Current Ophthalmology. 30(1):74-79. Mar 2018.

Purpose Mobile cell phones are used extensively these days, and their microwave (MW) radiation has been shown to affect the eye. The purpose of the present study was to evaluate the effects of MW radiation on rabbit retina.

Methods This experimental study (concluded in 2015) was conducted on 40 adult white New Zealand rabbits. A Global System for Mobile Communications (GSM) cell phone simulator was used for MW irradiation. The rabbits were randomized into five groups (8 in each) and treated as follows: Group 1: no irradiation (sham); Group 2: irradiation at 10 cm for 1 day; Group 3: irradiation at 30 cm for 1 day; Group 4: irradiation at 10 cm for

3 days; and Group 5: irradiation at 30 cm for 3 days. Scotopic and photopic electroretinography (ERG) responses were obtained at baseline and 7 days after the last exposure. Then all the rabbits were euthanized, and their eyes were enucleated and sent for pathology examination. Kruskal–Wallis and Chi-Square tests were used to evaluate intergroup differences in ERG parameters and histological findings, respectively.

Results ERG responses obtained 7 days after irradiation did not show any statistically significant difference between the groups (P > 0.1, for all tested parameters). There were statistically non-significant trends toward greater changes in the MW irradiated eyes. In pathological examination, retina was normal with no sign of degeneration or infiltration. Ciliary body congestion was observed in greater fraction of those who received higher MW doses. (P = 0.005).

Conclusions Histopathologically, cell phone simulated MW irradiation had no significant detrimental effect on the retina. However, ciliary body congestion was observed in greater fraction of those who received higher MW doses. Although there was no significant difference between post-treatment mean ERG values, there were statistically non-significant trends toward greater changes in the MW irradiated eyes.

https://ac.els-cdn.com/S2452232517300562/1-s2.0-S2452232517300562-main.pdf?_tid=4249e90b-438f-43f4-b681-a67c72fb8ce7&acdnat=1521759969_87729ccbd7b1a4e21078c03d443000be

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Electromagnetic radiation and behavioural response of ticks: an experimental test

Vargová B, Majláth I, Kurimský J, Cimbala R, Kosterec M, Tryjanowski P, Jankowiak Ł, Raši T, Majláthová V. Electromagnetic radiation and behavioural response of ticks: an experimental test. Exp Appl Acarol. 2018 Mar 31. doi: 10.1007/s10493-018-0253-z.

Abstract

Factors associated with the increased usage of electronic devices, wireless technologies and mobile phones nowadays are present in increasing amounts in our environment. All living organisms are constantly affected by electromagnetic radiation which causes serious environmental pollution. The distribution and density of ticks in natural habitats is influenced by a complex of abiotic and biotic factors. Exposure to radio-frequency electromagnetic field (RF-EMF) constitutes a potential cause altering the presence and distribution of ticks in the environment. Our main objective was to determine the affinity of Dermacentor reticulatus ticks towards RF-EMF exposure. Originally designed and constructed radiation-shielded tube (RST) test was used to test the affinity of ticks under controlled laboratory conditions. All test were performed in an electromagnetic compatibility laboratory in an anechoic chamber. Ticks were irradiated using a Double-Ridged Waveguide Horn Antenna to RF-EMF at 900 and 5000 MHz, 0 MHz was used as control. The RF-EMF exposure to 900 MHz induced a higher concentration of ticks on irradiated arm of RST as opposed to the RF-EMF at 5000 MHz, which caused an escape of ticks to the shielded arm. This study represents the first experimental evidence of RF-EMF preference in D. reticulatus. The projection of obtained results to the natural environment could help assess the risk of tick borne diseases and could be a tool of preventive medicine.

https://www.ncbi.nlm.nih.gov/pubmed/29605834

Excerpts

The results of testing D. reticulatus ticks in RST multi tubes revealed that ticks are attracted significantly more to a frequency of 900 MHz RF-EMF frequency in comparison to control or 5000 MHz RF-EMF frequency. Lázaro et al. (2016) found similar phenomenon in wild bees and bee flies which were attracted by the source of artificial EMF exposure in natural habitat (Lázaro et al. 2016). However, the exposure to 900 MHz FR-EMF radiation on D. reticulatusc showed specific behavioural response of ticks, the reaction was presented by unusual specific sudden movements during the RF-EMF exposition, which was described as a body jerking or

leg jerking (Vargová et al. 2017).

According to our laboratory findings, we hypothesize that RF-EMF radiation could influence the distribution of ticks in the natural habitats. The RF-EMF radiation of various frequencies can be, besides humidity, temperature or host presence, one of the factors causing non-homogenous or rather mosaic distribution of ticks in the natural habitats.

We confirmed the extraordinary preference and active movement of D. reticulatus ticks towards the electromagnetic field from the radio wave spectrum of 900 MHz frequency. This RF-EMF tick preference may point to a new phenomenon with possibly important ecological and epidemiological consequences. Increasing electromagnetic waves by using personal electronic devices in natural habitats where ticks occur could increase the risk tick infestation and diseases transmission. Further studies should be undertaken to support this hypothesis, which analyse the impact of RF-EMF directly in the natural habitats of ticks.

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Effect of Ginkgo biloba on hippocampus of rats exposed to long-term cellphone radiation

Gevrek, F. Histopathological, immunohistochemical, and stereological analysis of the effect of Ginkgo biloba (Egb761) on the hippocampus of rats exposed to long-term cellphone radiation. Histology and Histopathology. 33(5):463-473. May 2018. DOI: 10.14670/HH-11-943

Abstract

Cellular phones are major sources of electromagnetic radiation (EMR) that can penetrate the human body and pose serious health hazards. The increasingly widespread use of mobile communication systems has raised concerns about the effects of cellphone radiofrequency (RF) on the hippocampus because of its close proximity to radiation during cellphone use. The effects of cellphone EMR exposure on the hippocampus of rats and the possible counteractive effects of Ginkgo biloba (Egb761) were aimed to investigate. Rats were divided into three groups: Control, EMR, and EMR+Egb761. The EMR and EMR+Egb761 groups were exposed to cellphone EMR for one month. Egb761 was also administered to the EMR+Egb761 group. Specifically, we evaluated the effect of RF exposure on rat hippocampi at harmful EMR levels (0.96 W/kg specific absorption rate [SAR]) for one month and also investigated the possible impact of Egb761 using stereological, TUNEL-staining, and immunohistochemical methods. An increase in apoptotic proteins (Bax, Acas-3) and a decrease in anti-apoptotic protein (Bcl-2) immuno-reactivity along with a decrease in the total granule and pyramidal cell count were noted in the EMR group. A decrease in Bax and Acas-3 and an increase in Bcl-2 immunoreactivity were observed in rats treated with Egb761 in addition to a decrease in TUNEL-stained apoptotic cells and a higher total viable cell number. In conclusion, chronic cellphone EMR exposure may affect hippocampal cell viability, and Egb761 may be used to mitigate some of the deleterious effects.

https://www.ncbi.nlm.nih.gov/pubmed/29120031

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Genotoxicity and genomic instability in rat primary astrocytes exposed to 872 MHz RF and chemicals

Herrala M, Mustafa E, Naarala J, Juutilainen J. Assessment of genotoxicity and genomic in stability in rat primary astrocytes exposed to 872 MHz radiofrequency radiation and chemicals. International journal of radiation biology. Epub 2018 Mar 23. DOI:10.1080/09553002.2018.1450534

Abstract

PURPOSE: We examined genotoxicity, co-genotoxicity and induced genomic instability (IGI) in primary astrocytes exposed to radiofrequency (RF) radiation.

MATERIALS AND METHODS: Rat primary astrocytes were exposed to 872MHz GSM-modulated or continuous wave (CW) RF radiation at specific absorption rates of 0.6 or 6.0 W/kg for 24h. Menadione (MQ) and methyl methanesulfonate (MMS; only in genotoxicity experiments) were used as co-exposures. Alkaline Comet assay and flow cytometric micronucleus scoring were used to detect genetic damage.

RESULTS: No IGI was observed from RF radiation alone or combined treatment with MQ. RF radiation alone was not genotoxic. RF radiation combined with chemical exposure showed some statistically significant differences: increased DNA damage at 6.0 W/kg but decreased DNA damage at 0.6 W/kg in cells exposed to GSM-modulated RF radiation and MQ, and increased micronucleus frequency in cells exposed to CW RF radiation at 0.6 W/kg and MMS.

CONCLUSIONS: Exposure to GSM modulated RF radiation at levels up to 6.0 W/kg did not induce or enhance genomic instability in rat primary astrocytes. Lack of genotoxicity from RF radiation alone was convincingly shown in multiple experiments. Co-genotoxicity of RF radiation and genotoxic chemicals was not consistently supported by the results.

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Exposure of Insects to RF EMF from 2 to 120 GHz

Thielens A, Bell D, Mortimore DB, Greco MK, Martens L, Joseph W. Exposure of Insects to Radio-Frequency Electromagnetic Fields from 2 to 120 GHz. Scientific Reports. 8:3924. Mar 2, 2018. DOI: 10.1038/s41598-018-22271-3

Abstract

Insects are continually exposed to Radio-Frequency (RF) electromagnetic fields at different frequencies. The range of frequencies used for wireless telecommunication systems will increase in the near future from below 6 GHz (2 G, 3 G, 4 G, and WiFi) to frequencies up to 120 GHz (5 G). This paper is the first to report the absorbed RF electromagnetic power in four different types of insects as a function of frequency from 2 GHz to 120 GHz. A set of insect models was obtained using novel Micro-CT (computer tomography) imaging. These models were used for the first time in finite-difference time-domain electromagnetic simulations. All insects showed a dependence of the absorbed power on the frequency. All insects showed a general increase in absorbed RF power at and above 6 GHz, in comparison to the absorbed RF power below 6 GHz. Our simulations showed that a shift of 10% of the incident power density to frequencies above 6 GHz would lead to an increase in absorbed power between 3-370%

Excerpt

Figure 4 illustrates the frequency dependence of the absorption of RF-EMFs in the Western Honeybee in terms of the ratio of the electric field strength inside the insect to the maximum electric field in the simulation domain. At the currently used frequencies for telecommunication (<6 GHz), the wavelength is relatively large compared to the insects and the waves do not penetrate into the insects, which results in lower Pabs values. At 12–24 GHz, the fields penetrate more and more into the insect as the wavelength becomes comparable to the insects' size and the conductivity increases as well. At the highest studied frequencies, the fields penetrate less deep into the insect, but their amplitude is higher, resulting in a similar or slightly lower P_{abs}.

Figure 5 shows the P_{abs} linearly averaged over all twelve plane waves as a function of frequency for all studied insects. The absorbed power increases with increasing frequency from 2–6 GHz for all insects under exposure at a constant incident power density or incident electric field strength of 1 V/m...

The three smaller insects show their maximum at a frequency higher than 6 GHz: 60 GHz, 24 GHz, and 12 GHz for the Australian Stingless Bee, the Beetle, and the Honey Bee, respectively....

We investigated the absorbed radio-frequency electromagnetic power in four different real insects as a function of frequency from 2–120 GHz. Micro-CT imaging was used to obtain realistic models of real insects. These models were assigned dielectric parameters obtained from literature and used in finite-difference time-domain simulations. All insects show a dependence of the absorbed power on the frequency with a peak frequency that depends on their size and dielectric properties. The insects show a maximum in absorbed radio frequency power at wavelengths that are comparable to their body size. They show a general increase in absorbed radio-frequency power above 6 GHz (until the frequencies where the wavelengths are comparable to their body size), which indicates that if the used power densities do not decrease, but shift (partly) to higher frequencies, the absorption in the studied insects will increase as well. A shift of 10% of the incident power density to frequencies above 6 GHz would lead to an increase in absorbed power between 3–370%. This could lead to changes in insect behaviour, physiology, and morphology over time due to an increase in body temperatures, from dielectric heating. The studied insects that are smaller than 1 cm show a peak in absorption at frequencies (above 6 GHz), which are currently not often used for telecommunication, but are planned to be used in the next generation of wireless telecommunication systems. At frequencies above the peak frequency (smaller wavelengths) the absorbed power decreases slightly.

Open access paper: https://www.nature.com/articles/s41598-018-22271-3

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Results of lifespan exposure to ELF EMF administered alone to Sprague Dawley rats

L. Bua, E. Tibaldi, L. Falcioni, M. Lauriola, L. De Angelis, F. Gnudi, M. Manservigi, F. Manservisi, I. Manzoli, I. Menghetti, R. Montella, S. Panzacchi, D. Sgargi, V. Strollo, A. Vornoli, D. Mandrioli, Results of lifespan exposure to continuous and intermittent extremely low frequency electromagnetic fields (ELFEMF) administered alone to Sprague Dawley rats Environmental Research. 164:271-279. July 2018.

Highlights

• Carcinogenic effects of ELFEMF whole-body chronic exposure were evaluated on rats.
• Exposure to ELFEMF alone does not represent risk factor for neoplastic development.
• ELFEMF might act as a cancer enhancer if co-administered to other known carcinogens.

Abstract

Background Up to now, experimental studies on rodents have failed to provide definitive confirmation of the carcinogenicity of extremely low frequency electromagnetic fields (ELFEMF). Two recent studies performed in our laboratory on Sprague-Dawley rats reported a statistically significant increase in malignant tumors of different sites (mammary gland, C-cells carcinoma, hemolymphoreticular neoplasia, and malignant heart Schwannoma) when ELFEMF exposure was associated with exposure to formaldehyde (50 mg/l) or acute low dose of γ-radiation (0.1 Gy) (Soffritti et al., 2016a) (Soffritti et al., 2016b). The same doses of known carcinogenic agents (50 mg/l formaldehyde, or acute 0.1 Gy γ-radiation), when administered alone, previously failed to induce any statistically significant increase in the incidence of total and specific malignant tumors in rats of the same colony.

Objectives A lifespan whole-body exposure study was conducted to evaluate the possible carcinogenic effects of ELFEMF exposure administered alone to Sprague-Dawley rats, as part of the integrated project of the Ramazzini Institute (RI) for studying the effects on health of ELFEMF alone or in combination with other known carcinogens.

Methods Male and female Sprague-Dawley rats were exposed 19 h/day to continuous sinusoidal-50 Hz

magnetic fields (S-50 Hz MF) at flux densities of 0 (control group), 2, 20, 100 or 1000μT, and to intermittent (30 min on/30 min off) S-50 Hz MF at 1000 μT, from prenatal life until natural death.

Results Survival and body weight trends in all groups of rats exposed to ELFEMF were comparable to those found in sex-matched controls. The incidence and number of malignant and benign tumors was similar in all groups. Magnetic field exposure did not significantly increase the incidence of neoplasias in any organ, including those sites that have been identified as possible targets in epidemiological studies (leukemia, breast cancer, and brain cancer).

Conclusions Life-span exposures to continuous and intermittent sinusoidal-50 Hz ELFEMFs, when administered alone, did not represent a significant risk factor for neoplastic development in our experimental rat model. In light of our previous results on the carcinogenic effects of ELFEMF in combination with formaldehyde and γ-radiation, further experiments are necessary to elucidate the possible role of ELFEMF as cancer enhancer in presence of other chemical and physical carcinogens.

https://www.sciencedirect.com/science/article/pii/S001393511830104X

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ELF MF and Redox-Responsive Pathways Linked to Cancer Drug Resistance: Insights from Co-Exposure-Based In Vitro Studies

Falone S, Santini S, Cordone V, Di Emidio G, Tatone C, Caachio M, Amicarelli F. Extremely Low-Frequency Magnetic Fields and Redox-Responsive Pathways Linked to Cancer Drug Resistance: Insights from Co-Exposure-Based In Vitro Studies. 23 Feb 2018. https://doi.org/10.3389/fpubh.2018.00033

Electrical devices currently used in clinical practice and common household equipments generate extremely low-frequency magnetic fields (ELF-MF) that were classified by the International Agency for Research on Cancer as “possible carcinogenic.” Assuming that ELF-MF plays a role in the carcinogenic process without inducing direct genomic alterations, ELF-MF may be involved in the promotion or progression of cancers. In particular, ELF-MF-induced responses are suspected to activate redox-responsive intracellular signaling or detoxification scavenging systems. In fact, improved protection against oxidative stress and redox-active xenobiotics is thought to provide critical proliferative and survival advantage in tumors. On this basis, an ever-growing research activity worldwide is attempting to establish whether tumor cells may develop multidrug resistance through the activation of essential cytoprotective networks in the presence of ELF fields, and how this might trigger relevant changes in tumor phenotype. This review builds a framework around how the activity of redox-responsive mediators may be controlled by co-exposure to ELF-MF and reactive oxygen species-generating agents in tumor and cancer cells, in order to clarify whether and how such potential molecular targets could help to minimize or neutralize the functional interaction between ELF-MF and malignancies.

Open Access Paper: https://www.frontiersin.org/articles/10.3389/fpubh.2018.00033/full

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Genotoxic and carcinogenic effects of non-ionizing electromagnetic fields

Kocaman A, Altun G, Kaplan AA, Deniz ÖG, Yurt KK, Kaplan S. Genotoxic and carcinogenic effects of non-ionizing electromagnetic fields.
Environ Res. 2018 Feb 7;163:71-79. doi: 10.1016/j.envres.2018.01.034.

Abstract

New technologies in electronics and communications are continually emerging. An increasing use of these

electronic devices such as mobile phone, computer, wireless fidelity connectors or cellular towers is raising questions concerning whether they have an adverse effect on the body. Exposure to electromagnetic fields (EMF) is frequently suggested to have adverse health effects on humans and other organisms. This idea has been reported in many studies. In contrast, the therapeutic effects of EMF on different organs have also been reported. Research findings are inconsistent. This has given rise to very profound discrepancies. The duration and frequency of mobile phone calls and the association observed with various health effects has raised serious concerns due to the frequency with which these devices are used and the way they are held close to the head. The present review assesses the results of in vitro, in vivo, experimental, and epidemiological studies. The purpose of the study is to assess data concerning the carcinogenic and genotoxic effects of non-ionizing EMF. The major genotoxic and carcinogenic effects of EMF, divided into subsections as low frequency effects and radiofrequency effects, were reviewed. The inconsistent results between similar studies and the same research groups have made it very difficult to make any comprehensive interpretation. However, evaluation of current studies suggests that EMF may represent a serious source of concern and may be hazardous to living organisms.

https://www.ncbi.nlm.nih.gov/pubmed/29427953

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Towards 5G communication systems: Are there health implications?

Di Ciaula A. Towards 5G communication systems: Are there health implications? Int J Hyg Environ Health. 2018 Feb 2. pii: S1438-4639(17) 30814-3. doi: 10.1016/j.ijheh.2018.01.011.

Highlights

• RF-EMF exposure is rising and health effects of are still under investigation.
• Both oncologic and non-cancerous chronic effects have been suggested.
• 5G networks could have health effects and will use MMW, still scarcely explored.
• Adequate knowledge of RF-EMF biological effects is also needed in clinical practice.
• Underrating the problem could lead to a further rise in noncommunicable diseases.

Abstract

The spread of radiofrequency electromagnetic fields (RF-EMF) is rising and health effects are still under investigation. RF-EMF promote oxidative stress, a condition involved in cancer onset, in several acute and chronic diseases and in vascular homeostasis. Although some evidences are still controversial, the WHO IARC classified RF-EMF as "possible carcinogenic to humans", and more recent studies suggested reproductive, metabolic and neurologic effects of RF-EMF, which are also able to alter bacterial antibiotic resistance. In this evolving scenario, although the biological effects of 5G communication systems are very scarcely investigated, an international action plan for the development of 5G networks has started, with a forthcoming increment in devices and density of small cells, and with the future use of millimeter waves (MMW). Preliminary observations showed that MMW increase skin temperature, alter gene expression, promote cellular proliferation and synthesis of proteins linked with oxidative stress, inflammatory and metabolic processes, could generate ocular damages, affect neuro-muscular dynamics. Further studies are needed to better and independently explore the health effects of RF-EMF in general and of MMW in particular. However, available findings seem sufficient to demonstrate the existence of biomedical effects, to invoke the precautionary principle, to define exposed subjects as potentially vulnerable and to revise existing limits. An adequate knowledge of pathophysiological mechanisms linking RF-EMF exposure to health risk should also be useful in the current clinical practice, in particular in consideration of evidences pointing to extrinsic factors as heavy contributors to cancer risk and to the progressive epidemiological growth of noncommunicable diseases.

https://www.ncbi.nlm.nih.gov/pubmed/29402696

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RF radiation-related cancer: assessing causation in the occupational/military setting

Peleg M, Nativ O, Richter ED. Radio frequency radiation-related cancer: assessing causation in the occupational/military setting.
Environ Res. 2018 Feb 9;163:123-133. doi: 10.1016/j.envres.2018.01.003.

Abstract

BACKGROUND AND AIM: We reexamine whether radio frequency radiation (RFR) in the occupational and military settings is a human carcinogen.

METHODS: We extended an analysis of an already-reported case series of patients with cancer previously exposed to whole-body prolonged RFR, mainly from communication equipment and radar. We focused on hematolymphatic (HL) cancers. We used analysis by percentage frequency (PF) of a cancer type, which is the proportion of a specific cancer type relative to the total number of cancer cases. We also examined and analyzed the published data on three other cohort studies from similar military settings from different countries.

RESULTS: The PF of HL cancers in the case series was very high, at 40% with only 23% expected for the series age and gender profile, confidence interval CI95%: 26-56%, $p<0.01$, 19 out of 47 patients had HL cancers. We also found high PF for multiple primaries. As for the three other cohort studies: In the Polish military sector, the PF of HL cancers was 36% in the exposed population as compared to 12% in the unexposed population, $p<0.001$. In a small group of employees exposed to RFR in Israeli defense industry, the PF of HL cancers was 60% versus 17% expected for the group age and gender profile, $p<0.05$. In Belgian radar battalions the HL PF was 8.3% versus 1.4% in the control battalions as shown in a causes of deaths study and HL cancer mortality rate ratio was 7.2 and statistically significant. Similar findings were reported on radio amateurs and Korean war technicians. Elevated risk ratios were previously reported in most of the above studies.

CONCLUSIONS: The consistent association of RFR and highly elevated HL cancer risk in the four groups spread over three countries, operating different RFR equipment types and analyzed by different research protocols, suggests a cause-effect relationship between RFR and HL cancers in military/occupational settings. While complete measurements of RFR exposures were not available and rough exposure assessments from patients interviews and from partial exposure data were used instead, we have demonstrated increased HL cancers in occupational groups with relatively high RFR exposures. Our findings, combined with other studies, indicate that exposures incurred in the military settings evaluated here significantly increased the risk of HL cancers. Accordingly, the RFR military exposures in these occupations should be substantially reduced and further efforts should be undertaken to monitor and measure those exposures and to follow cohorts exposed to RFR for cancers and other health effects. Overall, the epidemiological studies on excess risk for HL and other cancers together with brain tumors in cellphone users and experimental studies on RFR and carcinogenicity make a coherent case for a cause-effect relationship and classifying RFR exposure as a human carcinogen (IARC group 1).

https://www.ncbi.nlm.nih.gov/pubmed/29433020

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Are Exposures to Multiple Frequencies the Key to Future Radiofrequency Research?

Sienkiewicz Z, Calderón C, Broom KA, Addison D, Gavard A, Lundberg L, Maslanyj M. Are Exposures to Multiple Frequencies the Key to Future Radiofrequency Research? Front Public Health. 2017 Dec 8;5:328. doi: 10.3389/fpubh.2017.00328.

Abstract

There is an extensive literature investigating possible effects of exposure to radiofrequency (RF) electromagnetic fields associated with mobile phone technologies. This has not identified any public health risks with any degree of certainty. Some epidemiological studies have observed associations between heavy users of mobile phones and some types of cancer, but animal studies do not support this association, although a few studies have reported increased tumor yields. However, there is a crucial difference between epidemiology studies and laboratory work in terms of signals investigated: most people are exposed to a complex mixture of frequencies and signals at varying intensities, whereas the majority of animal studies have been performed using a single frequency or intensity. Whether this might explain the differences in outcome will be discussed, and whether there is a need for additional laboratory investigations that reproduce more accurately realistic exposure conditions will be considered.

Open Access Paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5727023/

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On the effects of glasses on the SAR in human head resulting from wireless eyewear devices at phone call state

Lan JQ, Liang X, Hong T, Du GH. On the effects of glasses on the SAR in human head resulting from wireless eyewear devices at phone call state. Prog Biophys Mol Biol. 2018 Feb 8. pii: S0079-6107(17)30082-2. doi: 10.1016/j.pbiomolbio.2018.02.001.

Abstract

This paper evaluates the effects of glasses on the specific absorption rates (SAR) in the human head resulting from wireless eyewear device at phone call state. We mainly concentrate on the SAR in the eyes since their sensitivity to electromagnetic fields (EMF). We find wearing glasses obviously alters the distribution and magnitude of the SAR. The maximal SAR in the ocular tissues with glasses is even 6 times more than that without glasses. Wearing glasses also induce the new hotspot in the eyes which may cause the biggest SAR increment in the ocular tissues. Moreover, calculated results indicate that the maximal SAR is sensitive to the size of glasses and radiation frequency. Because of this, we believe wearing glasses may possibly increase the risk of health hazard to eyes of wireless eyewear device user. These calculated results could be a valuable reference for the glasses designer to reduce the SAR in the eyes.

https://www.ncbi.nlm.nih.gov/pubmed/29428220

Conclusions

Based on the calculated results, we find wearing glasses obviously alters the distribution and magnitude of SAR. The maximal SAR in the ocular tissues with glasses is even 6 times more than that without glasses. Wearing glasses also could induce the new hotspot in the eyeballs which may cause the biggest SAR increment in the ocular tissues. Moreover, calculated results indicate that the maximal SAR is sensitive to the size of glasses and radiation frequency. Therefore, we believe wearing glasses may possibly increase the risk of health hazard to human eyes. In order to decrease the SAR in the ocular tissues, people should choose the adaptive glasses according to the radiation frequency. If possible, we advise people to take off their glasses when they use the eyewear device. These calculated results could be a valuable reference for the glasses designer to reduce the SAR in the eyes. However, due to the limited research conditions, the experiment is not included. So conclusions, in this paper, are just indicative but not definitive.

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Exposure to Mobile Phone-Emitted EMF and Human Attention: No Evidence of a Causal Relationship:

Mini Review

Curcio G. Exposure to Mobile Phone-Emitted Electromagnetic Fields and Human Attention: No Evidence of a Causal Relationship. Front. Public Health, 23 February 2018.

No Abstract

Concluding Remarks

On the basis of reviewed literature, we can reasonably conclude that there is no evidence of a negative influence of mobile phone emitted EMFs on different aspects of human attention. As pointed out in Discussion, published literature is very heterogeneous with respect to methodology, dosimetry, or statistical analyses, and thus a conclusive generalization to everyday life is still very difficult. For these reasons, further research is needed, particularly on real-working settings and environments.

Open Access Paper: https://www.frontiersin.org/articles/10.3389/fpubh.2018.00042/full

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A Multi-Band Body-Worn Distributed RF Exposure Meter: Design, On-Body Calibration and Study of Body Morphology

Aminzadeh R, Thielens A, Agneessens S, Van Torre P, Van den Bossche M, Dongus S, Eeftens M, Huss A, Vermeulen R, de Seze R, Mazet P, Cardis E, Rogier H, Röösli M, Martens L Wout J. A Multi-Band Body-Worn Distributed Radio-Frequency Exposure Meter: Design, On-Body Calibration and Study of Body Morphology. Sensors. 18(1). Jan 2018.

Abstract

A multi-band Body-Worn Distributed exposure Meter (BWDM) calibrated for simultaneous measurement of the incident power density in 11 telecommunication frequency bands, is proposed. The BDWM consists of 22 textile antennas integrated in a garment and is calibrated on six human subjects in an anechoic chamber to assess its measurement uncertainty in terms of 68% confidence interval of the on-body antenna aperture. It is shown that by using multiple antennas in each frequency band, the uncertainty of the BWDM is 22 dB improved with respect to single nodes on the front and back of the torso and variations are decreased to maximum 8.8 dB. Moreover, deploying single antennas for different body morphologies results in a variation up to 9.3 dB, which is reduced to 3.6 dB using multiple antennas for six subjects with various body mass index values. The designed BWDM, has an improved uncertainty of up to 9.6 dB in comparison to commercially available personal exposure meters calibrated on body. As an application, an average incident power density in the range of 26.7–90.8 μW·m−2 is measured in Ghent, Belgium. **The measurements show that commercial personal exposure meters underestimate the actual exposure by a factor of up to 20.6.**

Excerpt

Two commercially available PEMs are used in this study: EME Spy 200 (MVG, Brest, France) and ExpoM-RF (Fields at Work GmbH, Zürich, Switzerland). Eleven frequency bands are studied in this paper ...

For the BWDM, the mean measured power densities are in the range of 26.7 μW/m2 (800-DL) to 90.8 μW/m2 (900 DL). The large standard deviation is due to the city environment where several buildings with different heights are present. For the EME Spy 200, the mean power density ranges from 4.41 μW/m2 (1800-DL) to 60.1 μW/m2 (900-DL). ExpoM-RF registered mean power densities in the range of 14.53 μW/m2 (1800-DL) to 151.5 μW/m2 (900-DL). All the three devices measured the maximum mean power density for 900-DL band (2G). For the BWDM, the median Sinc is in the range of 3.21 μW/m2 (800-DL) to 29 μW/m2 for 2100-DL. Both

PEMs registered the minimum p50 of Sinc for 1800-DL (EME Spy 200: 0.59 μW/m2, ExpoM-RF: 1.62 μW/m2) and the maximum median Sinc for 900-DL (EME Spy 200: 12.26 μW/m2, ExpoM-RF: 34.77 μW/m2).

Conclusions

For the first time, a multi-band body-worn distributed-exposure meter (BWDM) is proposed for simultaneous on-body measurements of the incident power density in 11 telecommunication bands. The BWDM is designed and calibrated on a male human subject, in an anechoic chamber. The optimized location of 22 nodes covering 11 frequency bands is determined on the front and on the back of the torso. The optimized BWDM is also calibrated on five more subjects in order to study the effect of human body morphology on the measurement uncertainty of the designed BWDM. The uncertainty is quantified as the 68% confidence interval of the on-body antenna aperture obtained during calibrations. It is shown that using multiple antennas improved the uncertainty up to 22 dB with respect to single nodes for all subjects in all frequency bands. We also demonstrated that, using single antennas, the variation on CI68 for the six people in this study was about 9.3 dB. This value reduced to the range of 1.2 to 3.6 dB for all the subjects, which is 5.7 dB improvement. Except for 1800-DL (3.6 dB) the maximum variation on the CI68 of subjects of this study is limited to below 2 dB. The designed BWDM has an improved CI68 of 9.6 dB compared to CI68 of commercially available PEMs calibrated on body. Using the proposed BWDM and two PEMs, fields along an outdoor route are measured in Ghent, Belgium including 800, 900, 1800 and 2100 MHz downlink bands. The BWDM measured a mean power density in the range of 26.7 to 90.8 μW/m2, which are below the issued reference levels by ICNIRP. The results show that commercial PEMs underestimate the actual incident power densities by a factor of 1.6 to 20.6. Moreover, the measured exposure to 2G and 3G signals are 3.8 to 9 times higher than the 4G signals. The study of the subject's posture and application of SAR measurement will be part of the future work.

https://www.researchgate.net/publication/322569489_A_Multi-Band_Body-Worn_Distributed_Radio-Frequency_Exposure_Meter_Design_On-Body_Calibration_and_Study_of_Body_Morphology

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Representativeness and repeatability of microenvironmental personal and head exposures to RF-EMF

Thielens A, Van den Bossche M, Brzozek C, Bhatt CR, Abramson MJ, Benke G, Martens L, Joseph W. Representativeness and repeatability of microenvironmental personal and head exposures to radio-frequency electromagnetic fields. Environ Res. 2018 Apr;162:81-96. doi: 10.1016/j.envres.2017.12.017.

Abstract

The aims of this study were to: i) investigate the repeatability and representativeness of personal radio frequency-electromagnetic fields (RF-EMFs) exposure measurements, across different microenvironments, ii) perform simultaneous evaluations of personal RF-EMF exposures for the whole body and the head, iii) validate the data obtained with a head-worn personal distributed exposimeter (PDE) against those obtained with an on-body worn personal exposimeter (PEM). Data on personal and head RF-EMF exposures were collected by performing measurements across 15 microenvironments in Melbourne, Australia. A body-worn PEM and a head-worn PDE were used for measuring body and head exposures, respectively. The summary statistics obtained for total RF-EMF exposure showed a high representativeness (r2 > 0.66 for two paths in the same area) and a high repeatability over time (r2 > 0.87 for repetitions of the same path). The median head exposure in the 900MHz downlink band ranged between 0.06V/m and 0.31V/m. The results obtained during simultaneous measurements using the two devices showed high correlations (0.42 < r2 < 0.94). The highest mean total RF-EMF exposure was measured in Melbourne's central business district (0.89V/m), whereas the lowest mean total exposure was measured in a suburban residential area (0.05V/m). This study shows that personal RF-EMF microenvironmental measurements in multiple microenvironments have high representativeness and repeatability over time. The personal RF-EMF exposure levels (i.e. body and head exposures) demonstrated moderate to high correlations.

https://www.ncbi.nlm.nih.gov/pubmed/29289859

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Effects of time delays on biological feedback systems and electromagnetic field exposures

Barnes F, Kandala S. Effects of time delays on biological feedback systems and electromagnetic field exposures. Bioelectromagnetics. 2018 Feb 19. doi: 10.1002/bem.22114.

No Abstract

https://www.ncbi.nlm.nih.gov/pubmed/29457641

Excerpts

Biological systems contain a large number of signaling pathway and amplifying systems. Often these signaling systems operate in parallel and include both feedback and feed forward signals. An extensive review of how feedback loops shape cellular signals in space and time is presented by Brandman and Meyer [2008]. There are over 3,000 signaling proteins and over 15 s messengers that lead to hundreds of cell-specific signaling systems. These multiple feedback loops lead to a wide variety of responses including oscillations, bi-stability, and system stabilization. The multiple feedback loops often make it hard to separate cause and effect.

Changes in concentrations of ROS molecules have been shown to have a wide range of both positive and negative effects on biological systems [Halliwell and Gutteridge, 2015]. Early works on the exposures of biological systems to microwaves show that even when the biological system was held at constant temperatures, there were changes in membrane resistance that differed from the first exposures to the second, and there was a time delay in the response [Arber and Lin, 1985a,b]. More recent works show that magnetic fields have been shown to modify ROS concentrations [Georgiou, 2010; Castello et al., 2014; Usselman et al., 2014, 2016].

We can expect signals such as modulated sine waves or pulses at different repetition rates containing more than one frequency to modify more than one biological process.

Overall, we know that there are many feedback and repair processes in biological systems. These feedback processes occur with time delays following a stimulus, and thus we can expect that the timing of a periodic stimulus can either lead to an amplified or attenuated response. Additionally, we can expect the responses of biological systems to be frequency-dependent. With knowledge of time constants for various biological and medical responses, we may be able to signal the systems to increase or decrease such things as cell growth rates or immune responses.

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RF EMR exposure effects on amygdala morphology, place preference behavior and brain caspase-3 activity in rats

Narayanan, SN, Mohapatra, N, John, P, Suresh Kumar, NKR,. Nayak, SB, Gopalakrishna Bhat, P. Radiofrequency electromagnetic radiation exposure effects on amygdala morphology, place preference behavior and brain caspase-3 activity in rats. Environmental Toxicology and Pharmacology. 58:220-229. 2018.

Abstract

The purpose of the study was to evaluate the changes in amygdala morphology and emotional behaviors, upon exposure to chronic RF-EMR in adolescent rats. Four weeks old male albino Wistar rats were exposed to 900 MHz (power density:146.60 μW/cm2) from a mobile phone in silent-mode for 28 days. Amygdala

morphology was studied using cresyl violet, TUNEL and Golgi-Cox staining. Place preference behavior was studied using light/dark chamber test and following this brain caspase-3 activity was determined. Number of healthy neurons was decreased in the basolateral amygdala and cortical amygdala but not in the central amygdala after RF-EMR exposure. It also induced apoptosis in the amygdala. RF-EMR exposure altered dendritic arborization pattern in basolateral amygdala but not in the central amygdala. Altered place preference and hyperactivity-like behavior was evident after RF-EMR exposure, but brain caspase-3 activity did not change. RF-EMR exposure perturbed normal cellular architecture of amygdala and this was associated with altered place preference.

https://doi.org/10.1016/j.etap.2018.01.009

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Cell phone exposure induces apoptosis, mitochondrial oxidative stress & TRPV1 channel activation in hippocampus of rats

Ertilav K, Uslusoy F, Ataizi S, Nazıroğlu M. Long term exposure to cell phone frequencies (900 and 1800 MHz) induces apoptosis, mitochondrial oxidative stress and TRPV1 channel activation in the hippocampus and dorsal root ganglion of rats. Metab Brain Dis. 2018 Jan 13. doi: 10.1007/s11011-017-0180-4.

Abstract

Mobile phone providers use electromagnetic radiation (EMR) with frequencies ranging from 900 to 1800 MHz. The increasing use of mobile phones has been accompanied by several potentially pathological consequences, such as neurological diseases related to hippocampal (HIPPON) and dorsal root ganglion neuron (DRGN). The TRPV1 channel is activated different stimuli, including CapN, high temperature and oxidative stress. We investigated the contribution TRPV1 to mitochondrial oxidative stress and apoptosis in HIPPON and DRGN following long term exposure to 900 and 1800 MHz in a rat model. Twenty-four adult rats were equally divided into the following groups: (1) control, (2) 900 MHz, and (3) 1800 MHz exposure. Each experimental group was exposed to EMR for 60 min/ 5 days of the week during the one year. The 900 and 1800 MHz EMR exposure induced increases in TRPV1 currents, intracellular free calcium influx (Ca2+), reactive oxygen species (ROS) production, mitochondrial membrane depolarization (JC-1), apoptosis, and caspase 3 and 9 activities in the HIPPON and DRGN. These deleterious processes were further increased in the 1800 MHz experimental group compared to the 900 MHz exposure group. In conclusion, mitochondrial oxidative stress, programmed cell death and Ca2+ entry pathway through TRPV1 activation in the HIPPON and DRGN of rats were increased in the rat model following exposure to 900 and 1800 MHz cell frequencies. Our results suggest that exposure to 900 and 1800 MHz EMR may induce a dose-associated, TRPV1-mediated stress response.

https://www.ncbi.nlm.nih.gov/pubmed/29332300

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RF EMR exposure effects on amygdala morphology, place preference behavior and brain caspase-3 activity in rats

Narayanan SN, Mohapatra N, John P, Kumar NKRS, Nayak SB, Bhat PG. Radiofrequency electromagnetic radiation exposure effects on amygdala morphology, place preference behavior and brain caspase-3 activity in rats. Environmental Toxicology and Pharmacology, Available online 31 January 2018.

Highlights

• Chronic 900 MHz exposure perturbed cellular architecture of rat amygdala.
• Number of healthy neurons decreased in basolateral, cortical nuclei but not in central nuclei.

• Dendritic arborization of basolateral neurons was found to be reduced.
• This was associated with altered place preference behavior.
• Brain caspase-3 was not found to be altered after chronic radiation exposure.

Abstract

The purpose of the study was to evaluate the changes in amygdala morphology and emotional behaviors, upon exposure to chronic RFEMR in adolescent rats. Four weeks old male albino Wistar rats were exposed to 900 MHz (power density:146.60 μW/cm2) from a mobile phone in silent-mode for 28 days. Amygdala morphology was studied using cresyl violet, TUNEL and Golgi-Cox staining. Place preference behavior was studied using light/dark chamber test and following this brain caspase-3 activity was determined. Number of healthy neurons was decreased in the basolateral amygdala and cortical amygdala but not in the central amygdala after RF-EMR exposure. It also induced apoptosis in the amygdala. RF-EMR exposure altered dendritic arborization pattern in basolateral amygdala but not in the central amygdala. Altered place preference and hyperactivity-like behavior was evident after RF-EMR exposure, but brain caspase-3 activity did not change. EMR exposure perturbed architecture of amygdala and this was associated with altered place preference.

https://www.sciencedirect.com/science/article/pii/S1382668918300164

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Evaluation of oxidative injury in sciatic nerves of male rats exposed to continuous 900-MHz EMF throughout adolescence

Kerimoğlu G, Güney C, Ersöz Ş, Odacı E. A histopathological and biochemical evaluation of oxidative injury in the sciatic nerves of male rats exposed to a continuous 900-megahertz electromagnetic field throughout all periods of adolescence. J Chem Neuroanat. 2018 Jan 10. pii: S0891-0618(17)30212-0. doi: 10.1016/j.jchemneu.2018.01.001.

Abstract

The effects on human health of the electromagnetic field (EMF) emitted by mobile phones, used by approximately 7 billion people worldwide, have become an important subject for scientific research. Studies have suggested that the EMF emitted by mobile phones can cause oxidative stress in different tissues and age groups. Young people in adolescence, a time period when risky behaviors and dependences increase, use mobile phones more than adults. The EMF emitted by mobile phones, which are generally carried in the pocket or in bags when not in use, will very probably affect the sciatic nerve. No previous study has investigated the effect of mobile phone use in adolescence on peripheral nerve. This study was planned accordingly. Twenty-four male Sprague Dawley rats aged 21 days were divided equally into control (CGr), Sham (SGr) and EMF (EMFGr) groups. No procedure was performed on CGr rats. EMFGr were exposed to the effect of a 900-megahertz (MHz) EMF for 1 h at the same time every day between postnatal days 21-59 (the entire adolescent period) inside a cage in the EMF apparatus. SGr rats were placed inside the cage for 1 h every day without being exposed to EMF. All rats were sacrificed at the end of the study period, and 1 cm sections of sciatic nerve were extracted. Malondialdehyde (MDA), glutathione, catalase (CAT) superoxide dismutase (SOD) values were investigated biochemically in half of the right sciatic nerve tissues. The other halves of the nerve tissues were subjected to routine histopathological tissue procedures, sectioned and stained with hematoxylin and eosin (H&E) and Masson's trichrome. Histopathological evaluation of slides stained with Masson's trichrome and H&E revealed a normal appearance in Schwann cells and axons in all groups. However, there was marked thickening in the epineurium of sciatic nerves from EMFGr rats. MDA, SOD and CAT levels were higher in EMFGr than in CGr and SGr at biochemical analyses. Apoptotıc index (AI) analysis revealed a significant increase in the number of TUNEL (+) cells when EMFGr was compared with CGr and SGr. In conclusion, our study results suggest that continuous exposure to a 900-MHz EMF for 1 h throughout adolescence can cause oxidative injury and thickening in the epineurium in the sciatic nerve in male rats.

https://www.ncbi.nlm.nih.gov/pubmed/29331319

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1950 MHz RF EMR Inhibits Testosterone Secretion of Mouse Leydig Cells

Lin YY, Wu T, Liu JY, Gao P, Li KC, Guo QY, Yuan M, Lang HY, Zeng LH, Guo GZ. 1950 MHz Radio Frequency Electromagnetic Radiation Inhibits Testosterone Secretion of Mouse Leydig Cells. Int J Environ Res Public Health. 2017 Dec 23;15(1). pii: E17. doi: 10.3390/ijerph15010017.

Abstract

More studies that are focused on the bioeffects of radio-frequency (RF) electromagnetic radiation that is generated from the communication devices, but there were few reports with confirmed results about the bioeffects of RF radiation on reproductive cells. To explore the effects of 1950 MHz RF electromagnetic radiation (EMR) on mouse Leydig (TM3) cells. TM3 cells were irradiated or sham-irradiated continuously for 24 h by the specific absorption rate (SAR) 3 W/kg radiation. At 0, 1, 2, 3, 4, and 5 days after irradiation, cell proliferation was detected by cell counting kit-8 (CCK-8) method, cell cycle distribution, percentage of apoptosis, and cellular reactive oxygen species (ROS) were examined by flow cytometry, Testosterone level was measured using enzyme-linked immunosorbent assay (ELISA) assay, messenger ribonucleic acid (mRNA) expression level of steroidogenic acute regulatory protein (StAR) and P450scc in TM3 cells was detected by real-time polymerase chain reaction (PCR). After being irradiated for 24 h, cell proliferation obviously decreased and cell cycle distribution, secretion capacity of Testosterone, and P450scc mRNA level were reduced. While cell apoptosis, ROS, and StAR mRNA level did not change significantly. The current results indicated that 24 h of exposure at 1950 MHz 3 W/kg radiation could cause some adverse effects on TM3 cells proliferation and Testosterone secretion, further studies about the biological effects in the reproductive system that are induced by RF radiation are also needed.

https://www.ncbi.nlm.nih.gov/pubmed/29295490

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Extremely Low Frequency Fields

Occupational exposure to ELF magnetic fields and risk of ALS: systematic review and meta-analysis

Huss A, Peters S, Vermeulen R. Occupational exposure to extremely low-frequency magnetic fields and the risk of ALS: A systematic review and meta-analysis. Bioelectromagnetics. doi:10.1002/bem.22104. Published online Jan 19, 2018.

Abstract

We performed a meta-analysis to examine associations of occupational exposure to extremely-low frequency magnetic fields (ELF-MF) with amyotrophic lateral sclerosis (ALS). Epidemiologic studies were identified in EMBASE and MEDLINE, in reference lists and a specialist database. We included studies that reported risk estimates of ALS in association with occupational ELF-MF exposure. Summary relative risks (RR) or odds ratios (OR) were obtained with random effect meta-analysis, and analyses were stratified by type of exposure assessment. This was done to evaluate whether observed heterogeneity between studies could be explained with differences in the way the exposure had been determined. We included 20 studies in our meta-analysis. Overall, studies reported a slightly increased risk of ALS in those exposed to higher levels of ELF-MF compared to lower levels with a summary RR (sRR) of 1.14 (95% Confidence Interval [CI] 1.00–1.30) and for workers in electrical occupations (sRR 1.41, CI 1.05–1.92), but with large heterogeneity between studies ($I^2 > 70\%$). Self-reported exposure or occupations determined from death certificates did not show increased

risks. Highest-longest types of exposure translated into increased risks of ALS if the studies had evaluated the whole occupational history, in contrast to evaluating only few points in time (e.g., from census records); sRR were 1.89 (CI 1.31–2.73, I^2 0%) and 1.06 (CI 0.75–1.57, I^2 76%), respectively. In this meta-analysis, we observed an increased risk of ALS in workers occupationally exposed to ELF-MF. Results of studies depended on the quality of the exposure assessment.

http://onlinelibrary.wiley.com/doi/10.1002/bem.22104/abstract

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Occupational exposure to ELF magnetic fields and risk of Alzheimer disease: systematic review and meta-analysis

Jalilian H, Teshnizi SH, Röösli M, Neghab M. Occupational exposure to extremely low frequency magnetic fields and risk of Alzheimer disease: A systematic review and meta-analysis. Neurotoxicology. 2017 Dec 24. pii: S0161-813X(17)30239-5. doi: 10.1016/j.neuro.2017.12.005.

Abstract

INTRODUCTION: Occupational exposure to extremely low frequency magnetic fields (ELF-MF) occurs in many occupations such as welders, electric utility workers, train drivers and sewing machine operators. There is some evidence suggesting ELF-MF exposure to be a risk factor for Alzheimer's disease (AD). The current study aims at systematically reviewing the literature and conducting a meta-analysis to evaluate the risk of AD amongst workers exposed to ELF-MF.

METHODS: Bibliographic databases were searched including PubMed, EMBASE, Cochrane Library, and Web of Science in November 2017. Risk of bias was assessed in the all included studies. Pooled estimates were obtained using random-effects meta-analysis. In addition, sources of heterogeneity between studies and publication bias were explored.

RESULTS: In total, 20 articles met the inclusion criteria. The pooled results suggest an increased risk of AD (RR: 1.63; 95% CI: 1.35, 1.96). Higher risk estimates were obtained from case-control studies (OR: 1.80; 95% CI: 1.40, 2.32) than from cohort studies (RR: 1.42; 95% CI: 1.08, 1.87). A moderate to high heterogeneity ($I2 = 61.0\%$) and indication for publication bias (Egger test: $p < 0.001$) were found.

CONCLUSION: The results suggested that occupational exposure to ELF-MF might increase the risk of AD. However, this suggestion should be interpreted with caution given the moderate to high heterogeneity and indication for publication bias.

https://www.ncbi.nlm.nih.gov/pubmed/29278690

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Distinguishing Polemic From Commentary in Science: Some Guidelines Illustrated With the Case of Sage and Burgio (2017)

Grimes DR, Bishop DV. Distinguishing Polemic From Commentary in Science: Some Guidelines Illustrated With the Case of Sage and Burgio (2017). Child Dev. 2017 Dec 21. doi: 10.1111/cdev.13013.

Abstract

Exposure to nonionizing radiation used in wireless communication remains a contentious topic in the public mind-while the overwhelming scientific evidence to date suggests that microwave and radio frequencies used

in modern communications are safe, public apprehension remains considerable. A recent article in Child Development has caused concern by alleging a causative connection between nonionizing radiation and a host of conditions, including autism and cancer. This commentary outlines why these claims are devoid of merit, and why they should not have been given a scientific veneer of legitimacy. The commentary also outlines some hallmarks of potentially dubious science, with the hope that authors, reviewers, and editors might be better able to avoid suspect scientific claims.

https://www.ncbi.nlm.nih.gov/pubmed/29266222

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Averaged head phantoms from magnetic resonance images of Korean children and young adults

Han M, Lee AK, Choi HD, Jung YW, Park JS. Averaged head phantoms from magnetic resonance images of Korean children and young adults. Phys Med Biol. 2017 Dec 14. doi: 10.1088/1361-6560/aaa1c7.

Abstract

Increased use of mobile phones raises concerns about the health risks of electromagnetic radiation. Phantom heads are routinely used for radiofrequency dosimetry simulations, and the purpose of this study was to construct averaged phantom heads for children and young adults. Using magnetic resonance images (MRI), sectioned cadaver images, and a hybrid approach, we initially built template phantoms representing 6-, 9-, 12-, 15-year-old children and adult. Our subsequent approach revised the template phantoms using 29 averaged items that were identified by averaging the MRI data from 500 children and young adults. In females, the brain size and cranium thickness peaked in the early teens and then decreased. This is contrary to what was observed in males, where brain size and cranium thicknesses either plateaued or grew continuously. The overall shape of brains was spherical in children and became ellipsoidal by adulthood. In this study, we devised a method to build averaged phantom heads by constructing surface and voxel models. The surface model could be used for phantom manipulation, whereas the voxel model could be used for compliance test of specific absorption rate (SAR) for users of mobile phones or other electronic devices.

https://www.ncbi.nlm.nih.gov/pubmed/29239853

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Effects of GSM and UMTS mobile telephony signals on neuron degeneration and blood-brain barrier permeation in the rat brain

Poulletier de Gannes F, Masuda H, Billaudel B, Poque-Haro E, Hurtier A, Lévêque P, Ruffié G, Taxile M, Veyret B, Lagroye I. Effects of GSM and UMTS mobile telephony signals on neuron degeneration and blood-brain barrier permeation in the rat brain. Sci Rep. 2017 Nov 14;7(1):15496. doi: 10.1038/s41598-017-15690-1.

Abstract

Blood-brain barrier (BBB) permeation and neuron degeneration were assessed in the rat brain following exposure to mobile communication radiofrequency (RF) signals (GSM-1800 and UMTS-1950). Two protocols were used: (i) single 2 h exposure, with rats sacrificed immediately, and 1 h, 1, 7, or 50 days later, and (ii) repeated exposures (2 h/day, 5 days/week, for 4 weeks) with the effects assessed immediately and 50 days after the end of exposure. The rats' heads were exposed at brain-averaged specific absorption rates (BASAR) of 0.026, 0.26, 2.6, and 13 W/kg. No adverse impact in terms of BBB leakage or neuron degeneration was

observed after single exposures or immediately after the end of repeated exposure, with the exception of a transient BBB leakage (UMTS, 0.26 W/kg). Fifty days after repeated exposure, the occurrence of degenerating neurons was unchanged on average. However, a significant increased albumin leakage was detected with both RF signals at 13 W/kg. In this work, the strongest, delayed effect was induced by GSM-1800 at 13 W/kg. Considering that 13 W/kg BASAR in the rat head is equivalent to 4 times as much in the human head, deleterious effects may occur following repeated human brain exposure above 50 W/kg.

Open Access Paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5686211/
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Extremely Low Frequency Fields

Exposure to Magnetic Field Non-Ionizing Radiation and the Risk of Miscarriage: A Prospective Cohort Study

Li DK, Chen H, Ferber JR, Odouli R, Quesenberry C. Exposure to Magnetic Field Non-Ionizing Radiation and the Risk of Miscarriage: A Prospective Cohort Study. Sci Rep. 2017 Dec 13;7(1):17541. doi: 10.1038/s41598-017-16623-8.

Abstract

Magnetic field (MF) non-ionizing radiation is widespread and everyone is exposed to some degree. This prospective cohort study of 913 pregnant women examined the association between high MF exposure and miscarriage risk. Cox (proportional hazards) regression was used to examine the association. After controlling for multiple other factors, women who were exposed to higher MF levels had 2.72 times the risk of miscarriage (hazard ratio = 2.72, 95% CI: 1.42-5.19) than those with lower MF exposure. The increased risk of miscarriage associated with high MF was consistently observed regardless of the sources of high MF. The association was much stronger if MF was measured on a typical day of participants' pregnancies. The finding also demonstrated that accurate measurement of MF exposure is vital for examining MF health effects. This study provides fresh evidence, directly from a human population, that MF non-ionizing radiation could have adverse biological impacts on human health.

Open Access Paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5727515/

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Exposure to ELF EMF during Lessons in Secondary Schools

Silangam W, Yoosook W, Kongtip P, Kongtawelert A, Theppeang K. EXPOSURE TO EXTREMELY LOW FREQUENCY ELECTROMAGNETIC FIELDS DURING LESSONS IN SECONDARY SCHOOLS. Radiat Prot Dosimetry. 2017 Dec 5:1-5. doi: 10.1093/rpd/ncx266. [Epub ahead of print]

Abstract

Schools are a significant location where children are exposed to electromagnetic fields (EMFs), which may cause adverse health effects. This cross-sectional study aimed to examine exposure levels to extremely low frequency magnetic fields (ELF-MFs) with a range of 5 Hz-32 kHz, and ELF-electric fields (ELF-EFs) with a range of 5 Hz-2 kHz in secondary schools in Bangkok, Thailand. This study was conducted in 60 classrooms from three schools during class hours. Spot measurements were taken with a Narda EFA 300 field analyzer to evaluate exposure levels. This study showed that ELF-EMF exposure levels are lower than ICNIRP guidelines, while 21.67% of classrooms had a magnetic field strength above 0.2 μT, and the main sources of ELF-EMFs were electrical equipment and electrical wiring. Future studies should measure ELF-EMF levels in other areas and evaluate the effects of long term exposure to ELF-EMFs on children's health.

https://www.ncbi.nlm.nih.gov/pubmed/29216404

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Stochastic Dosimetry for the Assessment of Children Exposure to Uniform 50 Hz Magnetic Field with Uncertain Orientation

Chiaramello E, Fiocchi S, Ravazzani P, Parazzini M. Stochastic Dosimetry for the Assessment of Children Exposure to Uniform 50 Hz Magnetic Field with Uncertain Orientation. Biomed Res Int. 2017;2017:4672124. doi: 10.1155/2017/4672124. Epub 2017 Oct 31.

Abstract

This study focused on the evaluation of the exposure of children aging from five to fourteen years to 50 Hz homogenous magnetic field uncertain orientation using stochastic dosimetry. Surrogate models allowed assessing how the variation of the orientation of the magnetic field influenced the induced electric field in each tissue of the central nervous system (CNS) and in the peripheral nervous system (PNS) of children. Results showed that the electric field induced in CNS and PNS tissues of children were within the ICNIRP basic restrictions for general public and that no significant difference was found in the level of exposure of children of different ages when considering 10000 possible orientations of the magnetic field. A "mean stochastic model," useful to estimate the level of exposure in each tissue of a representative child in the range of age from five to fourteen years, was developed. In conclusion, this study was useful to deepen knowledge about the ELF-MF exposure, including the evaluation of variable and uncertain conditions, thus representing a step towards a more realistic characterization of the exposure to EMF.

Open Access Paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5684611/

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Maternal cumulative exposure to ELF EMF and pregnancy outcomes in the Elfe cohort

Migault L, Piel C, Carles C, Delva F, Lacourt A, Cardis E, Zaros C, de Seze R, Baldi I, Bouvier G. Maternal cumulative exposure to extremely low frequency electromagnetic fields and pregnancy outcomes in the Elfe cohort. Environ Int. 2017 Dec 20;112:165-173. doi: 10.1016/j.envint.2017.12.025.

Abstract

OBJECTIVES: To study the relations between maternal cumulative exposure to extremely low frequency electromagnetic fields (ELF EMF) and the risk of moderate prematurity and small for gestational age within the Elfe cohort.

METHODS: The Elfe study included 18,329 infants born at 33weeks of gestation or more in France in 2011 and was designed to follow the children until 20years of age. Gestational age and anthropometric data at birth were collected in medical records and small for gestational age was defined according to a French customized growth standard. During interviews, mothers were asked to report their job status during pregnancy. If employed, their occupation was coded according to the International Standard Classification of Occupations 1988 and the date on which they stopped their work was recorded. Cumulative exposure to ELF EMF during pregnancy was assessed, for both mothers who worked and those who did not during pregnancy, using a recently-updated job-exposure matrix (JEM). Cumulative exposure was considered as a categorical variable (<17.5, 17.5-23.8, 23.8-36.2, 36.2-61.6 or ≥61.6μT-days), a binary variable (<44.1 and ≥44.1μT-days) and a continuous variable. Associations were analyzed by logistic regression, adjusting for the mother's lifestyle factors, sociodemographic characteristics and some mother's medical history during and before pregnancy. Analyses were restricted to single births and to complete values for the pregnancy outcomes (n=16,733).

RESULTS: Cumulative exposure was obtained for 96.0% of the mothers. Among them, 37.5% were classified in the 23.8-36.2μT-days category, but high exposures were rare: 1.3% in the ≥61.6μT-days category and 5.5% in the ≥44.1μT-days category. No significant association was observed between maternal cumulative exposure and moderate prematurity and small for gestational age in this exposure range.

CONCLUSION: This large population-based study does not suggest that maternal exposure to ELF EMF during pregnancy is highly associated with risks of moderate prematurity or small for gestational age.

https://www.ncbi.nlm.nih.gov/pubmed/29275242

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Effects of ELF EMF on Neurogenesis and Cognitive Behavior in an Experimental Model of Hippocampal Injury

Sakhaie MH, Soleimani M, Pourheydar B, Majd Z, Atefimanesh P, Asl SS, Mehdizadeh M. Effects of Extremely Low-Frequency Electromagnetic Fields on Neurogenesis and Cognitive Behavior in an Experimental Model of Hippocampal Injury. Behav Neurol. 2017;2017:9194261. doi: 10.1155/2017/9194261. Epub 2017 Nov 12.

Abstract

Exposure to extremely low-frequency electromagnetic fields may induce constant modulation in neuronal plasticity. In recent years, tremendous efforts have been made to design a suitable strategy for enhancing adult neurogenesis, which seems to be deterred due to brain senescence and several neurodegenerative diseases. In this study, we evaluated the effects of ELF-EMF on neurogenesis and memory, following treatment with trimethyltin chloride (TMT) as a neurotoxicant. The mice in all groups (n = 56) were injected with BrdU during the experiment for seven consecutive days to label newborn cells. Spatial memory was assessed by the Morris water maze (MWM) test. By the end of the experiment, neurogenesis and neuronal differentiation were assessed in the hippocampus, using immunohistochemistry and Western blot analysis. Based on the findings, exposure to ELF-EMF enhanced spatial learning and memory in the MWM test. ELF-EMF exposure significantly enhanced the number of BrdU+ and NeuN+ cells in the dentate gyrus of adult mice ($P < 0.001$ and $P < 0.05$, resp.). Western blot analysis revealed significant upregulation of NeuroD2 in ELF-EMF-exposed mice compared to the TMT-treated group ($P < 0.05$). These findings suggest that ELF-EMF might have clinical implications for the improvement of neurodegenerative processes and could help develop a novel therapeutic approach in regenerative medicine.

https://www.ncbi.nlm.nih.gov/pubmed/29259353

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Spatial memory recovery in Alzheimer's rat model by ELF EMF exposure

Akbarnejad Z, Esmaeilpour K, Shabani M, Asadi-Shekaari M, Saeedi Goraghani M, Ahmadi-Zeidabadi M. Spatial memory recovery in Alzheimer's rat model by electromagnetic field exposure. Int J Neurosci. 2017 Dec 20:1-6. doi: 10.1080/00207454.2017.1411353. [Epub ahead of print]

Abstract

INTRODUCTION: Although studies have shown a potential association between extremely low frequency electromagnetic fields (ELF-EMFs) exposure and Alzheimer's disease (AD), few studies have been conducted to investigate the effects of weak magnetic fields on brain functions such as cognitive functions in animal

models. Therefore, this study aimed to investigate the effect of ELF-EMF exposure (50 Hz, 10 mT) on spatial learning and memory changes in AD rats.

METHODS: Amyloid-β (Aβ) 1-42 was injected into lateral ventricle to establish an AD rat model. The rats were divided into six groups: Group I (control); Group II (surgical sham); Group III (AD) Alzheimer's rat model; Group IV (MF) rats exposed to ELF-MF for 14 consecutive days; Group V (Aβ injection+M) rats exposed to magnetic field for 14 consecutive days from day 0 to 14 days after the Aβ peptide injection; Group VI (AD+M) rats exposed to magnetic field for 14 consecutive days after 2 weeks of Aβ peptide injection from 14th to 28th day . Morris water maze investigations were performed.

RESULTS: AD rats showed a significant impairment in learning and memory compared to control rats. The results showed that ELF-MF improved the learning and memory impairments in Aβ injection+M and AD+M groups.

CONCLUSION: Our results showed that application of ELF-MF not only has improving effect on different cognitive disorder signs of AD animals, but also disrupts the processes of AD rat model formation.

https://www.ncbi.nlm.nih.gov/pubmed/29185809

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Impact of EMR emitted by monitors on cellular membrane structure and protective antioxidant effect of vitamin A - In vitro study

Lewicka M, Henrykowska G, Zawadzka M, Rutkowski M, Pacholski K, Buczyński A. Impact of electromagnetic radiation emitted by monitors on changes in the cellular membrane structure and protective antioxidant effect of vitamin A - In vitro study. Int J Occup Med Environ Health. 2017 Jul 14;30(5):695-703. doi: 10.13075/ijomeh.1896.00851. Epub 2017 May 30.

Abstract

OBJECTIVES: The increasing number of devices emitting electromagnetic radiation (EMR) in people's everyday life attracted the attention of researchers because of possible adverse effects of this factor on living organisms. One of the EMR effect may be peroxidation of lipid membranes formed as a result of free radical process. The article presents the results of in vitro studies aimed at identifying changes in malondialdehyde (MDA) concentration - a marker of lipid peroxidation and antioxidant role of vitamin A during the exposure of blood platelets to electromagnetic radiation generated by liquid-crystal-display (LCD) monitors.

MATERIAL AND METHODS: Electromagnetic radiation emitted by LCD monitors is characterized by parameters: 1 kHz frequency and 220 V/m intensity (15 cm from display screen). The time of exposure was 30 and 60 min. The study was conducted on porcine blood platelets. The samples were divided into 6 groups: unexposed to radiation, unexposed + vitamin A, exposed for 30 min, exposed for 30 min + vitamin A, exposed for 60 min, exposed for 60 min + vitamin A.

RESULTS: The MDA concentration in blood platelets increases significantly as compared to control values after 60 min of exposure to EMR. A significant decrease in MDA concentration after the addition of vitamin A was noticed. In the blood samples exposed to EMR for 30 and 60 min the MDA concentration was significantly increased by addition of vitamin A.

CONCLUSIONS: The results show the possibly negative effect of electromagnetic radiation on the cellular membrane structure manifested by changes in malondialdehyde concentration and indicate a possible protective role of vitamin A in this process.

https://www.ncbi.nlm.nih.gov/pubmed/28584329

Mortazavi SMJ. Letter to the Editor (July 26, 2017) concerning the paper "Impact of electromagnetic radiation emitted by monitors on changes in the cellular membrane structure and protective antioxidant effect of vitamin A - In vitro study". Int J Occup Med Environ Health. 2018 Jan 15;31(3):371-372. doi: 10.13075/ijomeh.1896.01245. Epub 2017 Dec 5. http://ijomeh.eu/Comments-on-Impact-of-electromagnetic-radiation-emitted-by-monitors-on-changes-in,80565,0,2.html

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Behavioral testing of mice exposed to intermediate frequency magnetic fields indicates mild memory impairment

Kumari K, Koivisto H, Viluksela M, Paldanius KMA, Marttinen M, Hiltunen M, Naarala J, Tanila H, Juutilainen J. Behavioral testing of mice exposed to intermediate frequency magnetic fields indicates mild memory impairment. PLoS One. 2017 Dec 4;12(12):e0188880. doi: 10.1371/journal.pone.0188880.

Abstract

Human exposure to intermediate frequency magnetic fields (MF) is increasing due to applications like electronic article surveillance systems and induction heating cooking hobs. However, limited data is available on their possible health effects. The present study assessed behavioral and histopathological consequences of exposing mice to 7.5 kHz MF at 12 or 120 μT for 5 weeks. No effects were observed on body weight, spontaneous activity, motor coordination, level of anxiety or aggression. In the Morris swim task, mice in the 120 μT group showed less steep learning curve than the other groups, but did not differ from controls in their search bias in the probe test. The passive avoidance task indicated a clear impairment of memory over 48 h in the 120 μT group. No effects on astroglial activation or neurogenesis were observed in the hippocampus. The mRNA expression of brain-derived neurotrophic factor did not change but expression of the proinflammatory cytokine tumor necrosis factor alpha mRNA was significantly increased in the 120 μT group. These findings suggest that 7.5 kHz MF exposure may lead to mild learning and memory impairment, possibly through an inflammatory reaction in the hippocampus.

Open Access Paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5714647/

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Behavioural phenotypes in mice after prenatal and early postnatal exposure to intermediate frequency magnetic fields

Kumari K, Koivisto H, Myles C, Jonne N, Matti V, Heikki T, Jukka J. Behavioural phenotypes in mice after prenatal and early postnatal exposure to intermediate frequency magnetic fields. Environ Res. 2017 Dec 22;162:27-34. doi: 10.1016/j.envres.2017.12.013.

Abstract

Electromagnetic fields are ubiquitous in the environment. Human exposure to intermediate frequency (IF) fields is increasing due to applications like electronic article surveillance systems, wireless power transfer, and induction heating cooking hobs. However, there are limited data on possible health effects of exposure to IF magnetic fields (MF). In the present study, we set out to assess cognitive and behavioural effects of IF MF in mice exposed during prenatal and early postnatal periods. Pregnant female mice were exposed continuously to 7.5kHz MFs at 12 and 120μT, from mating until weaning of pups. Sham exposed pregnant mice were used as a control group. A behavioural teratology study was conducted on the male offspring at two months of age to detect possible effects on the developing nervous system. Body weight development did not differ between the exposure groups. The exposure did not alter spontaneous motor activity when exploring a novel cage or anxiety in novelty-suppressed feeding or marble burying tests. Improved performance in the Rotarod task was

observed in the 12μT group, while the 120μT exposure group swam more slowly than the sham exposed group in the Morris swim navigation task. However, indices of learning and memory (path length and escape latency during task acquisition and search bias during the probe test) did not differ between the exposure groups. Furthermore, the passive avoidance task did not indicate any impairment of long-term memory over a 48h interval in the exposed groups. In a post-mortem histopathological analysis, there was no evidence for an effect of IF MF exposure on astroglial reactivity or hippocampal neurogenesis. The results suggest that the IF MF used did not have detrimental effects on spatial learning and memory or histological markers of tissue reaction. The two statistically significant findings that were observed (improved performance in the Rotarod task in the 12μT group and decreased swimming speed in the 120μT group) are likely to be chance findings, as they do not form an internally consistent, dose-dependent pattern indicative of specific developmental effects.

https://www.ncbi.nlm.nih.gov/pubmed/29276976

==========2017==========

ICNIRP To Revise 1998 Radio Frequency Guidelines

ICNIRP continues to ignore the preponderance of the research which documents non-thermal biologic and health effects from radio frequency radiation exposure. Are conflicts of interest the reason?

Munich, Germany, December 7, 2017

The International Commission on Non-Ionizing Radiation Protection's (ICNIRP) current guidelines for the high-frequency (100 kHz – 300 GHz) portion of the electromagnetic spectrum were published in 1998. Given the large body of relevant research that has been generated since those 1998 guidelines, ICNIRP is now revising the guidelines to incorporate this literature.

The revision of the guidelines has been underway since 2014, and a public consultation version of the updated guidelines is expected within the first half of 2018. Given this timing, ICNIRP has been asked whether, in the interim period, the current guidelines can still be considered as protective. This is a very reasonable question, particularly given that changes are anticipated in the revised guidelines.

As part of the revision process ICNIRP has considered in detail whether the 1998 guidelines remain protective for current exposure scenarios, where it was noted that the anticipated changes relate primarily to the improvement of transparency and consistency across the exposure limits and the addition of new limits to account for exposure situations associated with potential technological advances, and further that the anticipated exposure limit changes are very small compared to the large degree of precaution that was built into the 1998 guidelines. ICNIRP therefore concluded that the 1998 guidelines do remain protective. That is, the 1998 guidelines still provide protection against all known health effects of high-frequency radiation within the frequency range 100 kHz – 300 GHz. However, if ICNIRP should discover aspects of the 1998 guidelines that are not sufficiently protective during the remainder of the high-frequency guidelines revision process, ICNIRP will immediately publish interim amendments that would remain in force until the revised guidelines are published.

ICNIRP is keen to obtain feedback on the upcoming high frequency guidelines, and will seek this feedback via a public consultation process. It is anticipated that the public consultation document will be completed mid-2018, with the associated public consultation period beginning thereafter.

Further updates on the high-frequency guidelines revision process, including publication of the public consultation document, will be made available through this website and via newsletter (www.icnirp.org; www.icnirp.org/en/contact/newsletter).

http://www.icnirp.org/en/activities/news/news-article/revision-of-hf-guidelines-2017.html

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EMF-Portal Stops Importing New Papers on Radio Frequency (RF) Radiation

Why did EMF-Portal's funders only stop funding the Portal's work on RF radiation?

EMF-Portal issued the following announcement on November 28:

"Due to a lack of financial resources, we unfortunately have to suspend the import of any new radio frequency and mobile phone-related articles as of now (November 27, 2017)."

The portal has continued to import other EMF papers.

This archive is an invaluable resource to the field. EMF-Portal has an extensive database which includes more than 25,000 publications and 6,000 summaries of scientific studies on the effects of electromagnetic fields.

The head of the project is Dr. rer. nat. Sarah Drießen (driessen@femu.rwth-aachen.de). Perhaps your letters of support can assist Dr. Drießen's efforts to find more funding.

I hope this problem is resolved quickly.

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Measurements of Radiofrequency Radiation with a Body-Borne Exposimeter in Swedish Schools with Wi-Fi

Lena K. Hedendahl, Michael Carlberg, Tarmo Koppel, Lennart Hardell. Measurements of Radiofrequency Radiation with a Body-Borne Exposimeter in Swedish Schools with Wi-Fi. Front. Public Health, 20 November 2017 | https://doi.org/10.3389/fpubh.2017.00279

Introduction: Wireless access to the Internet is now commonly used in schools. Many schools give each student their own laptop and utilize the laptops and wireless fidelity (Wi-Fi) connection for educational purposes. Most children also bring their own mobile phones to school. Since children are obliged by law to attend school, a safe environment is important. Lately, it has been discussed if radiofrequency (RF) radiation can have long-term adverse effects on children's health.

Method: This study conducted exposimetric measurements in schools to assess RF emissions in the classroom by measuring the teachers' RF exposure in order to approximate the children's exposure. Teachers in grades 7–12 carried a body-borne exposimeter, EME-Spy 200, in school during 1–4 days of work. The exposimeter can measure 20 different frequency bands from 87 to 5,850 MHz.

Results: Eighteen teachers from seven schools participated. The mean exposure to RF radiation ranged from 1.1 to 66.1 μW/m2. The highest mean level, 396.6 μW/m2, occurred during 5 min of a lesson when the teacher let the students stream and watch YouTube videos. Maximum peaks went up to 82,857 μW/m2 from mobile phone uplink.

Discussion: Our measurements are in line with recent exposure studies in schools in other countries. The exposure levels varied between the different Wi-Fi systems, and if the students were allowed to use their own smartphones on the school's Wi-Fi network or if they were connected to GSM/3G/4G base stations outside the school. An access point over the teacher's head gave higher exposure compared with a school with a wired Internet connection for the teacher in the classroom. All values were far below International Commission on

Non-Ionizing Radiation Protection's reference values, but most mean levels measured were above the precautionary target level of 3–6 μW/m2 as proposed by the Bioinitiative Report. The length of time wireless devices are used is an essential determinant in overall exposure. Measures to minimize children's exposure to RF radiation in school would include preferring wired connections, allowing laptops, tablets and mobile phones only in flight mode and deactivating Wi-Fi access points, when not used for learning purposes.

In Conclusion

1. The ICNIRP guidelines are based on short-term heating (thermal) effects, and are therefore not relevant to decide on the appropriateness of long-term exposure.

2. The environmental exposure to RF radiation in some schools is higher than reported levels for non-thermal biological effects. In order to reduce children's exposure to RF radiation, schools should prefer wired network connections, allow laptop, tablets, and mobile phone usage only in flight mode and deactivate Wi-Fi access points when internet is not needed for learning purposes.

Open source paper: https://www.frontiersin.org/articles/10.3389/fpubh.2017.00279/full

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Exposure to extremely low frequency EMF during lessons in secondary schools

Silangam W, Yoosook W, Kongtip P, Kongtawelert A, Theppeang K. Exposure to extremely low frequency EMF during lessons in secondary schools. Radiat Prot Dosimetry. 2017 Dec 5:1-5.

Abstract

Schools are a significant location where children are exposed to electromagnetic fields (EMFs), which may cause adverse health effects. This cross-sectional study aimed to examine exposure levels to extremely low frequency magnetic fields (ELF-MFs) with a range of 5 Hz-32 kHz, and ELF-electric fields (ELF-EFs) with a range of 5 Hz-2 kHz in secondary schools in Bangkok, Thailand. This study was conducted in 60 classrooms from three schools during class hours. Spot measurements were taken with a Narda EFA 300 field analyzer to evaluate exposure levels. This study showed that ELF-EMF exposure levels are lower than ICNIRP guidelines, while 21.67% of classrooms had a magnetic field strength above 0.2 μT, and the main sources of ELF-EMFs were electrical equipment and electrical wiring. Future studies should measure ELF-EMF levels in other areas and evaluate the effects of long term exposure to ELF-EMFs on children's health.

https://www.ncbi.nlm.nih.gov/pubmed/29216404

In this study, exposure levels of ELF-MFs and ELF-EFs in classrooms during lessons at all three schools were lower than ICNIRP guideline recommendations. The dominant measured frequency was 50 Hz, and the main sources of ELF-EMFs were electrical equipment and electrical wiring. Future research should focus on the effect of ELF-EMF exposure during school time on children's health, should measure the ELF-EMF intensity in other areas of the school (e.g. library, canteen and walkways) to determine the level of ELF-EMFs both inside and outside the classroom. Moreover, to characterize the exposure of the children to ELF-EMF, measurements should be carried out in the children's bedrooms, where they sleep.

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Phenotypic and genotypic characterization of antioxidant enzyme system in human population exposed to mobile tower radiation

Gulati S, Yadav A, Kumar N, Priya K, Aggarwal NK, Gupta R. Phenotypic and genotypic characterization of antioxidant enzyme system in human population exposed to radiation from mobile towers.Mol Cell Biochem. 2017 Aug 17.

Abstract

In the present era, cellular phones have changed the life style of human beings completely and have become an essential part of their lives. The number of cell phones and cell towers are increasing in spite of their disadvantages. These cell towers transmit radiation continuously without any interruption, so people living within 100s of meters from the tower receive 10,000 to 10,000,000 times stronger signal than required for mobile communication. In the present study, we have examined superoxide dismutase (SOD) enzyme activity, catalase (CAT) enzyme activity, lipid peroxidation assay, and effect of functional polymorphism of SOD and CAT antioxidant genes against mobile tower-induced oxidative stress in human population. From our results, we have found a significantly lower mean value of manganese superoxide dismutase (MnSOD) enzyme activity, catalase (CAT) enzyme activity, and a high value of lipid peroxidation assay in exposed as compared to control subjects. Polymorphisms in antioxidant MnSOD and CAT genes significantly contributed to its phenotype. In the current study, a significant association of genetic polymorphism of antioxidant genes with genetic damage has been observed in human population exposed to radiations emitted from mobile towers.

https://www.ncbi.nlm.nih.gov/pubmed/28819931

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EMF Exposure Changes Due to the Digital Television Switchover in Thessaloniki, Greece

Gkonis F, Boursianis A, Samaras T. Electromagnetic Field Exposure Changes Due to the Digital Television Switchover in Thessaloniki, Greece. Health Phys. 2017 Nov;113(5):382-386.

Abstract

In the present work, the changes in the exposure to electromagnetic fields due to television signals incurred by the digital switchover in Thessaloniki, Greece, are investigated. It is shown that the measured electric fields comply with ICNIRP guidelines but are higher than those in the reported literature for other countries. However, this may be attributed to the selection of measurement points. Moreover, it is shown that the median value of the power density dropped from 60 μW m during analog broadcasting to 13.3 μW m for digital television. This finding indicates that the digital switchover has resulted in reduced exposure for the population to radiofrequency fields in the UHF range.

https://www.ncbi.nlm.nih.gov/pubmed/28961586

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RAPD Profiling, DNA Fragmentation, and Histomorphometric Examination in Brains of Wistar Rats Exposed to Indoor 2.5 Ghz Wi-Fi Devices Radiation

Ibitayo AO, Afolabi OB, Akinyemi AJ, Ojiezeh TI, Adekoya KO, Ojewunmi OO. RAPD Profiling, DNA Fragmentation, and Histomorphometric Examination in Brains of Wistar Rats Exposed to Indoor 2.5 Ghz Wi-Fi Devices Radiation. Biomed Res Int. 2017;2017:8653286.

Abstract

The advent of Wi-Fi connected high technology devices in executing day-to-day activities is fast evolving especially in developing countries of the world and hence the need to assess its safety among others. The

present study was conducted to investigate the injurious effect of radiofrequency emissions from installed Wi-Fi devices in brains of young male rats. Animals were divided into four equal groups; group 1 served as control while groups 2, 3, and 4 were exposed to 2.5 Ghz at intervals of 30, 45, and 60 consecutive days with free access to food and water ad libitum. Alterations in harvested brain tissues were confirmed by histopathological analyses which showed vascular congestion and DNA damage in the brain was assayed using agarose gel electrophoresis. Histomorphometry analyses of their brain tissues showed perivascular congestion and tissue damage as well.

Conclusion

In this study, the effect of Wi-Fi radiation exposure as a threat to brain health was studied using genomic analysis and histopathological study which showed the high risk of its genotoxicity especially in prolonged exposure spectrum through the findings from this study. The genomic analysis confirmed DNA damage due to Wi-Fi radiation toxicity and DNA damage effect which was seen through the RAPD profiles of animals from the exposed groups. The histopathological analyses also confirmed significant deleterious alterations in the brain tissues of Wi-Fi-exposed animals. Hence, the need to exhibit caution in handling smart devices that are used from day to day is fast becoming a threat to human health and wellness.

Open Access Paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5585657/

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Histopathological, immunohistochemical, and stereological analysis of the effect of Gingko biloba (Egb761) on the hippocampus of rats exposed to long-term cellphone radiation

Gevrek F. Histopathological, immunohistochemical, and stereological analysis of the effect of Gingko biloba (Egb761) on the hippocampus of rats exposed to long-term cellphone radiation. Histol Histopathol. 2017 Nov 9:11943.

Abstract

Cellular phones are major sources of electromagnetic radiation (EMR) that can penetrate the human body and pose serious health hazards. The increasingly widespread use of mobile communication systems has raised concerns about the effects of cellphone radiofrequency (RF) on the hippocampus because of its close proximity to radiation during cellphone use. The effects of cellphone EMR exposure on the hippocampus of rats and the possible counteractive effects of ginkgo biloba (Egb761) were aimed to investigate. Rats were divided into three groups: Control, EMR, and EMR+Egb761. The EMR and EMR+Egb761 groups were exposed to cellphone EMR for one month. Egb761 was also administered to the EMR+Egb761 group. Specifically, we evaluated the effect of RF exposure on rat hippocampi at harmful EMR levels (0.96 W/kg specific absorption rate [SAR]) for one month and also investigated the possible impact of ginkgo biloba (Egb761) using stereological, TUNEL-staining, and immunohistochemical methods. An increase in apoptotic proteins (Bax, Acas-3) and a decrease in anti-apoptotic protein (Bcl-2) immunoreactivity along with a decrease in the total granule and pyramidal cell count were noted in the EMR group. A decrease in Bax and Acas-3 and an increase in Bcl-2 immunoreactivity were observed in rats treated with Egb761 in addition to a decrease in TUNEL-stained apoptotic cells and a higher total viable cell number. In conclusion, chronic cellphone EMR exposure may affect hippocampal cell viability, and Egb761 may be used to mitigate some of the deleterious effects.

https://www.ncbi.nlm.nih.gov/pubmed/29120031

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Changes in numbers and size of synaptic vesicles of cortical neurons induced by exposure to 835 MHz RF EMF

Kim JH, Kim HJ, Yu DH, Kweon HS, Huh YH, Kim HR. Changes in numbers and size of synaptic vesicles of cortical neurons induced by exposure to 835 MHz radiofrequency-electromagnetic field. PLoS One. 2017 Oct 18;12(10):e0186416.

Abstract

We studied the effects of radiofrequency electromagnetic fields (RF-EMFs) exposure on neuronal functions of mice. Particularly, we focused on RF-EMF effects on synaptic vesicles (SVs), which store neurotransmitters at axon terminals or synaptic boutons. C57 BL/6 mice were exposed to 835 MHz RF-EMF (4.0 W/kg SAR, for 5 h daily) and alterations in SVs at presynaptic terminals in the cerebral cortex were determined. Ultrastructure of randomly selected cortical neurons was observed using typical electron microscopy and bio-high voltage electron microscopy (Bio-HVEM) methods, which enable the estimation of the numbers and size of SVs. The density of the SVs (number /10 μm2 or 40 μm3) was significantly decreased in the presynaptic boutons of cortical neurons after RF-EMF exposure. Furthermore, qPCR and immunoblotting analyses revealed that the expression of synapsins I/II (Syns I/II) genes and proteins were significantly decreased in the cortical neurons of RF-EMF exposed mice. The present study suggested that alteration of SVs and Syn levels may result in alterations of neurotransmitters in the cerebral cortex following RF-EMF exposure.

https://www.ncbi.nlm.nih.gov/pubmed/29045446

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The effects of GSM cellphone radiation on rabbit's retina

Mohammad R. Talebnejad, Ali Sadeghi-Sarvestani, M. Hossein Nowroozzadeh, Seyed Mohammad J. Mortazavi, Mohammad R. Khalili. The effects of microwave radiation on rabbit's retina. Journal of Current Ophthalmology, Available online 9 October 2017.

Abstract

Purpose Mobile cell phones are used extensively these days, and their microwave (MW) radiation has been shown to affect the eye. The purpose of the present study was to evaluate the effects of MW radiation on rabbit retina.

Methods This experimental study (concluded in 2015) was conducted on 40 adult white New Zealand rabbits. A Global System for Mobile Communications (GSM) cell phone simulator was used for MW irradiation. The rabbits were randomized into five groups (8 in each) and treated as follows: Group 1: no irradiation (sham); Group 2: irradiation at 10 cm for 1 day; Group 3: irradiation at 30 cm for 1 day; Group 4: irradiation at 10 cm for 3 days; and Group 5: irradiation at 30 cm for 3 days. Scotopic and photopic electroretinography (ERG) responses were obtained at baseline and 7 days after the last exposure. Then all the rabbits were euthanized, and their eyes were enucleated and sent for pathology examination. Kruskal–Wallis and Chi-Square tests were used to evaluate intergroup differences in ERG parameters and histological findings, respectively.

Results ERG responses obtained 7 days after irradiation did not show any statistically significant difference between the groups ($P > 0.1$, for all tested parameters). There were statistically non-significant trends toward greater changes in the MW irradiated eyes. In pathological examination, retina was normal with no sign of degeneration or infiltration. Ciliary body congestion was observed in greater fraction of those who received higher MW doses. ($P = 0.005$).

Conclusions Histopathologically, cell phone simulated MW irradiation had no significant detrimental effect on the retina. However, ciliary body congestion was observed in greater fraction of those who received higher MW doses. Although there was no significant difference between post-treatment mean ERG values, there were statistically non-significant trends toward greater changes in the MW irradiated eyes.

http://www.sciencedirect.com/science/article/pii/S2452232517300562

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Extremely high-frequency electromagnetic radiation enhances neutrophil response to particulate agonists

Vlasova II, Mikhalchik EV, Gusev AA, Balabushevich NG, Gusev SA, Kazarinov KD. Extremely high-frequency electromagnetic radiation enhances neutrophil response to particulate agonists. Bioelectromagnetics. 2017 Nov 30. doi: 10.1002/bem.22103.

Abstract

The growing use of extremely high-frequency electromagnetic radiation (EHF EMR) in information and communication technology and in biomedical applications has raised concerns regarding the potential biological impact of millimeter waves (MMWs). Here, we elucidated the effects of MMW radiation on neutrophil activation induced by opsonized zymosan or E. coli in whole blood ex vivo. After agonist addition to blood, two samples were prepared. A control sample was incubated at ambient conditions without any treatment, and a test sample was exposed to EHF EMR (32.9-39.6 GHz, 100 W/m2). We used methods that allowed us to assess the functional status of neutrophils immediately after exposure: oxidant production levels were measured by luminol-dependent chemiluminescence, and morphofunctional changes to neutrophils were observed in blood smears. Results revealed that the response of neutrophils to both agonists was intensified if blood was exposed to MMW radiation for 15 min. Neutrophils were intact in both the control and irradiated samples if no agonist was added to blood before incubation. Similarly, exposing suspensions of isolated neutrophils in plasma to MMW radiation.

https://www.ncbi.nlm.nih.gov/pubmed/29194676

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Spatial memory recovery in Alzheimer's rat model by electromagnetic field exposure

Akbarnejad Z, Esmaeilpour K, Shabani M, Asadi-Shekaari M, Saeedi-Goraghani M, Ahmadi M. Spatial memory recovery in Alzheimer's rat model by electromagnetic field exposure. Int J Neurosci. 2017 Nov 29:1-14. doi: 10.1080/00207454.2017.1411353.

Abstract

INTRODUCTION: Although studies have shown a potential association between extremely low frequency electromagnetic fields (ELF-EMFs) exposure and Alzheimer's disease (AD), few studies have been conducted to investigate the effects of weak magnetic fields on brain functions such as cognitive functions in animal models. Therefore, this study aimed to investigate the effect of ELF-EMF exposure (50 Hz, 10 mT) on spatial learning and memory changes in AD rats.

METHODS: Amyloid-β (Aβ) 1-42 (5 µl/ bilateral, single-dose) was injected into lateral ventricle to establish an AD rat model. The rats were divided into six groups: Group I (control); Group II (surgical sham); Group III (AD) Alzheimer's rat model; Group IV (MF) rats exposed to ELF-MF for 14 consecutive days; Group V (Aβ injection+M) rats exposed to magnetic field for 14 consecutive days from day 0-14 days after the Aβ peptide injection; Group VI (AD+M) rats exposed to magnetic field for 14 consecutive days after 2 weeks of Aβ peptide injection from 14th to 28th day. Morris water maze investigation were implemented and performed 24 h after termination of ELF-MF, respectively.

RESULTS: AD rats showed a significant impairment in learning and memory compared to control rats. The

results showed that ELF-MF improved the learning and memory impairments in Aβ injection+M and AD+M groups.

CONCLUSION: Our results showed that application of ELF-MF not only has improving effect on different cognitive disorder signs of AD animals, but also disrupts the processes of AD rat model formation.

https://www.ncbi.nlm.nih.gov/pubmed/29185809

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Generation and propagation of yeast prion are elevated under ELF and 2.0 GHz RF EMF

Lian HY, Lin KW, Yang C, Cai P. Generation and propagation of yeast prion [URE3] are elevated under electromagnetic field. Cell Stress Chaperones. 2017 Dec 6. doi: 10.1007/s12192-017-0867-9.

Abstract

In this study, we studied the effect of 2.0 GHz radio frequency electromagnetic field (RF-EMF) and 50 Hz extremely low frequency electromagnetic field (ELF-EMF) exposure on prion generation and propagation using two budding yeast strains, NT64C and SB34, as model organisms. Under exposure to RF-EMF or ELF-EMF, the de novo generation and propagation of yeast prions [URE3] were elevated in both strains. The elevation increased over time, and the effects of ELF-EMF occurred in a dose-dependent manner. The transcription and expression levels of the molecular chaperones Hsp104, Hsp70-Ssa1/2, and Hsp40-Ydj1 were not statistically significantly changed after exposure. Furthermore, the levels of ROS, as well as the activities of superoxide dismutase (SOD) and catalase (CAT), were significantly elevated after short-term, but not long-term exposure. This work demonstrated for the first time that EMF exposure could elevate the de novo generation and propagation of yeast prions and supports the hypothesis that ROS may play a role in the effects of EMF on protein misfolding. The effects of EMF on protein folding and ROS levels may mediate the broad effects of EMF on cell function.

https://www.ncbi.nlm.nih.gov/pubmed/29214607

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Biophysical control of the growth of Agrobacterium tumefaciens using ELF EMF at resonance frequency

Fadel MA, El-Gebaly RH, Mohamed SA, Abdelbacki AMM. Biophysical control of the growth of Agrobacterium tumefaciens using extremely low frequency electromagnetic waves at resonance frequency. Biochem Biophys Res Commun. 2017 Dec 9;494(1-2):365-371.

Abstract

Isolated Agrobacterium tumefaciens was exposed to different extremely low frequencies of square amplitude modulated waves (QAMW) from two generators to determine the resonance frequency that causes growth inhibition. The carrier was 10 MHz sine wave with amplitude ±10 Vpp which was modulated by a second wave generator with a modulation depth of ± 2Vpp and constant field strength of 200 V/m at 28 °C. The exposure of A. tumefaciens to 1.0 Hz QAMW for 90 min inhibited the bacterial growth by 49.2%. In addition, the tested antibiotics became more effective against A. tumefaciens after the exposure. Furthermore, results of DNA, dielectric relaxation and TEM showed highly significant molecular and morphological changes due to the exposure to 1.0 Hz QAMW for 90 min. An in-vivo study has been carried out on healthy tomato plants to test the pathogenicity of A. tumefaciens before and after the exposure to QAMW at the inhibiting frequency. Symptoms of crown gall and all pathological symptoms were more aggressive in tomato plants treated with

non-exposed bacteria, comparing with those treated with exposed bacteria. We concluded that, the exposure of A. tumefaciens to 1.0 Hz QAMW for 90 min modified its cellular activity and DNA structure, which inhibited the growth and affected the microbe pathogenicity.

https://www.ncbi.nlm.nih.gov/pubmed/28988110

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Behavioral testing of mice exposed to intermediate frequency magnetic fields indicates mild memory impairment

Kumari K, Koivisto H, Viluksela M, Paldanius KMA, Marttinen M, Hiltunen M, Naarala J, Tanila H, Juutilainen J. Behavioral testing of mice exposed to intermediate frequency magnetic fields indicates mild memory impairment. PLoS One. 2017 Dec 4;12(12):e0188880.

Abstract

Human exposure to intermediate frequency magnetic fields (MF) is increasing due to applications like electronic article surveillance systems and induction heating cooking hobs. However, limited data is available on their possible health effects. The present study assessed behavioral and histopathological consequences of exposing mice to 7.5 kHz MF at 12 or 120 μT for 5 weeks. No effects were observed on body weight, spontaneous activity, motor coordination, level of anxiety or aggression. In the Morris swim task, mice in the 120 μT group showed less steep learning curve than the other groups, but did not differ from controls in their search bias in the probe test. The passive avoidance task indicated a clear impairment of memory over 48 h in the 120 μT group. No effects on astroglial activation or neurogenesis were observed in the hippocampus. The mRNA expression of brain-derived neurotrophic factor did not change but expression of the proinflammatory cytokine tumor necrosis factor alpha mRNA was significantly increased in the 120 μT group. These findings suggest that 7.5 kHz MF exposure may lead to mild learning and memory impairment, possibly through an inflammatory reaction in the hippocampus.

https://www.ncbi.nlm.nih.gov/pubmed/29206232

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Scientometric study of the effects of exposure to non-ionizing EMF on fertility: Understanding reasons of partial failure

Bernabò N, Ciccarelli R, Greco L, Ordinelli A, Mattioli M, Barboni B. Scientometric study of the effects of exposure to non-ionizing electromagnetic fields on fertility: A contribution to understanding the reasons of partial failure. PLoS One. 2017 Dec 6;12(12):e0187890.

Abstract

The exposure to Non-Ionizing-Electromagnetic Fields (NI-EMFs) is often indicated as a cofactor responsible for the fertility reduction, which has been described in recent years. Despite the great interest in this topic and the research effort in exploring it, to date, there are no reliable data. Therefore, we carried out a scientometric analysis of the scientific literature published in peer reviewed Journals concerning this topic to better understand the reasons of this partial failure. To this aim, we identified and analysed 104 papers, published in last 26 years in peer-reviewed Journals, present in ISI Web of Knowledge Core Collection. Then, we analysed the impact of the Journals in which the papers were published as well as that of the single papers, the paper citation dynamics, the keywords citation busts, the geographical localization of citations and the co-authorship dynamics of the Authors. As a result, we found that different animal models (rodent, rabbit, guinea pig, and

swine) and different experimental approaches (epidemiological vs. experimental studies) have the same impact, highlighting the lack of universally adopted standard in research activity. The analysis of the temporal trend in keywords and the high differences in citations between the different countries (also in those belonging to the same geographical and socio-economical area) pointed out the difficulties in approaching this branch of study. Lastly, it was evident that the Authors did not behave as a connected community, but as unconnected clusters of very small size. In conclusion, based on the results of our analysis, we think that important efforts must be undertaken to adopt more standardized models and to improve the research quality and the information exchange within the scientific community, with the aim of improving the reliability and usefulness of the results of research regarding the effect of NI-EMFs on fertility.

https://www.ncbi.nlm.nih.gov/pubmed/29211813

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EMF-Portal, Nov 20, 2017

From November 8-10, 2017, the two international organizations responsible for developing the systems of radiation protection worldwide, the International Commission on Radiological Protection (ICRP), and the International Commission on Non-Ionizing Radiation Protection (ICNIRP) exchanged information and views on the scientific basis, ethical basis, and basic principles of protection. The objectives of this meeting in Munich, Germany, were to increase mutual understanding of the approaches to protection, to reach a common understanding of the state of the systems of protection and to explore possibilities for continued collaboration. Both organizations have reached an agreement in principle to strengthen communication and collaboration between them and with other organizations with similar interests.

There are many commonalities between the systems of protection used for ionizing and non-ionizing radiation. There are also differences, most stemming from different biological effects. Ionizing radiation can cause stochastic and deterministic effects, while most effects due to exposure from non-ionizing radiation appear to be deterministic. However, stochastic effects have been demonstrated due to exposure to ultraviolet radiation, which bridges the ionizing and non-ionizing parts of the electromagnetic spectrum. For ionizing radiation there is a greater emphasis on optimization of protection even at low levels of exposure, whereas for non-ionizing radiation there is a greater emphasis on keeping exposures below thresholds for observed effects.

You can download the official statement on the meeting from the ICNIRP homepage:
http://www.icnirp.org/cms/upload/doc/JointNoteSystemsofProtectionNov2017.pdf

My note: The statement above seems to reflect a fundamental misunderstanding about the biological effects of non-ionizing radiation. It is no wonder that ICNIRP's radiofrequency guidelines are inadequate to protect human health.

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NTP Study Update: https://ntp.niehs.nih.gov/results/areas/cellphones/

Two-year oncogenicity evaluations of cell phone radiofrequency radiation in Sprague-Dawley rats and B6C3F1 mice

McCormick D. Two-year oncogenicity evaluations of cell phone radiofrequency radiation in Sprague-Dawley rats and B6C3F1 mice. Toxicology Letters. 280 (Suppl. 1): S31. Oct 20, 2017.https://doi.org/10.1016/j.toxlet.2017.07.07

Epidemiology data concerning possible health effects of exposure to radiofrequency fields (RF) are conflicting. For this reason, well-designed and controlled studies in predictive laboratory animal models provide the best

prospective opportunity to identify effects of RF exposure that may translate into human health hazards. The U.S. National Toxicology Program supported a program in our laboratory to identify and characterize effects of acute, subchronic, and chronic exposure to non-thermal levels of RF in Sprague-Dawley rats and B6C3F1 mice.

Five-day pilot studies were performed to identify the maximum Specific Absorption Ratios (SARs) to which juvenile, adult, and pregnant rodents can be exposed without increasing body temperature by >1.0 °C. Subsequent subchronic (ten-week) toxicity studies failed to identify any toxicologically significant effects of non-thermal RF on survival, body weight, clinical signs, hematology, or gross or microscopic pathology.

Two-year studies were performed to determine if exposure to non-thermal levels of RF increases the incidence of neoplasia in any site. Male rats exposed to RF demonstrated significantly increased incidences of glioma (brain) and schwannoma (heart); these increases were not seen in female rats or in either sex of mice.

Gliomas and schwannomas have been identified in some epidemiology studies as possible RF-induced neoplasms. Considering (a) the conflicting results of RF epidemiology studies and (b) the lack of generally accepted biophysical or molecular mechanisms through which RF could induce or promote neoplasia, data from animal bioassays will play a central role in “weight-of-the-evidence” assessments of the possible health effects of RF exposure.

http://www.sciencedirect.com/science/article/pii/S0378427417303120?via%3Dihub

Also see: **National Toxicology Program Finds Cell Phone Radiation Causes Cancer**

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Assessment of long-term spatio-temporal radiofrequency electromagnetic field exposure

Aerts S, Wiart J, Martens L, Joseph W. Assessment of long-term spatio-temporal radiofrequency electromagnetic field exposure. Environ Res. 2017 Nov 13;161:136-143. doi: 10.1016/j.envres.2017.11.003.

Abstract

As both the environment and telecommunications networks are inherently dynamic, our exposure to environmental radiofrequency (RF) electromagnetic fields (EMF) at an arbitrary location is not at all constant in time. In this study, more than a year's worth of measurement data collected in a fixed low-cost exposimeter network distributed over an urban environment was analysed and used to build, for the first time, a full spatio-temporal surrogate model of outdoor exposure to downlink Global System for Mobile Communications (GSM) and Universal Mobile Telecommunications System (UMTS) signals. Though no global trend was discovered over the measuring period, the difference in measured exposure between two instances could reach up to 42dB (a factor 12,000 in power density). Furthermore, it was found that, taking into account the hour and day of the measurement, the accuracy of the surrogate model in the area under study was improved by up to 50% compared to models that neglect the daily temporal variability of the RF signals. However, further study is required to assess the extent to which the results obtained in the considered environment can be extrapolated to other geographic locations.

https://www.ncbi.nlm.nih.gov/pubmed/29145005

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Prevalence of various environmental intolerances in a Swedish and Finnish general population

Karvala K, Sainio M, Palmquist E, Nyback MH, Nordin S. Prevalence of various environmental intolerances in

a Swedish and Finnish general population. Environ Res. 2017 Nov 18;161:220-228. doi: 10.1016/j.envres.2017.11.014.

Abstract

OBJECTIVE: To determine the prevalence of various environmental intolerances (EIs), using several criteria in a Swedish and a Finnish general population. Ill-health attributed to low-level environmental exposures is a commonly encountered challenge in occupational and environmental medicine.

METHODS: In population-based questionnaire surveys, the Västerbotten Environmental Health Study (Sweden) and the Österbotten Environmental Health Study (Finland), EI was inquired by one-item questions on symptom attribution to chemicals, certain buildings, or electromagnetic fields (EMFs), and difficulties tolerating sounds. The respondents were asked whether they react with central nervous system (CNS) symptoms or have a physician-diagnosed EI attributed to the corresponding exposures. Prevalence rates were determined for different age and sex groups and the Swedish and Finnish samples in general.

RESULTS: In the **Swedish sample (n = 3406)**, 12.2% had self-reported intolerance to chemicals, 4.8% to certain buildings, **2.7% to EMFs,** and 9.2% to sounds. The prevalence rates for the **Finnish sample (n = 1535)** were 15.2%, 7.2%, **1.6%**, and 5.4%, respectively, differing statistically significantly from the Swedish. EI to chemicals and certain buildings was more prevalent in Finland, while **EI to EMFs** and sounds **more prevalent in Sweden**. The prevalence rates for EI with CNS-symptoms were lower and physician-diagnosed EIs considerably lower than self-reported EIs. Women reported EI more often than men and the young (18-39 years) to a lesser degree than middle-aged and elderly.

CONCLUSIONS: The findings reflect the heterogeneous nature of EI. The differences in EI prevalence between the countries might reflect disparities concerning which exposures people perceive harmful and focus their attention to.

https://www.ncbi.nlm.nih.gov/pubmed/29161654

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Assessment of exposure to RF EMF from smart meters in GB; part II) numerical assessment of SAR within human body

Qureshi MRA, Alfadhl Y, Chen X, Peyman A, Maslanyj M, Mann S. Assessment of exposure to radio frequency electromagnetic fields from smart utility meters in GB; part II) numerical assessment of induced SAR within the human body. Bioelectromagnetics. 2017 Nov 16.

Abstract

Human body exposure to radiofrequency electromagnetic waves emitted from smart meters was assessed using various exposure configurations. Specific energy absorption rate distributions were determined using three anatomically realistic human models. Each model was assigned with age- and frequency-dependent dielectric properties representing a collection of age groups. Generalized exposure conditions involving standing and sleeping postures were assessed for a home area network operating at 868 and 2,450 MHz. The smart meter antenna was fed with 1 W power input which is an overestimation of what real devices typically emit (15 mW max limit). The highest observed whole body specific energy absorption rate value was 1.87 mW kg^{-1}, within the child model at a distance of 15 cm from a 2,450 MHz device. The higher values were attributed to differences in dimension and dielectric properties within the model. Specific absorption rate (SAR) values were also estimated based on power density levels derived from electric field strength measurements made at various distances from smart meter devices. All the calculated SAR values were found to be very small in comparison to International Commission on Non-Ionizing Radiation Protection limits for public exposure.

https://www.ncbi.nlm.nih.gov/pubmed/29143352

Also see: **Health Experts Caution About Smart Meters**

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Acute effects of the electromagnetic waves emitted by mobile phones on attention in emergency physicians

Altuntas G, Sadoglu D, Ardic S, Yilmaz H, Imamoglu M, Turedi S.Acute effects of the electromagnetic waves emitted by mobile phones on attention in emergency physicians. Am J Emerg Med. 2017 Nov 13. pii: S0735-6757(17)30940-3. doi: 10.1016/j.ajem.2017.11.031.

Abstract

STUDY OBJECTIVE: The purpose of this study was to investigate the acute effects of the electromagnetic waves (EMW) emitted by mobile phones on attention in emergency physicians.

METHODS: This single-center, prospective, randomized, double-blinded clinical study was performed among emergency physicians in a tertiary hospital. Thirty emergency physicians were enrolled in the study. Initial d2 test was applied in the evaluation of attention and concentration of all the physicians, who were randomly assigned into one of two groups. The control group members hold mobile phones in 'off' mode to their left ears for 15min. The members of the intervention group hold mobile phones in 'on' mode to their left ears for 15min, thus exposing them to 900-1800MHz EMW. The d2 test was re-applied to both groups after this procedure. Differences in attention and concentration levels between the groups were compared.

RESULTS: Difference between initial and final d2 test in total performance (TN-E, p=0.319), in total number of figures marked (TN, p=0.177), in test performance percentile (PR, p=0.619) and in attention fluctuation (FR, p=0.083) were similar between the groups. However, difference in the number of figures missed (E1 selective attention, p=0.025), difference between numbers of incorrectly marked figures (E2, p=0,018) and difference in focus levels (E, p=0.016) were significantly in favor of the intervention group.

CONCLUSION: According to our study findings, the EMW emitted by mobile phones has no deleterious effect on the attention and concentration levels of emergency physicians, and even has a positive impact on selective attention levels.

https://www.ncbi.nlm.nih.gov/pubmed/29157789

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Effects of 1.8 GHz Radiofrequency Fields on the Emotional Behavior and Spatial Memory of Adolescent Mice

Zhang JP, Zhang KY, Guo L, Chen QL, Gao P, Wang T, Li J, Guo GZ, Ding GR. Effects of 1.8 GHz Radiofrequency Fields on the Emotional Behavior and Spatial Memory of Adolescent Mice. Int J Environ Res Public Health. 2017 Nov 5;14(11). pii: E1344. doi: 10.3390/ijerph14111344.

Abstract

The increasing use of mobile phones by teenagers has raised concern about the cognitive effects of radiofrequency (RF) fields. In this study, we investigated the effects of 4-week exposure to a 1.8 GHz RF field on the emotional behavior and spatial memory of adolescent male mice. Anxiety-like behavior was evaluated by open field test (OFT) and elevated plus maze (EPM) test, while depression-like behavior was evaluated by sucrose preference test (SPT), tail suspension test (TST) and forced swim test (FST). The spatial learning and

memory ability were evaluated by Morris water maze (MWM) experiments. The levels of amino acid neurotransmitters were determined by liquid chromatography-mass spectrometry (LC-MS). The histology of the brain was examined by hematoxylin-eosin (HE) staining. It was found that the depression-like behavior, spatial memory ability and histology of the brain did not change obviously after RF exposure. However, the anxiety-like behavior increased in mice, while, the levels of γ-aminobutyric acid (GABA) and aspartic acid (Asp) in cortex and hippocampus significantly decreased after RF exposure. These data suggested that RF exposure under these conditions do not affect the depression-like behavior, spatial memory and brain histology in adolescent male mice, but it may however increase the level of anxiety, and GABA and Asp were probably involved in this effect.

Note: The 1.8 GHz frequency field was not modulated like cellphone radiation.

Excerpts

Mice were exposed to 1.8 GHz frequency field for 28 days, 6 h/day (9:00 AM to 3:00 PM). During exposure, the animals had access to food and water. The SAR of whole body and brain were approximately 2.7 W/kg and 2.2 W/kg at a distance of 1 m from the antenna. Since the incidence and polarization of free movement mice kept changing during exposure, the deviation between the average SAR value and the maximum and the minimum of SAR was about 8%. The power density in this study was 530 μW/cm^2 ...

It was found that exposure to 2.70 W/kg RF field did not obviously affect the surface body temperature of mice (Figure 1), which suggested that no gross thermal effects were involved. Additionally, the air temperature of the exposure cage with a temperature hygrometer was measured and the results showed that air temperature difference did not exceed 0.1 °C during 6 h exposure.

Effects of RF Exposure on Anxiety-Like Behaviors

The anxiety-like behaviors of mice were evaluated by OFT and EPM after RF exposure. OFT results showed that there were no significant differences in accumulative total distance traveled between the sham group and RF group (Figure 2a). However, the accumulative distance in the center area and the time spent in the central area decreased significantly in the RF group, compared with the sham group (Figure 2b,c), which indicated that 4-week RF exposure could increase the animals' anxiety-like behavior.

In addition, EPM results showed that there were no significant differences in the number of total entries into the arms between the sham group and RF group, which indicated that the locomotor activity in the mice did not change after RF exposure (Figure 3a). However, the percentage of the total time spent in the open arms and the percentage of the entries into the open arms decreased significantly in the RF group, compared with the sham group (Figure 3b,c). These results were consistent with that of OFT.

It was reported that GABA in mice brain, plays a key role in the modulation of anxiety response [40,41,42,43], and in this study, we found that the level of GABA in mice brain decreased significantly after RF exposure. Considering the OFT and EPM results, we speculated that the GABA probably was involved in RF induce anxiety in mice. Additionally, it was found that the level of Asp in mice brain significantly changed after RF exposure. Regarding the relationship between the behavior and Asp remains unclear.

In the present study, brain SAR 2.2 W/kg was selected based on the 2.0 W/kg limit by the International Commission on Nonionizing Radiation Protection (ICNIRP) and Institute of Electrical and Electronics Engineers (IEEE) [44,45]. It was found that after 6 h RF field exposure, the temperature of mice surface body did not change obviously compared with sham group, which suggested that no gross thermal effects were involved in RF-induced anxiety behavior in mice.

Conclusions

4-week exposure to 1.8 GHz RF field had no significant effect on depression-like behavior, spatial learning and memory ability or the histology of brain in adolescent male mice. However, it may increase the level of anxiety, and amino acid neurotransmitters such as GABA might be involved.

Open Access Paper: http://www.mdpi.com/1660-4601/14/11/1344

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Exposure to 835 MHz RF EMF induces autophagy in hippocampus but not in brain stem of mice

Kim JH, Yu DH, Kim HJ, Huh YH, Cho SW, Lee JK, Kim HG, Kim HR. Exposure to 835 MHz radiofrequency electromagnetic field induces autophagy in hippocampus but not in brain stem of mice. Toxicol Ind Health. 2017 Jan 1:748233717740066. doi: 10.1177/0748233717740066.

Abstract

The exploding popularity of mobile phones and their close proximity to the brain when in use has raised public concern regarding possible adverse effects from exposure to radiofrequency electromagnetic fields (RF-EMF) on the central nervous system. Numerous studies have suggested that RF-EMF emitted by mobile phones can influence neuronal functions in the brain. Currently, there is still very limited information on what biological mechanisms influence neuronal cells of the brain. In the present study, we explored whether autophagy is triggered in the hippocampus or brain stem after RF-EMF exposure. C57BL/6 mice were exposed to 835 MHz RF-EMF with specific absorption rates (SAR) of 4.0 W/kg for 12 weeks; afterward, the hippocampus and brain stem of mice were dissected and analyzed. Quantitative real-time polymerase chain reaction (qRT-PCR) analysis demonstrated that several autophagic genes, which play key roles in autophagy regulation, were significantly upregulated only in the hippocampus and not in the brain stem. Expression levels of LC3B-II protein and p62, crucial autophagic regulatory proteins, were significantly changed only in the hippocampus. In parallel, transmission electron microscopy (TEM) revealed an increase in the number of autophagosomes and autolysosomes in the hippocampal neurons of RF-EMF-exposed mice. The present study revealed that autophagy was induced in the hippocampus, not in the brain stem, in 835 MHz RF-EMF with an SAR of 4.0 W/kg for 12 weeks. These results could suggest that among the various adaptation processes to the RF-EMF exposure environment, autophagic degradation is one possible mechanism in specific brain regions.

https://www.ncbi.nlm.nih.gov/pubmed/29166827

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Rats exposed to 2.45 GHz of non-ionizing radiation exhibit behavioral changes with increased brain expression of apoptotic caspase 3

Varghese R, Majumdar A, Kumar G, Shukla A. Rats exposed to 2.45GHz of non-ionizing radiation exhibit behavioral changes with increased brain expression of apoptotic caspase 3. Pathophysiology. 2017 Nov 14. pii: S0928-4680(17)30052-4. doi: 10.1016/j.pathophys.2017.11.001.

Highlights

• The exposure to non-ionizing radiation of 2.45 GHz caused detrimental changes in rat brain leading to

learning and memory decline and expression of anxiety behavior.
• The exposure to radiation induced oxidative stress and fall in brain antioxidants.
• The exposure triggered the gene expression of caspase 3.

Abstract

In recent years there has been a tremendous increase in use of Wi-Fi devices along with mobile phones, globally. Wi-Fi devices make use of 2.4 GHz frequency. The present study evaluated the impact of 2.45 GHz radiation exposure for 4h/day for 45 days on behavioral and oxidative stress parameters in female Sprague Dawley rats. Behavioral tests of anxiety, learning and memory were started from day 38. Oxidative stress parameters were estimated in brain homogenates after sacrificing the rats on day 45. In morris water maze, elevated plus maze and light dark box test, the 2.45 GHz radiation exposed rats elicited memory decline and anxiety behavior. Exposure decreased activities of super oxide dismutase, catalase and reduced glutathione levels whereas increased levels of brain lipid peroxidation was encountered in the radiation exposed rats, showing compromised anti-oxidant defense. Expression of caspase 3 gene in brain samples were quantified which unraveled notable increase in the apoptotic marker caspase 3 in 2.45 GHz radiation exposed group as compared to sham exposed group. No significant changes were observed in histopathological examinations and brain levels of TNF-α. Analysis of dendritic arborization of neurons showcased reduction in number of dendritic branching and intersections which corresponds to alteration in dendritic structure of neurons, affecting neuronal signaling. The study clearly indicates that exposure of rats to microwave radiation of 2.45GHz leads to detrimental changes in brain leading to lowering of learning and memory and expression of anxiety behavior in rats along with fall in brain antioxidant enzyme systems.

https://www.ncbi.nlm.nih.gov/pubmed/29153770

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Effects of exposure to EMF from 915 MHz RFID system on circulating blood cells in the healthy adult rat

Kim HS, Park JS, Jin YB, Do Choi H, Kwon JH, Pack JK, Kim N, Ahn YH. Effects of exposure to electromagnetic field from 915 MHz radiofrequency identification system on circulating blood cells in the healthy adult rat. Bioelectromagnetics. 2017 Nov 24. doi: 10.1002/bem.22093.

Abstract

We investigated whether exposure to the 915 MHz radiofrequency identification (RFID) signal affected circulating blood cells in rats. Sprague-Dawley rats were exposed to RFID at a whole-body specific absorption rate of 2 W/kg for 8 h per day, 5 days per week, for 2 weeks. Complete blood counts were performed after RFID exposure, and the CD4+ /CD8+ ratio was determined by flow cytometry. The number of red blood cells (RBCs) and the values of hemoglobin, hematocrit, and RBC indices were increased in the RFID-exposed group compared with those in the cage-control and sham-exposed groups ($P < 0.05$). However, the RBCs and platelet numbers were within normal physiologic response ranges. The number of white blood cells, including lymphocytes, was decreased in RFID-exposed rats. However, there was no statistically significant difference between the sham-exposed and RFID-exposed groups in terms of T-cell counts or CD4+ /CD8+.

https://www.ncbi.nlm.nih.gov/pubmed/29171038

Excerpts

A period of 2 weeks in rats corresponds to 1.5 years in human if calculated based on a human life expectancy of 80 years.

2 W/kg is about five times the occupational exposure limit 0.4 W/kg of ICNIRP/IEEE guidelines at the distance of 12 cm from RFID antenna.

As RF-EMF exposure can affect body temperature, we measured rectal temperature before and after RFID exposure; no statistically significant changes in temperature were found in our exposure system ....

... although circulating blood cell counts were significantly affected by exposure to 915 MHz RFID at a whole-body SAR of 2 W/kg for 2 weeks, these changes do not necessarily indicate that RFID exposure is harmful, as values remained within normal physiological response ranges.

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Exposure to a specific time-varying electromagnetic field inhibits cell proliferation via cAMP and ERK signaling in cancer cells

Buckner CA, Buckner AL, Koren SA, Persinger MA, Lafrenie RM. Exposure to a specific time-varying electromagnetic field inhibits cell proliferation via cAMP and ERK signaling in cancer cells. Bioelectromagnetics. 2017 Nov 10. doi: 10.1002/bem.22096.

Abstract

Exposure to specific electromagnetic field (EMF) patterns can affect a variety of biological systems. We have shown that exposure to Thomas-EMF, a low-intensity, frequency-modulated (25-6 Hz) EMF pattern, inhibited growth and altered cell signaling in malignant cells. Exposure to Thomas-EMF for 1 h/day inhibited the growth of malignant cells including B16-BL6 mouse melanoma cells, MDA-MB-231, MDA-MB-468, BT-20, and MCF-7 human breast cancer and HeLa cervical cancer cells but did not affect non-malignant cells. The Thomas-EMF-dependent changes in cell proliferation were mediated by adenosine 3',5'-cyclic monophosphate (cAMP) and extracellular-signal-regulated kinase (ERK) signaling pathways. Exposure of malignant cells to Thomas-EMF transiently changed the level of cellular cAMP and promoted ERK phosphorylation. Pharmacologic inhibitors (SQ22536) and activators (forskolin) of cAMP production both blocked the ability of Thomas-EMF to inhibit cell proliferation, and an inhibitor of the MAP kinase pathway (PD98059) was able to partially block Thomas-EMF-dependent inhibition of cell proliferation. Genetic modulation of protein kinase A (PKA) in B16-BL6 cells also altered the effect of Thomas-EMF on cell proliferation. Cells transfected with the constitutively active form of PKA (PKA-CA), which interfered with ERK phosphorylation, also interfered with the Thomas-EMF effect on cell proliferation. The non-malignant cells did not show any EMF-dependent changes in cAMP levels, ERK phosphorylation, or cell growth. These data indicate that exposure to the specific Thomas-EMF pattern can inhibit the growth of malignant cells in a manner dependent on contributions from the cAMP and MAP kinase pathways.

https://www.ncbi.nlm.nih.gov/pubmed/29125193

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Oxidative stress response in SH-SY5Y cells exposed to short-term 1800 MHz radiofrequency radiation

Marjanovic Cermak AM, Pavicic I, Trosic I. Oxidative stress response in SH-SY5Y cells exposed to short-term 1800 MHz radiofrequency radiation. J Environ Sci Health A Tox Hazard Subst Environ Eng. 2017 Nov 17:1-7. doi: 10.1080/10934529.2017.1383124.

Abstract

The exact mechanism that could explain the effects of radiofrequency (RF) radiation exposure at non-thermal level is still unknown. Increasing evidence suggests a possible involvement of reactive oxygen species (ROS) and development of oxidative stress. To test the proposed hypothesis, human neuroblastoma cells (SH-SY5Y)

were exposed to 1800 MHz short-term RF exposure for 10, 30 and 60 minutes. Electric field strength within Gigahertz Transverse Electromagnetic cell (GTEM) was 30 V m-1 and specific absorption rate (SAR) was calculated to be 1.6 W kg-1. Cellular viability was measured by MTT assay and level of ROS was determined by fluorescent probe 2',7'-dichlorofluorescin diacetate. Concentrations of malondialdehyde and protein carbonyls were used to assess lipid and protein oxidative damage and antioxidant activity was evaluated by measuring concentrations of total glutathione (GSH). After radiation exposure, viability of irradiated cells remained within normal physiological values. Significantly higher ROS level was observed for every radiation exposure time. After 60 min of exposure, the applied radiation caused significant lipid and protein damage. The highest GSH concentration was detected after 10 minute-exposure. The results of our study showed enhanced susceptibility of SH-SY5Y cells for development of oxidative stress even after short-term RF exposure.

https://www.ncbi.nlm.nih.gov/pubmed/29148897

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Effects of GSM and UMTS mobile telephony signals on neuron degeneration and blood-brain barrier permeation in the rat brain

Poulletier de Gannes F, Masuda H, Billaudel B, Poque-Haro E, Hurtier A, Lévêque P, Ruffié G, Taxile M, Veyret B, Lagroye I. Effects of GSM and UMTS mobile telephony signals on neuron degeneration and blood-brain barrier permeation in the rat brain. Sci Rep. 2017 Nov 14;7(1):15496. doi: 10.1038/s41598-017-15690-1.

Abstract

Blood-brain barrier (BBB) permeation and neuron degeneration were assessed in the rat brain following exposure to mobile communication radiofrequency (RF) signals (GSM-1800 and UMTS-1950). Two protocols were used: (i) single 2 h exposure, with rats sacrificed immediately, and 1 h, 1, 7, or 50 days later, and (ii) repeated exposures (2 h/day, 5 days/week, for 4 weeks) with the effects assessed immediately and 50 days after the end of exposure. The rats' heads were exposed at brain-averaged specific absorption rates (BASAR) of 0.026, 0.26, 2.6, and 13 W/kg. No adverse impact in terms of BBB leakage or neuron degeneration was observed after single exposures or immediately after the end of repeated exposure, with the exception of a transient BBB leakage (UMTS, 0.26 W/kg). Fifty days after repeated exposure, the occurrence of degenerating neurons was unchanged on average. However, a significant increased albumin leakage was detected with both RF signals at 13 W/kg. In this work, the strongest, delayed effect was induced by GSM-1800 at 13 W/kg. Considering that 13 W/kg BASAR in the rat head is equivalent to 4 times as much in the human head, deleterious effects may occur following repeated human brain exposure above 50 W/kg.

Excerpt

In the present work, BBB permeability in the whole rat brain increased significantly 50 days after repeated exposures: 3-fold for GSM and 2.4-fold for UMTS at 13 W/kg. **A similar significant effect was seen in the whole brain with GSM-1800 at 0.26 W/kg. However, while the mean number of spots was quite similar at different BASAR levels, their distribution among the animals varied.** For example, 20% of the 0.026 W/kg rats had between 4 and 5.5 spots, versus 45% of the 13 W/kg rats (data not shown). Thus, **the effect was much stronger and consistent at 13 W/kg than at 0.026 W/kg or 0.26 W/kg.** It is also noteworthy that the highest albumin levels were comparable to the highest background levels in cage-control rats (Fig. 3).

Open Access Paper: https://www.nature.com/articles/s41598-017-15690-1

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Exposure to 2100 MHz electromagnetic field radiations induces reactive oxygen species generation in Allium cepa roots

Shikha Chandel, Shalinder Kaur, Harminder Pal Singh, Daizy Rani Batish, Ravinder Kumar Kohli. Exposure to 2100 MHz electromagnetic field radiations induces reactive oxygen species generation in Allium cepa roots. Journal of Microscopy and Ultrastructure, 5(4):225-229. Dec 2017,

Abstract

During the last few decades there has been an enormous increase in the usage of cell phones as these are one of the most convenient gadgets and provide excellent mode of communication without evoking any hindrance to movement. However, these are significantly adding to the electromagnetic field radiations (EMF-r) in the environment and thus, are required to be analysed for their impacts on living beings. The present study investigated the role of cell phone EMF-r in inciting oxidative damage in onion (Allium cepa) roots at a frequency of 2100 MHz. Onion roots were exposed to continuous wave homogenous EMF-r for 1, 2 and 4 h for single day and generation of reactive oxygen species (ROS) in terms of malondialdehyde (MDA), hydrogen peroxide (H2O2) and superoxide anion (O2−) content and changes in the activities of antioxidant enzymes- superoxide dismutases (SOD) and catalases (CAT) were measured. The results showed that EMF-r exposure enhanced the content of MDA, H2O2 and O2−. Also, there was an upregulation in the activity of antioxidant enzymes− SOD and CAT− in onion roots. The study concluded that 2100 MHz cell phone EMF-r incite oxidative damage in onion roots by altering the oxidative metabolism.

Open Access Paper: http://www.sciencedirect.com/science/article/pii/S2213879X17300809

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Retrospective estimation of ELF & MF exposure in in vitro studies reveal considerable potential for uncertainty

Portelli LA, Falldorf K, Thuróczy G, Cuppen J. Retrospective estimation of the electric and magnetic field exposure conditions in in vitro experimental reports reveal considerable potential for uncertainty. Bioelectromagnetics. 2017 Nov 24. doi: 10.1002/bem.22099.

Abstract

Experiments on cell cultures exposed to extremely low frequency (ELF, 3-300 Hz) magnetic fields are often subject to multiple sources of uncertainty associated with specific electric and magnetic field exposure conditions. Here we systemically quantify these uncertainties based on exposure conditions described in a group of bioelectromagnetic experimental reports for a representative sampling of the existing literature. The resulting uncertainties, stemming from insufficient, ambiguous, or erroneous description, design, implementation, or validation of the experimental methods and systems, were often substantial enough to potentially make any successful reproduction of the original experimental conditions difficult or impossible. Without making any assumption about the true biological relevance of ELF electric and magnetic fields, these findings suggest another contributing factor which may add to the overall variability and irreproducibility traditionally associated with experimental results of in vitro exposures to low-level ELF magnetic fields.

https://www.ncbi.nlm.nih.gov/pubmed/29171034

Conclusions

In bioelectromagnetics experiments, the general aim of exposures is to increase the likelihood of evoking discernible low-level ELF magnetic field effects, even if they are small. It follows that all biologically relevant experimental conditions must be reasonably reproducible in order for any such effects to be consistently observed and mature into established scientific facts. This work shows that the potential electric and magnetic field exposure uncertainties associated with a considerable portion of the in vitro low-level ELF magnetic field experiments reported are substantial. For these cases, the uncertainties may exceed levels that would allow

for satisfactory reproduction of such exposures in subsequent experimental attempts, and raise doubts about the quality of the reported data to reasonably assess the significance of the biological effects of such exposures, should they exist. Although the definitive importance of this study is contingent on the concrete biological relevance of low-level ELF electric and magnetic fields, these findings suggest another factor which may contribute to the overall variability and irreproducibility traditionally associated with experimental results in this area.

Therefore, it is imperative that the dedicated bioelectromagnetics researcher puts sufficient care into minimizing any potential sort of experimental exposure conditions uncertainty by designing, validating, executing, and reporting the experimental systems and methods carefully and completely from a replication perspective specifically. It is clear that individual experiments and protocols cannot be standardized as they differ in an endpoint-to-endpoint basis; nevertheless, it is the direct responsibility of the researcher to build the necessary framework that fits his specific experimental systems and procedures in a way that they may be replicated within reasonable bounds. For this, the resources presented in this manuscript and those provided by several other researchers in the community for more than 40 years can be useful [Bassett et al., 1974; Bassen et al., 1992; Valberg, 1995; Kuster and Schönborn, 2000; Vijayalaxmi, 2016; Markov, 2017]. Additionally, this endeavor may require the consideration of factors typically excluded from the standard dosimetric scope without proper justification other than for being difficult to characterize. For instance, in acknowledging the hard reality that cellular systems respond to diverse aspects of their immediate environment, the bioelectromagnetics community may embrace the need for complete uncertainty budgets based on computation and experimental validation of the electric and magnetic fields at the cellular level. This may result in the consideration of microdosimetric analysis as an additional (and perhaps indispensable) approach to reduce uncertainty within reasonable levels, depending on the specific experimental conditions at play.

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Cellular Response to ELF-MF and Heat: Evidence for a Common Involvement of Heat Shock Proteins?

Zeni O, Simkó M, Rosaria Scarfi M, Mattsson MO.Cellular Response to ELF-MF and Heat: Evidence for a Common Involvement of Heat Shock Proteins? Public Health, 18 October 2017 | https://doi.org/10.3389/fpubh.2017.00280

It has been shown that magnetic fields in the extremely low frequency range (ELF-MF) can act as a stressor in various *in vivo* or *in vitro* systems, at flux density levels below those inducing excitation of nerve and muscle cells, which are setting the limits used by most generally accepted exposure guidelines, such as the ones published by the International Commission on Non-Ionizing Radiation Protection. In response to a variety of physiological and environmental factors, including heat, cells activate an ancient signaling pathway leading to the transient expression of heat shock proteins (HSPs), which exhibit sophisticated protection mechanisms. A number of studies suggest that also ELF-MF exposure can activate the cellular stress response and cause increased HSPs expression, both on the mRNA and the protein levels. In this review, we provide some of the presently available data on cellular responses, especially regarding HSP expression, due to single and combined exposure to ELF-MF and heat, with the aim to compare the induced effects and to detect possible common modes of action. Some evidence suggest that MF and heat can act as costressors inducing a kind of thermotolerance in cell cultures and in organisms. The MF exposure might produce a potentiated or synergistic biological response such as an increase in HSPs expression, in combination with a well-defined stress, and in turn exert beneficial effects during certain circumstances.

Open Access Paper: https://www.frontiersin.org/articles/10.3389/fpubh.2017.00280/full

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Effects of EMF emissions from undersea electric cables on coral reef fish

Kilfoyle AK, Jermain RF, Dhanak MR, Huston JP, Spieler RE. Effects of EMF emissions from undersea electric cables on coral reef fish. Bioelectromagnetics. 2017 Nov 9. doi: 10.1002/bem.22092.

Abstract

The objective of this study was to determine if electromagnetic field (EMF) emissions from undersea power cables impacted local marine life, with an emphasis on coral reef fish. The work was done at the South Florida Ocean Measurement Facility of Naval Surface Warfare Center in Broward County, Florida, which has a range of active undersea detection and data transmission cables. EMF emissions from a selected cable were created during non-destructive visual fish surveys on SCUBA. During surveys, the transmission of either alternating current (AC), direct current (DC), or none (OFF) was randomly initiated by the facility at a specified time. Visual surveys were conducted using standardized transect and point-count methods to acquire reef fish abundances and species richness prior to and immediately after a change in transmission frequency. The divers were also tasked to note the reaction of the reef fish to the immediate change in EMF during a power transition. In general, analysis of the data did not find statistical differences among power states and any variables. However, this may be a Type II error as there are strong indications of a potential difference of a higher abundance of reef fish at the sites when the power was off, and further study is warranted.

https://www.ncbi.nlm.nih.gov/pubmed/29119574

Conclusions

In conclusion, much of the literature dealing with EMF effects on marine vertebrates can be summed up as contradictory or inconclusive. This study is in some measures likewise. There are some caveats to consider. We did not see adequate numbers of some species, especially elasmobranchs, known to reside in or transit the area. Thus, some local species might be impacted but our results would not clearly show it. Also, we cannot discount the possibility that the time intervals between power states utilized here (approximately 30 min) to assess changes in reef fish populations was too short to capture slow changes that may be occurring as a result of altering the power state, and the low sample sizes and high count variability may be obscuring some statistical analyses. These caveats notwithstanding, we did not find that the EMF provided at the SFOMF had dramatic impact on the fish assemblage we examined. Nonetheless, although no behavioral effects were noted, the distribution data do provide evidence that the EMF may be eliciting some short-term impact on fish leading to their avoidance of both the AC- and DC-generated EMF. We are reluctant to say this impact is benign. Subtle changes in place preference may result from EMF-induced changes in orientation, anxiety, temperature, etc. The potential long-term effect of such impact, if any, on the distributions of fish populations and community structure is not known, and further research is needed. Additional studies involving larger sample sizes, longer time intervals with the power remaining constant for each particular current type (OFF vs. AC vs. DC), different power strengths, and sites are required. Because the potential sensitivity of most non-elasmobranch fish to EMFs appears low, combining such field studies in conjunction with laboratory behavioral studies would likely produce more conclusive results.

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News Item: International EMF Expert Group to Counter ICNIRP

ECERI Newsletter. No. 6, June 2017

Following a recent meeting with WHO representatives in Geneva, members of this ECERI group have decided to publish their own data in the form of a scientific consensus paper on the effects of non-thermal EMFs on behalf of the ECERI. Finally, since several ECERI scientists believe that environmental pollution may in fact be a cause of cancer and other diseases such as Alzheimer disease and autism, ECERI has proposed to create another international group comprising scientists and jurists to discuss the possibility that intentional massive pollution could be recognized by the International Criminal Court (ICC) as a true crime against health. This

proposal will be discussed at the next ECERI Executive Committee and General Assembly in Brussels.

Following the meeting with WHO in Geneva on March, the 3rd, it was proposed to create an ECERI-related working group to oppose ICNIRP (International Commission on Non-Ionizing Radiation Protection), that might be termed “International commission of scientific expertise on non-thermal radiation effects (ICSENTRE). The members of this group so far are: Dominique Belpomme (France), Igor Belyaev (Slovakia), Ernesto Burgio (Italy), David Carpenter (USA), Lennart Hardell (Sweden), Magda Havas (Canada), SMJ Mortazavi (Iran), André Vander Vorst (Belgium) and Gérard Ledoigt (France). If you wish to join this group, please contact Christine Campagnac (sg.eceri@gmail.com).

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Thermal Modeling for the Next Generation of Radiofrequency Exposure Limits: Commentary

Foster KR, Ziskin MC, Balzano Q. Thermal Modeling for the Next Generation of Radiofrequency Exposure Limits: Commentary. Health Phys. 2017 Jul;113(1):41-53. doi: 10.1097/HP.0000000000000671.

Abstract

This commentary evaluates two sets of guidelines for human exposure to radiofrequency (RF) energy, focusing on the frequency range above the "transition" frequency at 3-10 GHz where the guidelines change their basic restrictions from specific absorption rate to incident power density, through the end of the RF band at 300 GHz. The analysis is based on a simple thermal model based on Pennes' bioheat equation (BHTE) (Pennes 1948) assuming purely surface heating; an Appendix provides more details about the model and its range of applicability. This analysis suggests that present limits are highly conservative relative to their stated goals of limiting temperature increase in tissue. As applied to transmitting devices used against the body, they are much more conservative than product safety standards for touch temperature for personal electronics equipment that are used in contact with the body. Provisions in the current guidelines for "averaging time" and "averaging area" are not consistent with scaling characteristics of the bioheat equation and should be refined. The authors suggest the need for additional limits on fluence for protection against brief, high intensity pulses at millimeter wave frequencies. This commentary considers only thermal hazards, which form the basis of the current guidelines, and excludes considerations of reported "non-thermal" effects of exposure that would have to be evaluated in the process of updating the guidelines.

https://www.ncbi.nlm.nih.gov/pubmed/28542010

Excerpts

"To avoid misinterpretation, the authors emphasize that they consider only thermal hazards and do not comment on the contentious issue of “non-thermal” effects, which would have to be evaluated by the expert panels that update the limits...."

"Low-level effects: Despite more than 50 years of RF research, low-level biological effects have not been established. No theoretical mechanism has been established that supports the existence of any effect characterized by trivial heating other than microwave hearing.”

"The technology for exposure assessment needs to be improved, particularly at frequencies between the transition (10 GHz for ICNIRP) and the beginning of the mm wave band (30 GHz) where the energy penetration depth in skin ranges from about 2 mm (10 GHz) to less than 1 mm (30 GHz) (Table A1, Appendix).

The transition between use of SAR as the dosimetric quantity below the transition frequency to incident power density above it is not reflected in the physics of electromagnetic waves, which obey the same propagation laws at all frequencies."

"Moreover, thermal modeling remains problematic, particularly for long-term (several minutes or more) exposures. The applicability and accuracy of the BHTE for calculating skin temperature increases for general exposure situations (arbitrary exposed areas of skin, steady state temperatures) have been subjected to almost no experimental tests for RF exposures at any frequency. Absent experimental validation of a generally useful thermal model, this calls for caution in setting limits based on thermal modeling."

"The authors declare no conflicts of interest."

"Acknowledgments—This work was sponsored by Mobile Manufacturers Forum, which had no control over the contents of this paper. The authors thank Dr. C-K Chou for helpful suggestions on this work."

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Mobile phone use, school EMF levels & related symptoms: cross-sectional survey among high school students in Turkish city

Durusoy R, Hassoy H, Özkurt A, Karababa AO. Mobile phone use, school electromagnetic field levels and related symptoms: a cross-sectional survey among 2150 high school students in Izmir. Environ Health. 2017 Jun 2;16(1):51. doi: 10.1186/s12940-017-0257-x.

Abstract

BACKGROUND: Health outcomes of electromagnetic fields (EMF) from mobile phones and their base stations are of concern. Conducting multidisciplinary research, targeting children and exploring dose-response are recommended. Our objectives were to describe the mobile phone usage characteristics of high school students and to explore the association between mobile phone usage characteristics, high school EMF levels and self-reported symptoms.

METHODS: This cross-sectional study's data were collected by a survey questionnaire and by measuring school EMF levels between November 2009 and April 2011. A sample size of 2530 was calculated from a total of 20,493 students in 26 high schools and 2150 (85.0%) were included in the analysis. The frequencies of 23 symptoms were questioned and analysed according to 16 different aspects of mobile phone use and school EMF levels, exploring also dose-response. School EMF levels were measured with Aaronia Spectran HF-4060 device. Chi square and trend tests were used for univariate and logistic regression was used for multivariate analyses.

RESULTS: Among participants, 2021 (94.0%) were using mobile phones and 129 (6.0%) were not. Among users, 49.4% were speaking <10 min and 52.2% were sending/receiving 75 or more messages per day. Headache, fatigue and sleep disturbances were observed respectively 1.90 (95% CI 1.30-2.77), 1.78 (1.21-2.63) and 1.53 (1.05-2.21) times more among mobile phone users. Dose-response relationships were observed especially for the number of calls per day, total duration of calls per day, total number of text messages per day, position and status of mobile phone at night and making calls while charging as exposures and headache, concentration difficulties, fatigue and sleep disturbances as general symptoms and warming of the ear and flushing as local symptoms.

CONCLUSIONS: We found an association between mobile phone use and especially headache, concentration difficulties, fatigue, sleep disturbances and warming of the ear showing also dose-response. We have found limited associations between vicinity to base stations and some general symptoms; however, we did not find any association with school EMF levels. Decreasing the numbers of calls and messages, decreasing the duration of calls, using earphones, keeping the phone away from the head and body and similar precautions

might decrease the frequencies or prevalence of the symptoms.

https://www.ncbi.nlm.nih.gov/pubmed/28577556

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On the biophysical mechanism of sensing atmospheric discharges by living organisms

Dimitris J. Panagopoulos, Alfonso Balmori. On the biophysical mechanism of sensing atmospheric discharges by living organisms. Science of the Total Environment. 599-600:2026-2034. Dec 1, 2017. https://doi.org/10.1016/j.scitotenv.2017.05.089• The symptoms are mainly headache, fatigue, sleep disorders etc.

• Sferics consist of partially polarized electromagnetic pulses.
• Sferics have adequate intensity and polarization to cause biological/health effects.
• We provide a novel biophysical explanation for sensing sferics by living organisms.

Abstract

Atmospheric electrical discharges during thunderstorms, and the related electromagnetic fields (EMFs)/waves called sferics, can be sensed by humans at long distances through a variety of symptoms, mainly headache, fatigue, etc. Up to today there is no explanation for this association. Sferics consist of partially polarized electromagnetic pulses with an oscillating carrier signal in the very low frequency (VLF) band and a pulse repetition frequency in the extremely low frequency (ELF) band. Their ELF intensity may reach ~ 5 mV/m at global ranges, and ~ 0.5 V/m at ~ 1000 km from the lightning. The health symptoms associated with sferics are also associated with antennas of mobile telephony base stations and handsets, which emit radio frequency (RF) radiation pulsed on ELF, and expose humans at similar or stronger electric field intensities with sferics. According to the Ion Forced-Oscillation mechanism, polarized ELF EMFs of intensities down to 0.1–1 mV/m are able to disrupt any living cell's electrochemical balance and function by irregular gating of electro-sensitive ion channels on the cell membranes, and thus initiate a variety of health symptoms, while VLF EMFs need to be thousands of times stronger in order to be able to initiate health effects. We examine EMFs from sferics in terms of their bioactivity on the basis of this mechanism. We introduce the hypothesis that stronger atmospheric discharges may reasonably be considered to be ~ 70% along a straight line, and thus the associated EMFs (sferics) ~ 70% polarized. We find that sferics mainly in the ELF band have adequate intensity and polarization to cause biological/health effects. We provide explanation for the effects of sferics on human/animal health on the basis of this mechanism.

http://www.sciencedirect.com/science/article/pii/S0048969717311890

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Environmental Factors That Influence Stem Cell Migration: An "Electric Field"

Iwasa SN, Babona-Pilipos R, Morshead CM. Environmental Factors That Influence Stem Cell Migration: An "Electric Field". Stem Cells Int. 2017;2017:4276927. doi: 10.1155/2017/4276927. Epub 2017 May 15.

Abstract

Environmental Stimulus of Electric Fields on Stem Cell Migration. The movement of cells in response to electric potential gradients is called galvanotaxis. In vivo galvanotaxis, powered by endogenous electric fields (EFs), plays a critical role during development and wound healing. This review aims to provide a perspective on how stem cells transduce EFs into directed migration and an understanding of the current literature relating to the mechanisms by which cells sense and transduce EFs. We will comment on potential EF-based regenerative medicine therapeutics.

https://www.ncbi.nlm.nih.gov/pubmed/28588621

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RF EMF Risk Perception Revisited: Is the Focus on Concern Sufficient for Risk Perception Studies?

Wiedemann PM, Freudenstein F, Böhmert C, Wiart J, Croft RJ. RF EMF Risk Perception Revisited: Is the Focus on Concern Sufficient for Risk Perception Studies? Int J Environ Res Public Health. 2017 Jun 8;14(6). pii: E620. doi: 10.3390/ijerph14060620.

Abstract

An implicit assumption of risk perception studies is that concerns expressed in questionnaires reflect concerns in everyday life. The aim of the present study is to check this assumption, i.e., the extrapolability of risk perceptions expressed in a survey, to risk perceptions in everyday life. To that end, risk perceptions were measured by a multidimensional approach. In addition to the traditional focus on measuring the magnitude of risk perceptions, the thematic relevance (how often people think about a risk issue) and the discursive relevance (how often people think about or discuss a risk issue) of risk perceptions were also collected. Taking into account this extended view of risk perception, an online survey was conducted in six European countries with 2454 respondents, referring to radio frequency electromagnetic field (RF EMF) risk potentials from base stations, and access points, such as WiFi routers and cell phones. The findings reveal that the present study's multidimensional approach to measuring risk perception provides a more differentiated understanding of RF EMF risk perception. High levels of concerns expressed in questionnaires do not automatically imply that these concerns are thematically relevant in everyday life. We use thematic relevance to distinguish between enduringly concerned (high concern according to both questionnaire and thematic relevance) and not enduringly concerned participants (high concern according to questionnaire but no thematic relevance). Furthermore, we provide data for the empirical value of this distinction: Compared to other participants, enduringly concerned subjects consider radio frequency electromagnetic field exposure to a greater extent as a moral and affective issue. They also see themselves as highly exposed to radio frequency electromagnetic fields. However, despite these differences, subjects with high levels of thematic relevance are nevertheless sensitive to exposure reduction as a means for improving the acceptance of base stations in their neighborhood. This underlines the value of exposure reduction for the acceptance of radio frequency electromagnetic field communication technologies.

https://www.ncbi.nlm.nih.gov/pubmed/28594366

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Microwave-induced Apoptosis and Cytotoxicity of NK Cells through ERK1/2 Signaling

Zhao L, Li J, Hao YH, Gao YB, Wang SM, Zhang J, Dong J, Zhou HM, Liu SC, Peng RY. Microwave-induced Apoptosis and Cytotoxicity of NK Cells through ERK1/2 Signaling. Biomed Environ Sci. 2017 May;30(5):323-332. doi: 10.3967/bes2017.043.

Abstract

OBJECTIVE: To investigate microwave-induced morphological and functional injury of natural killer (NK) cells and uncover their mechanisms.

METHODS: NK-92 cells were exposed to 10, 30, and 50 mW/cm2 microwaves for 5 min. Ultrastructural changes, cellular apoptosis and cell cycle regulation were detected at 1 h and 24 h after exposure. Cytotoxic activity was assayed at 1 h after exposure, while perforin and NKG2D expression were detected at 1 h, 6 h, and 12 h after exposure. To clarify the mechanisms, phosphorylated ERK (p-ERK) was detected at 1 h after exposure. Moreover, microwave-induced cellular apoptosis and cell cycle regulation were analyzed after blockade of ERK signaling by using U0126.

RESULTS: Microwave-induced morphological and ultrastructural injury, dose-dependent apoptosis ($P < 0.001$) and cell cycle arrest ($P < 0.001$) were detected at 1 h after microwave exposure. Moreover, significant apoptosis was still detected at 24 h after 50 mW/cm2 microwave exposure ($P < 0.01$). In the 30 mW/cm2 microwave exposure model, microwaves impaired the cytotoxic activity of NK-92 cells at 1 h and down regulated perforin protein both at 1 h and 6 h after exposure ($P < 0.05$). Furthermore, p-ERK was down regulated at 1 h after exposure ($P < 0.05$), while ERK blockade significantly promoted microwave-induced apoptosis ($P < 0.05$) and downregulation of perforin ($P < 0.01$).

CONCLUSION: Microwave dose-dependently induced morphological and functional injury in NK-92 cells, possibly through ERK-mediated regulation of apoptosis and perforin expression.

https://www.ncbi.nlm.nih.gov/pubmed/28549488

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Resveratrol may reverse effects of long-term occupational exposure to EMF on power plant workers

Zhang D, Zhang Y, Zhu B, Zhang H, Sun Y, Sun C. Resveratrol may reverse the effects of long-term occupational exposure to electromagnetic fields on workers of a power plant. Oncotarget. 2017 May 7. doi: 10.18632/oncotarget.17668. [Epub ahead of print]

Abstract

High-voltage electricity lines are known to generate extremely low-frequency electromagnetic fields (ELF-EMFs). With the process of urbanization, increasing concerns has been focused on the potentially hazardous impacts of ELF-EMF on human health, and the conclusions are controversial. Little is known about the method of prevention against ELF-EMF induced healthy problems. A total of 186 male workers with occupational exposure to high-voltage electricity lines, and 154 male subjects with insignificant exposure as reference control were enrolled in this study. Resveratrol or placebo was given as dietary supplements (500 mg twice daily), and several inflammatory biomarkers and biomarkers of oxidative stress were assessed. Workers who had long-term exposure to high-voltage electricity lines exhibited elevated urinary levels of 8-hydroxy-2-deoxy-guanosine (8-OHdG) and F2-isoprostane, compared to the reference group. Lower plasma nuclear factor kappa B (NF-κB) and interleukin (IL)-6 were observed in exposed workers compared to the reference group. Resveratrol significantly reversed the adverse impacts of ELF-EMF. Stimulated cytokine production by resveratrol was found in exposed workers but not in the reference group. This study supported that occupational and long-term exposure to high-voltage electricity lines has an adverse effect on homeostasis of human body, and resveratrol supplement could be an effective protection strategy against the adverse effects induced by ELF-EMFs.

https://www.ncbi.nlm.nih.gov/pubmed/28537898

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Exposure to magnetic fields from power lines & childhood asthma in Danish National Birth Cohort

Sudan M, Arah OA, Becker T, Levy Y, Sigsgaard T, Olsen J, Vergara X, Kheifets L. Re-examining the association between residential exposure to magnetic fields from power lines and childhood asthma in the Danish National Birth Cohort. PLoS One. 2017 May 17;12(5):e0177651. doi: 10.1371/journal.pone.0177651.

Abstract

BACKGROUND: A study reported an increased risk of asthma in children whose mothers were exposed to magnetic field (MF) levels above 0.2 μT during pregnancy. We re-examined this association using data from mothers and children in the Danish National Birth Cohort (DNBC).

METHODS: This study included 92,676 singleton-born children and their mothers from the DNBC. MF exposure from power lines was estimated for all residences where the mothers lived during pregnancy and for all children from birth until the end of follow up. Exposure was categorized into 0 μT, 0.1 μT, and ≥ 0.2 μT for analysis. Definitive and possible asthma cases were identified using data from three independent data sources: 1) mothers' reports, 2) a national hospitalization register, 3) a national prescription drug register. We calculated hazard ratios (HR) and 95% confidence intervals (CI) for the association between the highest level of exposure during pregnancy and asthma in children, adjusting for several potential confounding factors. We also examined the sensitivity of the risk estimates to changes in exposure and outcome definitions.

RESULTS: No differences or trends in the risk of asthma development were detected between children with different levels of MF exposure regardless of the asthma case definition or outcome data source. For definitive cases, the HR (95% CI) for those with any exposure was 0.72 (0.27-1.92), and it was 0.41 (0.06-2.92) for those exposed to ≥ 0.2 μT. Adjustments for confounding and variations in the exposure definition did not appreciably alter the results.

CONCLUSION: We did not find evidence that residential exposure to MF during pregnancy or early childhood increased the risk of childhood asthma. This interpretation is in line with the lack of an established biological mechanism directly linking MF exposure to asthma, but high exposure was very rare in this cohort.

https://www.ncbi.nlm.nih.gov/pubmed/28545137

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Exposure to ELF and IF magnetic and electric fields among children from the INMA-Gipuzkoa cohort

Gallastegi M, Jiménez-Zabala A, Santa-Marina L, Aurrekoetxea JJ, Ayerdi M, Ibarluzea J, Kromhout H, González J, Huss A. Exposure to extremely low and intermediate-frequency magnetic and electric fields among children from the INMA-Gipuzkoa cohort.Environ Res. 2017 May 30;157:190-197. doi: 10.1016/j.envres.2017.05.027. [Epub ahead of print]

Abstract

Detailed assessment of exposure to extremely low frequency (ELF) and intermediate frequency (IF) fields is essential in order to conduct informative epidemiological studies of the health effects from exposure to these fields. There is limited information available regarding ELF electric fields and on both magnetic and electric field exposures of children in the IF range. The aim of this study was to characterize ELF and IF exposure of children in the Spanish INMA cohort. A combination of spot and fixed measurements was carried out in 104 homes, 26 schools and their playgrounds and 105 parks. Low levels of ELF magnetic fields (ELF-MF) were observed (with the highest 24-h time-weighted average (TWA) exposure being 0.15μT in one home). The interquartile range (IQR) of ELF electric fields (ELF-EF) ranged from 1 to 15V/m indoors and from 0.3 to 1.1V/m outdoors and a maximum value observed was 55.5V/m in one school playground. IQR ranges for IF magnetic and electric fields were between 0.02 and 0.23μT and 0.2 and 0.5V/m respectively and maximum

values were 0.03μT and 1.51V/m in homes. Correlations between magnetic and electric fields were weak for ELF (Spearman 0.04-0.36 in different settings) and moderate for IF (between 0.28 and 0.75). Children of INMA-Gipuzkoa cohort were exposed to very low levels of ELF-MF in all settings and to similar levels of ELF-EF compared to the range of previously reported levels, although somewhat higher exposures occurred at home. Children enrolled to our study were similarly exposed to IF in all settings.

https://www.ncbi.nlm.nih.gov/pubmed/28575784

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Effects of acute & chronic exposure to 900 MHz & 2100 MHz EMR on glutamate receptor signaling pathway

Gökçek-Saraç Ç, Er H, Kencebay Manas C, Kantar Gök D, Özen Ş, Derin N. Effects of acute and chronic exposure to both 900 MHz and 2100 MHz electromagnetic radiation on glutamate receptor signaling pathway. Int J Radiat Biol. 2017 Jun 1:1-29. doi: 10.1080/09553002.2017.1337279. [Epub ahead of print]

Abstract

PURPOSE: To demonstrate molecular effects of acute and chronic exposure to both 900 MHz and 2100 MHz radiofrequency electromagnetic radiation (RF-EMR) on the hippocampal level/activity of some of the enzymes - including PKA, CaMKIIα, CREB, and p44/42 MAPK - from N-methyl-D-aspartate receptor (NMDAR) related signaling pathways.

MATERIALS AND METHODS: Rats were divided into following groups: Sham rats, rats exposed to 900 MHz and 2100 MHz RF-EMR for 2 h/day for acute (1 week) or chronic (10 weeks), respectively. The Western Blotting and activity measurement assays were used to assess the level/activity of the selected enzymes.

RESULTS: The obtained results have revealed that the hippocampal level/activity of selected enzymes was significantly higher in chronic groups as compared to acute groups at both 900 MHz and 2100 MHz RF-EMR exposure. In addition, hippocampal level/activity of selected enzymes was significantly higher at 2100 MHz RF-EMR than 900 MHz RF-EMR in both acute and chronic groups.

CONCLUSION: The present study provides experimental evidence that both exposure duration (1 week versus 10 weeks) and different carrier frequencies (900 MHz versus 2100 MHz) had different effects on protein expression of hippocampus in Wistar rats, which might encourage further research on protection against RF-EMR exposure.

https://www.ncbi.nlm.nih.gov/pubmed/28565929

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Adaptive Response Induced by Pre-Exposure to 915 MHz RF: A Possible Role for Antioxidant Enzyme Activity

Mortazavi SMJ, Mostafavi-Pour Z, Daneshmand M, Zal F, Zare R, Mosleh-Shirazi MA. Adaptive Response Induced by Pre-Exposure to 915 MHz Radiofrequency: A Possible Role for Antioxidant Enzyme Activity. J Biomed Phys Eng. 2017 Jun 1;7(2):137-142.

Abstract

BACKGROUND: Over the past few years, the rapid use of high frequency electromagnetic fields like mobile phones has raised global concerns about the negative health effects of its use. Adaptive response is the ability of a cell or tissue to better resist stress damage by prior exposure to a lesser amount of stress. This study

aimed to assess whether radiofrequency radiation can induce adaptive response by changing the antioxidant balance.

MATERIALS AND METHODS: In order to assess RF-induced adaptive response in tissues, we evaluated the level of GSH and the activity of GR in liver. 50 rats were divided into 5 groups. Three groups were pre-exposed to 915 MHz RF radiation, 4 hours per day for one week at different powers, as low, medium and high. 24 hours after the last exposure to radiation, they were exposed to 4 Gy sublethal dose of gamma radiation and then sacrificed after 5 hours. Their livers were removed, washed and were kept at -80o C until used.

RESULTS: Our finding showed that pre-exposure to 915 MHz radiofrequency radiation with specific power could induce adaptive response in liver by inducing changes in the activity and level of antioxidant enzymes.

CONCLUSION: It can be concluded that pre-exposure to microwave radiation could increase the level of GSH and the activity of GR enzyme, although these increases were seen just in low power group, and the GR activity was indicated in medium power group. This increase protects tissue from oxidative damage induced by sublethal dose of gamma radiation.

https://www.ncbi.nlm.nih.gov/pubmed/28580335

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Alterations of thymic morphology and antioxidant biomarkers in male rats following exposure to continuous 900 MHz EMF during adolescence

Kulaber A, Kerimoğlu G, Ersöz Ş, Çolakoğlu S, Odacı E. Alterations of thymic morphology and antioxidant biomarkers in 60-day-old male rats following exposure to a continuous 900 MHz electromagnetic field during adolescence. Biotech Histochem. 2017 Jun 9:1-7. doi: 10.1080/10520295.2017.1312525.

Abstract

We investigated changes in thymic tissue of male rats exposed to a 900 megahertz (MHz) electromagnetic field (EMF) on postnatal days 22-59. Three groups of six 21-day-old male Sprague-Dawley rats were allocated as: control (CG), sham (SG) and EMF (EMFG) groups. No procedure was performed on the CG rats. SG rats were placed in a Plexiglas cage for 1 h every day between postnatal days 22 and 59 without exposure to EMF. EMFG rats were placed in the same cage for the same periods as the SG rats and were exposed to 900 MHz EMF. Rats were sacrificed on postnatal day 60. Sections of thymus were stained for histological assessment. Oxidant/antioxidant parameters were investigated biochemically. Malondialdehyde (MDA) levels in EMFG increased compared to the other groups. Extravascular erythrocytes were observed in the medullary/corticomedullary regions in EMFG sections. We found that 900 MHz EMF applied for 1 h/day on postnatal days 22-59 can increase tissue MDA and histopathological changes in male rat thymic tissue.

https://www.ncbi.nlm.nih.gov/pubmed/28598680

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Warburg effect-damping of electromagnetic oscillations

Pokorný J, Pokorný J, Borodavka F. Warburg effect-damping of electromagnetic oscillations. Electromagn Biol Med. 2017 Jun 2:1-9. doi: 10.1080/15368378.2017.1326933.

Abstract

Mitochondrial dysfunction is a central defect in cells creating the Warburg and reverse Warburg effect cancers. However, the link between mitochondrial dysfunction and cancer has not yet been clearly explained. Decrease of mitochondrial oxidative energy production to about 50 % in comparison with healthy cells may be caused by inhibition of pyruvate transfer into mitochondrial matrix and/or disturbed H+ ion transfer across inner mitochondrial membrane into cytosol. Lowering of the inner membrane potential and shifting of the working point of mitochondria to high values of pH above an intermediate point causes reorganization of the ordered water layer at the mitochondrial membrane. The reorganized ordered water layers at high pH values release electrons which are transferred to the cytosol rim of the layer. The electrons damp electromagnetic activity of Warburg effect cancer cells or fibroblasts associated with reverse Warburg effect cancer cells leading to lowered electromagnetic activity, disturbed coherence, increased frequency of oscillations and decreased level of biological functions. In reverse Warburg effect cancers, associated fibroblasts supply energy-rich metabolites to the cancer cell resulting in increased power of electromagnetic field, fluctuations due to shift of oscillations to an unstable nonlinear region, decreased frequency and loss of coherence.

https://www.ncbi.nlm.nih.gov/pubmed/28574758

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Electrical Grounding Improves Vagal Tone in Preterm Infants

Passi R, Doheny KK, Gordin Y, Hinssen H, Palmer C. Electrical Grounding Improves Vagal Tone in Preterm Infants. Neonatology. 2017 Jun 10;112(2):187-192. doi: 10.1159/000475744.

Abstract

BACKGROUND: Low vagal tone (VT) is a marker of vulnerability to stress and the risk of developing necrotizing enterocolitis in preterm infants. Electric fields produced by equipment in the neonatal intensive care unit (NICU) induce an electric potential measurable on the skin in reference to ground. An electrical connection to ground reduces the skin potential and improves VT in adults.

OBJECTIVES: We aimed to measure the electric field strengths in the NICU environment and to determine if connecting an infant to electrical ground would reduce the skin potential and improve VT. We also wished to determine if the skin potential correlated with VT.

METHODS: Environmental magnetic flux density (MFD) was measured in and around incubators. Electrical grounding (EG) was achieved with a patch electrode and wire that extended to a ground outlet. We measured the skin potential in 26 infants and heart rate variability in 20 infants before, during, and after grounding. VT was represented by the high-frequency power of heart rate variability.

RESULTS: The background MFD in the NICU was below 0.5 mG, but it ranged between 1.5 and 12.7 mG in the closed incubator. A 60-Hz oscillating potential was recorded on the skin of all infants. With EG, the skin voltage dropped by about 95%. Pre-grounding VT was inversely correlated with the skin potential. VT increased by 67% with EG. After grounding, the VT fell to the pre-grounding level.

CONCLUSION: The electrical environment affects autonomic balance. EG improves VT and may improve resilience to stress and lower the risk of neonatal morbidity in preterm infants.

https://www.ncbi.nlm.nih.gov/pubmed/28601861

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ELF EMFs Affect Myogenic Processes in C2C12 Myoblasts: Role of Gap-Junction-Mediated Intercellular Communication

Morabito C, Steimberg N, Rovetta F, Boniotti J, Guarnieri S, Mazzoleni G, Mariggiò MA. Extremely Low-Frequency Electromagnetic Fields Affect Myogenic Processes in C2C12 Myoblasts: Role of Gap-Junction-Mediated Intercellular Communication. Biomed Res Int. 2017;2017:2460215. doi: 10.1155/2017/2460215.

Abstract

Extremely low-frequency electromagnetic fields (ELF-EMFs) can interact with biological systems. Although they are successfully used as therapeutic agents in physiatrics and rehabilitative practice, they might represent environmental pollutants and pose a risk to human health. Due to the lack of evidence of their mechanism of action, the effects of ELF-EMFs on differentiation processes in skeletal muscle were investigated. C2C12 myoblasts were exposed to ELF-EMFs generated by a solenoid. The effects of ELF-EMFs on cell viability and on growth and differentiation rates were studied using colorimetric and vital dye assays, cytomorphology, and molecular analysis of MyoD and myogenin expression, respectively. The establishment of functional gap junctions was investigated analyzing connexin 43 expression levels and measuring cell permeability, using microinjection/dye-transfer assays. The ELF-EMFs did not affect C2C12 myoblast viability or proliferation rate. Conversely, at ELF-EMF intensity in the mT range, the myogenic process was accelerated, through increased expression of MyoD, myogenin, and connexin 43. The increase in gap-junction function suggests promoting cell fusion and myotube differentiation. These data provide the first evidence of the mechanism through which ELF-EMFs may provide therapeutic benefits and can resolve, at least in part, some conditions of muscle dysfunction.

https://www.ncbi.nlm.nih.gov/pubmed/28607928

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World Health Organization, radiofrequency radiation and health - a hard nut to crack (Review)

Hardell L. World Health Organization, radiofrequency radiation and health - a hard nut to crack (Review). International Journal of Oncology. Published online on: June 21, 2017. https://doi.org/10.3892/ijo.2017.4046

Abstract

In May 2011 the International Agency for Research on Cancer (IARC) evaluated cancer risks from radiofrequency (RF) radiation. Human epidemiological studies gave evidence of increased risk for glioma and acoustic neuroma. RF radiation was classified as Group 2B, a possible human carcinogen. Further epidemiological, animal and mechanistic studies have strengthened the association. In spite of this, in most countries little or nothing has been done to reduce exposure and educate people on health hazards from RF radiation. On the contrary ambient levels have increased. In 2014 the WHO launched a draft of a Monograph on RF fields and health for public comments. It turned out that five of the six members of the Core Group in charge of the draft are affiliated with International Commission on Non-Ionizing Radiation Protection (ICNIRP),

an industry loyal NGO, and thus have a serious conflict of interest. Just as by ICNIRP, evaluation of non-thermal biological effects from RF radiation are dismissed as scientific evidence of adverse health effects in the Monograph. This has provoked many comments sent to the WHO. However, at a meeting on March 3, 2017 at the WHO Geneva office it was stated that the WHO has no intention to change the Core Group.

Open Access Paper: https://www.spandidos-publications.com/10.3892/ijo.2017.4046

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Use of cell phones and brain tumors: a true association?

Mortazavi, S.A.R., Mortazavi, G. & Mortazavi, S.M.J. Letter to the Editor: Use of cell phones and brain tumors: a true association? Neurol Sci (2017). doi:10.1007/s10072-017-3055-x.

Dear Editor:

With great interest, we have read the editorial by Beghi entitled “Use of cell phones and brain tumors: a true association?” that is published in the journal of Neurol Sci 2017 doi: 10.1007/s10072-017-2992-8 [1]. In this article, the author confirms the lack of robust evidence of association between use of cell phones and brain tumors. However, Beghi mentions that absence of evidence does not necessarily mean that there is no any association. The editorial authored by Beghi addresses a very challenging issue. However, this editorial cannot be considered as a good contribution in the field of radiofrequency exposure and cancer. Over the past several years, our team has conducted several studies on the possible association of exposure to radiofrequency electromagnetic fields (RF-EMFs) and adverse health effects. Beghi claims that the findings of case–control studies have not been confirmed by cohort studies “First of all, the positive results of some case–control studies have not been confirmed by cohort studies. Case–control studies, even when methodologically robust, cannot replace cohort studies in confirming or disproving an association between a given exposure and a disease. ….In this context, none of the cohort studies found an increased risk of brain tumors in people exposed to cell phones.” Although what he claims about the advantages of cohort studies seems to be right, his conclusion is problematic. Beghi does not mention that the number of cohort studies conducted on this topic so far is drastically low and all of these studies had some basic limitations. Therefore, the absence of cohort-proven findings does not necessarily mean that there is no detrimental effect. In this light, as free radical formation after exposure to RF-EMF is confirmed in many studies, even without firm conclusions from cohort studies, these exposures should be limited.

Furthermore, Beghi claims that “Second, the increased risk of brain tumors in case–control studies, if proven, is at best modest and, as brain tumors are rare diseases, the total number of tumors appears only slightly increased.” It is worth mentioning that a systematic review and meta-analysis recently published by Yang et al. could not find a link between mobile phone use of any duration and the odds of high-grade glioma. However, there was a 2.22 times greater odds of the occurrence of low-grade glioma for long-term mobile phone use (OR = 2.22, 95% CI = 1.69–2.92) [2]. Beghi also claims that a clear dose–response effect has never been confirmed. Over the past several years, our team has conducted several studies on the possible association of RF-EMFs and adverse health effects. Mortazavi et al. have also recently addressed the shortcoming of some of the papers claiming lack of association between exposure to RF-EMF and cancer. They have provided evidence showing that exposure to RF-EMFs, at least at high levels and long durations, can increase the risk of cancer [3]. Substantial evidence now indicates that the current controversy regarding the carcinogenesis of RF-EMFs might be caused by the lack of accurate information regarding the magnitude of exposure to RF-EMFs which possibly plays a basic role in RF-induced carcinogenesis [4]. We have also provided evidence which shows that, in a similar pattern with ionizing radiation, the carcinogenesis of non-ionizing RF-EMF may have a nonlinear J-shaped dose–response relationship [4].

https://www.ncbi.nlm.nih.gov/pubmed/28689225

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Use of mobile and cordless phones and change in cognitive function: a prospective cohort analysis of Australian primary school children

Bhatt CR, Benke G, Smith CL, Redmayne M, Dimitriadis C, Dalecki A, Macleod S, Sim MR, Croft RJ, Wolfe R, Kaufman J, Abramson MJ Use of mobile and cordless phones and change in cognitive function: a prospective cohort analysis of Australian primary school children. Environ Health. 2017 Jun 19;16(1):62. doi: 10.1186/s12940-017-0250-4.

Abstract

BACKGROUND: Some previous studies have suggested an association between children's use of mobile phones (MPs)/cordless phones (CPs) and development of cognitive function. We evaluated possible longitudinal associations between the use of MPs and CPs in a cohort of primary school children and effects on their cognitive function.

METHODS: Data on children's socio-demographics, use of MPs and CPs, and cognitive function were collected at baseline (2010-2012) and follow-up (2012-2013). Cognitive outcomes were evaluated with the CogHealth™ test battery and Stroop Color-Word test. The change in the number of MP/CP voice calls weekly from baseline to follow-up was dichotomized: "an increase in calls" or a "decrease/no change in calls". Multiple linear regression analyses, adjusting for confounders and clustering by school, were performed to evaluate the associations between the change in cognitive outcomes and change in MP and CP exposures.

RESULTS: Of 412 children, a larger proportion of them used a CP (76% at baseline and follow-up), compared to a MP (31% at baseline and 43% at follow-up). Of 26 comparisons of changes in cognitive outcomes, four demonstrated significant associations. The increase in MP usage was associated with larger reduction in response time for response inhibition, smaller reduction in the number of total errors for spatial problem solving and larger increase in response time for a Stroop interference task. Except for the smaller reduction in detection task accuracy, the increase in CP usage had no effect on the changes in cognitive outcomes.

CONCLUSION: Our study shows that a larger proportion of children used CPs compared to MPs. We found limited evidence that change in the use of MPs or CPs in primary school children was associated with change in cognitive function.

https://www.ncbi.nlm.nih.gov/pubmed/28629417

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Patterns of cellular phone use among young people in 12 countries: Implications for RF exposure

Langer CE, de Llobet P, Dalmau A, Wiart J, Goedhart G, Hours M, et al. (32 authors). Patterns of cellular phone use among young people in 12 countries: Implications for RF exposure. Environ Int. 2017 Jun 29;107:65-74. doi: 10.1016/j.envint.2017.06.002.

Highlights

• Number and duration of calls varied by sex, age range, and socioeconomic status
• Laterality and hands-free use were less influenced by user characteristics
• Country of origin explained most of the variance in number and duration of calls, as well as SMS and data/Wi-Fi

Abstract

Characterizing exposure to radiofrequency (RF) fields from wireless telecommunications technologies during

childhood and adolescence is a research priority in investigating the health effects of RF. The Mobi-Expo study aimed to describe characteristics and determinants of cellular phone use in 534 young people (10-24years) in 12 countries. The study used a specifically designed software application installed on smartphones to collect data on the use of wireless telecommunications devices within this age group. The role of gender, age, maternal education, calendar period, and country was evaluated through multivariate models mutually adjusting for all variables. Call number and duration were higher among females compared to males (geometric mean (GM) ratio 1.17 and 1.42, respectively), among 20-24year olds compared to 10-14year olds (GM ratio 2.09 and 4.40, respectively), and among lowest compared to highest social classes (GM ratio 1.52 and 1.58, respectively). The number of SMS was higher in females (GM ratio 1.46) and the middle age group (15-19year olds: GM ratio 2.21 compared to 10-14year olds) and decreased over time. Data use was highest in the oldest age group, whereas Wi-Fi use was highest in the middle age group. Both data and Wi-Fi use increased over time. Large differences in the number and duration of calls, SMS, and data/Wi-Fi use were seen by country, with country and age accounting for up to 50% of the variance. Hands-free and laterality of use did not show significant differences by sex, age, education, study period, or country. Although limited by a convenience sample, these results provide valuable insights to the design, analysis, and interpretation of future epidemiological studies concerning the health effects of exposure resulting from cellular phone use in young people. In addition, the information provided by this research may be used to design strategies to minimize RF exposure.

https://www.ncbi.nlm.nih.gov/pubmed/28668725

Excerpts

Participants made on average 30.6 calls per week (median 20.9) and spent 60.8 min per week making or receiving calls (median 34.3; Table 2).

A total of 248 (46.4%) subjects had usable data for laterality. For these participants, 18.8% of total call time was “hands-free” on average (median 10.6%), i.e. using the speaker phone, a hands-free kit, or holding the phone away from the head (Table 2). Out of the total call time near the head (not “hands-free”), participants used the phone on the right side of the head in 63.8% of the time on average (median 70.8% - Table 2). With respect to gender, there was no statistically significant difference between males and females for hands-free usage, although females tended to speak somewhat less on their right-hand side (68% in males versus 61% in females, adj OR 0.75; 95% CI 0.54, 1.03).

Overall, UMTS (3G) was the most commonly used communication protocol with 37% of voice calls occurring using UMTS. HSDPA (3G transitional) was the next most common, with 32% of voice calls. UMTS was the most common communication protocol in Canada, France, Greece, Italy, and The Netherlands (80%, 30%, 36%, 41%, and 55%, respectively) (Fig. 2). In contrast, HSDPA was the most common network in Australia, Germany, Israel, Japan, New Zealand, and Spain (69%, 36%, 68%, 51%, 46%, and 33%, respectively). The most common network in Korea was “other” (43%). GPRS and EDGE (both 2G transitional) were not commonly used in any of the countries during our study period; use ranged from 0% (Japan and Korea) to 32% (The Netherlands) GPRS and 22% (France and Germany) EDGE, respectively.

In comparison with our findings, CEFALO, a study among 7–19 year old children and adolescents investigating possible associations between cellular phone use and brain tumors, had a much lower level of phone use among controls during a period from early 2004 through mid-2008 (Aydin et al., 2011). The top quartile of controls had a cumulative lifetime use of 2638 calls and 144 h spent on voice calls. Using the mean number and duration of calls, it would take the participants in our study less than three years to reach the lifetime use of the highest quartile of CEFALO controls.

First, the handset is not near the head for the full call duration, but rather for about 83% of the time. In addition to intentional hands-free device or speaker phone usage, this is explained by other hands-free use such as answering and ending a call. Furthermore, the time spent with the phone on one side of the head was not as high as the 90% assigned to the self-reported predominant side within the RF dose algorithm used in the

INTERPHONE study (Cardis et al., 2011a), but that was a study of older adults.

A major limitation of this study is that it is a convenience sample, limiting the generalizability of the results. Given that most of the volunteers were found through friends and/or colleagues of the research team, the education level and in turn socioeconomic status is likely higher than that of the general population.

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Functional brain MRI in patients complaining of EHS after long term exposure to EMF

Heuser G, Heuser SA. Functional brain MRI in patients complaining of electrohypersensitivity after long term exposure to electromagnetic fields. Rev Environ Health. 2017 Jul 5.

Abstract

INTRODUCTION: Ten adult patients with electromagnetic hypersensitivity underwent functional magnetic resonance imaging (fMRI) brain scans. All scans were abnormal with abnormalities which were consistent and similar. It is proposed that fMRI brain scans be used as a diagnostic aid for determining whether or not a patient has electromagnetic hypersensitivity. Over the years we have seen an increasing number of patients who had developed multi system complaints after long term repeated exposure to electromagnetic fields (EMFs). These complaints included headaches, intermittent cognitive and memory problems, intermittent disorientation, and also sensitivity to EMF exposure. Regular laboratory tests were within normal limits in these patients. The patients refused to be exposed to radioactivity. This of course ruled out positron emission tomography (PET) and single-photon emission computed tomography (SPECT) brain scanning. This is why we ordered fMRI brain scans on these patients. We hoped that we could document objective abnormalities in these patients who had often been labeled as psychiatric cases.

MATERIALS AND METHODS: Ten patients first underwent a regular magnetic resonance imaging (MRI) brain scan, using a 3 Tesla Siemens Verio MRI open system. A functional MRI study was then performed in the resting state using the following sequences: A three-dimensional, T1-weighted, gradient-echo (MPRAGE) Resting state network. The echo-planar imaging (EPI) sequences for this resting state blood oxygenation level dependent (BOLD) scan were then post processed on a 3D workstation and the independent component analysis was performed separating out the various networks. Arterial spin labeling. Tractography and fractional anisotropy.

RESULTS: All ten patients had abnormal functional MRI brain scans. The abnormality was often described as hyper connectivity of the anterior component of the default mode in the medial orbitofrontal area. Other abnormalities were usually found. Regular MRI studies of the brain were mostly unremarkable in these patients.

CONCLUSION: We propose that functional MRI studies should become a diagnostic aid when evaluating a patient who claims electrohypersensitivity (EHS) and has otherwise normal studies. Interestingly, the differential diagnosis for the abnormalities seen on the fMRI includes head injury. It turns out that many of our patients indeed had a history of head injury which was then followed sometime later by the development of EHS. Many of our patients also had a history of exposure to potentially neurotoxic chemicals, especially mold. Head injury and neurotoxic chemical exposure may make a patient more vulnerable to develop EHS.

https://www.ncbi.nlm.nih.gov/pubmed/28678737

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An off-the-shelf meter for measuring body amperage: A new gold standard for epidemiologic studies?

Milham S. An off-the-shelf meter for measuring body amperage: A new gold standard for epidemiologic studies? Electromagn Biol Med. 2017 Jun 26:1. doi: 10.1080/15368378.2017.1336101.

No Abstract (letter)

https://www.ncbi.nlm.nih.gov/pubmed/28650676

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Effects of folic acid on rat kidney exposed to 900 MHz EMR

Ömür Gülsüm Deniz, Elfide Gizem Kıvrak, Arife Ahsen Kaplan, Berrin Zuhal Altunkaynak. Effects of folic acid on rat kidney exposed to 900 MHz electromagnetic radiation. Journal of Microscopy and Ultrastructure. Available online 17 June 2017.

Highlights

• The kidneys of adult male rats were investigated after exposure to 900-MHz electromagnetic radiation.
• Folic acid exhibited protective effects in the kidney against the side-effects of electromagnetic radiation exposure.
• Changes in volume and numbers of glomeruli in the kidney were analyzed using unbiased stereological methods.

Abstract

Because of increased use of cell phones, the purpose of this study was to investigation of the oxidative damage caused by electromagnetic radiation (EMR) emitted by cell phones and histological and morphometrical determination of the possible protective role of folic acid (FA) in preventing the detrimental effects of EMR on the kidney. Twenty-four adult male Wistar albino rats were divided into control (Cont), EMR, EMR + FA and FA groups, each containing six rats. The EMR and EMR + FA groups were exposed to EMR for 60 min a day over a period of 21 days, while no EMR exposure was applied to the Cont and FA groups. The source of the EMR was an EMR device which emits a digital signal producing 900-MHz frequency radiation. The generator connected to a one-monopole antenna was used in this study and the rats were placed in the plexiglass restrainer at an equal distance from the monopole antenna. Following the experimental period, and after tissue processing, a physical disector-Cavalieri method combination was applied to the sections. The mean volume of the cortex, medulla, proximal and distal tubules increased significantly in the EMR groups compared to the Cont group ($p < 0.01$). Contrarily, the total number of glomeruli in the EMR group decreased compared to the Cont group ($p < 0.01$). The protective effects of FA was observed in the kidney ($p < 0.05$).

In conclusion, the 900-MHz EMR leads to kidney damage. FA may exhibit a protective effect against the adverse effects of EMR exposure in terms of the total number of glomeruli.

http://www.sciencedirect.com/science/article/pii/S2213879X17300500

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Changes in locomotor activity in mice due to low-intensity microwaves amplitude modulated in the

EEG spectral domain

Eeghem VV, Arfani AE, Anthoula A, Walrave L, Pourkazemi A, Bentea E, Demuyser T, Smolders I, Stiens J. Selective changes in locomotor activity in mice due to low-intensity microwaves amplitude modulated in the EEG spectral domain. Neuroscience. 2017 Jul 4. pii: S0306-4522(17)30461-X. doi: 10.1016/j.neuroscience.2017.06.056.

Abstract

Despite the numerous benefits of microwave applications in our daily life, microwaves were associated with diverse neurological complaints such as headaches and impaired sleep patterns, and changes in the electroencephalogram (EEG). To which extent microwaves influence the brain function remains unclear. This exploratory study assessed the behavior and neurochemistry in mice immediately or 4 weeks after a 6-day exposure to low-intensity 10 GHz microwaves with an amplitude modulation (AM) of 2 or 8 Hz. These modulation frequencies of 2 and 8 Hz are situated within the delta and theta-alpha frequency bands in the EEG spectrum and are associated with sleep and active behavior, respectively. During these experiments, the specific absorbance rate was 0.3 W/kg increasing the brain temperature with 0.23°C. For the first time, exposing mice to 8 Hz AM significantly reduced locomotor activity in an open field immediately after exposure which normalized after 4 weeks. This in contrast to 2 Hz AM which didn't induce significant changes in locomotor activity immediately and 4 weeks after exposure. Despite this difference in motor behavior, no significant changes in striatal dopamine and DOPAC levels and DOPAC/dopamine turnover nor in cortical glutamate concentrations were detected. In all cases, no effects on motor coordination on a rotarod, spatial working memory, anxiety nor depressive-like behavior were observed. The outcome of this study indicates that exposing mice to low-intensity 8 Hz AM microwaves can alter the locomotor activity in contrast to 2 Hz AM which did not affect the tested behaviors.

https://www.ncbi.nlm.nih.gov/pubmed/28687311

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Influence of RF EMF from 3rd-generation cellular phones on fertilization and embryo development in mice (W-CDMA study)

Suzuki S, Okutsu M, Suganuma R, Komiya H, Nakatani-Enomoto S, Kobayashi S, Ugawa Y, Tateno H, Fujimori K.Influence of radiofrequency-electromagnetic waves from 3rd-generation cellular phones on fertilization and embryo development in mice. Bioelectromagnetics. 2017 Jun 19. doi: 10.1002/bem.22063.

Abstract

The purpose of this study was to evaluate the effects of 3rd-generation (3G) cellular phone radiofrequency-electromagnetic wave (RF-EMW) exposure on fertilization and embryogenesis in mice. Oocytes and spermatozoa were exposed to 3G cellular phone RF-EMWs, 1.95 GHz wideband code division multiple access, at a specific absorption rate of 2 mW/g for 60 min, or to sham exposure. After RF-EMW exposure, in vitro fertilization and intracytoplasmic sperm injection were performed. Rates of fertilization, embryogenesis (8-cell embryo, blastocyst), and chromosome aberration were compared between the combined spermatozoa and oocyte groups: both exposed, both non-exposed, one exposed, and the other non-exposed. Rates of fertilization, embryogenesis, and blastocyst formation did not change significantly across the four groups. Considering that the degree of exposure in the present study was ≥100 times greater than daily exposure of human spermatozoa and even greater than daily exposure of oocytes, the present results indicate safety of RF-EMW exposure in humans.

https://www.ncbi.nlm.nih.gov/pubmed/28628221

Also see:

Pregnancy & Wireless Radiation Risks
Female Infertility & Cell Phone Radiation

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The Effects of Exposure to ELF EMF on Male Fertility

Darbandi M, Darbandi S, Agarwal A, Henkle R, Sadeghi MR. The Effects of Exposure to Low Frequency Electromagnetic Fields on Male Fertility. Altern Ther Health Med. 2017 Jun 23. pii: AT5423. [Epub ahead of print]

Abstract

Context • People are increasingly exposed to low frequency (LF) electromagnetic fields (EMFs), mainly from electricity distribution networks and electronic devices. Critics of this widespread exposure believe that it can have detrimental effects on the human body. On the other hand, many in vivo and in vitro studies have claimed that low frequency electromagnetic therapy can function as a form of alternative medicine and that therapists can treat disease by applying electromagnetic radiation or pulsed EMFs to the body or cells. It is not yet entirely clear, however, whether LF-EMF is beneficial or harmful.
Objectives • This study aimed to examine the effects of LF-EMFs on men's reproductive functions, according to the types of waveform and the frequency and duration of exposure.
Design • The study reviewed all available research, both human and animal, on the effects of LF-EMFs on male reproductive functions, covering the literature from January 1978 to June 2016. The documents were obtained from PubMed, Science Direct, and Google Scholar, and any article that was irrelevant or a duplicate was excluded. A total of 61 articles were found, and 27 articles were reviewed.
Setting • This project was performed at the Avicenna Research Center (Tehran, Iran).
Participants • Literature included human and animal studies conducted on rabbits, mice, rats, and boars.
Intervention • Among these studies, any article that was irrelevant, a duplicate, or published with duplicate data was excluded. At the end, 27 articles were checked.
Outcome Measures • Outcome measures included testing related to reproductive organ weights, reproductive endocrinal hormones, fetal development, and spermatogenesis as well as sperm motility, morphology, and vitality.
Results • The reviewed studies provided contradictory results that were highly dependent on the exposure parameters, such as the shape and frequency of wave, intensity, duration, and timing of the exposure.
Conclusions • LF-EMF at 15 Hz with a peak intensity of 8 Gauss, with a square waveform of 50 Hz frequency and a duration of a few hours or less can have a positive effect on sperm quality, motility, and fertility. Exposures at other frequencies either had no effects on the sperm's performance and quality or held biological hazard for cells. It appears that there is still little understanding of how EMF affects cellular functions. Therefore, more standardized and controlled studies should be carried out to understand the effects of EMF on the body.

https://www.ncbi.nlm.nih.gov/pubmed/28646801

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Proteomic Analysis of the Effect of ELF-EMF With Different Intensities in SH-SY5Y Neuroblastoma Cell Line

Rezaie-Tavirani M, Hasanzadeh H, Seyyedi S, Zali H.Proteomic Analysis of the Effect of Extremely Low-Frequency Electromagnetic Fields (ELF-EMF) With Different Intensities in SH-SY5Y Neuroblastoma Cell Line.J Lasers Med Sci. 2017 Spring;8(2):79-83. doi: 10.15171/jlms.2017.14.

Abstract

Introduction: During the last 3 decades, human is exposed to extremely low frequency electromagnetic fields (ELF-EMF) emitted by power lines and electronic devices. It is now well accepted that ELF-EMF are able to produce a variety of biological effects, although the molecular mechanism is unclear and controversial. Investigation of different intensities effects of 50 Hz ELF-EMF on cell morphology and protein expression is the aim of this study.
Methods: SH-SY5Y human neuroblastoma cell line was exposed to 0.5 and 1 mT 50 Hz (ELF-EMF) for 3 hours. Proteomics techniques were used to determine the effects of these fields on protein expression. Bioinformatic and statistical analysis of proteomes were performed using Progensis SameSpots software.
Results: Our results showed that exposure to ELF-EMF changes cell morphology and induces a dose-dependent decrease in the proliferation rate of the cells. The proteomic studies and bioinformatic analysis indicate that exposure to 50 Hz ELF-EMF leads to alteration of cell protein expression in both dose-dependent and intensity dependent manner, but the later is more pronounced.
Conclusion: Our data suggests that increased intensity of ELF-EMF may be associated with more alteration in cell protein expression, as well as effect on cell morphology and proliferation.

https://www.ncbi.nlm.nih.gov/pubmed/28652900

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The bee, the flower, and the electric field: electric ecology and aerial electroreception

Clarke D, Morley E, Robert D. The bee, the flower, and the electric field: electric ecology and aerial electroreception. J Comp Physiol A Neuroethol Sens Neural Behav Physiol. 2017 Jun 24. doi: 10.1007/s00359-017-1176-6.

Abstract

Bees and flowering plants have a long-standing and remarkable co-evolutionary history. Flowers and bees evolved traits that enable pollination, a process that is as important to plants as it is for pollinating insects. From the sensory ecological viewpoint, bee-flower interactions rely on senses such as vision, olfaction, humidity sensing, and touch. Recently, another sensory modality has been unveiled; the detection of the weak electrostatic field that arises between a flower and a bee. Here, we present our latest understanding of how these electric interactions arise and how they contribute to pollination and electroreception. Finite-element modelling and experimental evidence offer new insights into how these interactions are organised and how they can be further studied. Focusing on pollen transfer, we deconstruct some of the salient features of the three ingredients that enable electrostatic interactions, namely the atmospheric electric field, the capacity of bees to accumulate positive charge, and the propensity of plants to be relatively negatively charged. This article also aims at highlighting areas in need of further investigation, where more research is required to better understand the mechanisms of electrostatic interactions and aerial electroreception.

https://www.ncbi.nlm.nih.gov/pubmed/28647753

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Biological effects related to geomagnetic activity and possible mechanisms

Krylov VV. Biological effects related to geomagnetic activity and possible mechanisms. Bioelectromagnetics. 2017 Jun 21. doi: 10.1002/bem.22062. [Epub ahead of print]

Abstract

This review presents contemporary data on the biological effects of geomagnetic activity. Correlations between

geomagnetic indices and biological parameters and experimental studies that used simulated geomagnetic storms to detect possible responses of organisms to these events in nature are discussed. Possible mechanisms by which geomagnetic activity influences organisms are also considered. Special attention is paid to the idea that geomagnetic activity is perceived by organisms as a disruption of diurnal geomagnetic variation. This variation, in turn, is viewed by way of a secondary zeitgeber for biological circadian rhythms. Additionally, we discuss the utility of cryptochrome as a biological detector of geomagnetic storms. The possible involvement of melatonin and protein coding by the CG8198 gene in the biological effects of geomagnetic activity are discussed. Perspectives for studying mechanisms by which geomagnetic storms affect organisms are suggested.

https://www.ncbi.nlm.nih.gov/pubmed/28636777

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Canadian data from INTERPHONE study of mobile phone use and head tumor risk reported for the first time

Since the 13-nation Interphone study was published in 2010, several methods papers have been published that reanalyze the data to correct for biases in the original paper. In most instances the glioma risk estimates increased after adjustment for study biases among long term or heavy mobile phone users.

The following paper just published in the ***American Journal of Epidemiology*** applies statistical adjustments to the Interphone data from Canada. The authors found that the risk estimate for glioma among the highest quartile of cell phone users increased after adjustment. Risk estimates for other types of head tumors did not change.

The substantive results reported for glioma risk in Canada should be of interest to Health Canada. The original Canadian Interphone study data which had not been reported previously found a statistically significant doubling of risk for glioma among the highest **quartile** of cell phone users (over 558 lifetime hours). In contrast, the original 13-nation Interphone study found a 1.4-fold increase in glioma among the highest **decile** of use (1640 or more lifetime hours). After adjustment for selection and recall bias, the 2.0 odds ratio originally found in Canada increased to 2.2. Among the potential explanations the authors provided for this disparity between Canada and the 13-nation study (which included Canadian data):

"real differences in risk related to different communication technologies between Canada and other INTERPHONE countries."

Momoli F, Siemiatycki J, McBride ML, Parent MÉ, Richardson L, Bedard D, Platt R, Vrijheid M, Cardis E, Krewski D. Probabilistic multiple-bias modelling applied to the Canadian data from the INTERPHONE study of mobile phone use and risk of glioma, meningioma, acoustic neuroma, and parotid gland tumors. Am J Epidemiol. 2017 May 23. doi: 10.1093/aje/kwx157. [Epub ahead of print]

Abstract

We undertook a re-analysis of the Canadian data from the thirteen-country INTERPHONE case-control study (2001-2004), which evaluated the association between mobile phone use and risk of brain, acoustic neuroma, and parotid gland tumors. The main publication of the multinational INTERPHONE study concluded that "biases and errors prevent a causal interpretation". We applied a probabilistic multiple-bias model to address possible biases simultaneously, using validation data from billing records and non-participant questionnaires as

information on recall error and selective participation. Our modelling sought to adjust for these sources of uncertainty and to facilitate interpretation. For glioma, the odds ratio comparing highest quartile of use (over 558 lifetime hours) to non-regular users was 2.0 (95% confidence interval: 1.2, 3.4). The odds ratio was 2.2 (95% confidence interval: 1.3, 4.1) when adjusted for selection and recall biases. There was little evidence of an increase in the risk of meningioma, acoustic neuroma, or parotid gland tumors in relation to mobile phone use. Adjustments for selection and recall biases did not materially affect interpretation in our Canadian results.

https://www.ncbi.nlm.nih.gov/pubmed/28535174

Excerpts

The OR of 2.0 for glioma in the highest cumulative exposure category (558+ hours of cumulative call time) in the Canadian study is higher than the value of 1.4 in the highest cumulative exposure category (1640+ hours) in the international study (4). This may simply reflect sampling variability, differential biases between study centers, matching strategies, or real differences in risk related to different communication technologies between Canada and other INTERPHONE countries (see appendix of (27)).

Unlike in the Canadian data, the INTERPHONE multinational study found marked decreased risk associated with most measures of phone use and an increased risk only in the highest decile of use. The study Group concluded that “biases and errors prevent a causal interpretation” (4, pg.1). To the extent that the bias model applied in the present re-analysis of the Canadian data is reasonable, conventional modelling of existing data likely resulted in slight underestimation of the magnitude of associations; however, interpretation of bias-adjusted results would not have materially changed from the original Canadian results.

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Mobile phone use and glioma risk: A systematic review and meta-analysis

Yang M, Guo W, Yang C, Tang J, Huang Q, Feng S, Jiang A, Xu X, Jiang G. Mobile phone use and glioma risk: A systematic review and meta-analysis. PLoS One. 2017 May 4;12(5):e0175136. doi: 10.1371/journal.pone.0175136.

Abstract

OBJECTIVE: Many studies have previously investigated the potential association between mobile phone use and the risk of glioma. However, results from these individual studies are inconclusive and controversial. The objective of our study was to investigate the potential association between mobile phone use and subsequent glioma risk using meta-analysis.

METHODS: We performed a systematic search of the Science Citation Index Embase and PubMed databases for studies reporting relevant data on mobile phone use and glioma in 1980-2016. The data were extracted and measured in terms of the odds ratio (OR) and 95% confidence interval (CI) using the random effects model. Subgroup analyses were also carried out. This meta-analysis eventually included 11 studies comprising a total 6028 cases and 11488 controls.

RESULTS: There was a significant positive association between long-term mobile phone use (minimum, 10 years) and glioma (OR = 1.44, 95% CI = 1.08-1.91). And there was a significant positive association between

long-term ipsilateral mobile phone use and the risk of glioma (OR = 1.46, 95% CI = 1.12-1.92). Long-term mobile phone use was associated with 2.22 times greater odds of low-grade glioma occurrence (OR = 2.22, 95% CI = 1.69-2.92). Mobile phone use of any duration was not associated with the odds of high-grade glioma (OR = 0.81, 95% CI = 0.72-0.92). Contralateral mobile phone use was not associated with glioma regardless of the duration of use. Similarly, this association was not observed when the analysis was limited to high-grade glioma.

CONCLUSIONS: Our results suggest that long-term mobile phone use may be associated with an increased risk of glioma. There was also an association between mobile phone use and low-grade glioma in the regular use or long-term use subgroups. However, current evidence is of poor quality and limited quantity. It is therefore necessary to conduct large sample, high quality research or better characterization of any potential association between long-term ipsilateral mobile phone use and glioma risk.

Open Access Paper: http://bit.ly/2peeylc

Three additional reviews of mobile phone use and brain tumor research published in 2017: http://bit.ly/2mg6NFq

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Neurodevelopment for first 3 years following prenatal mobile phone use, RF radiation & lead exposure

Kyung-Hwa Choi, Mina Ha, Eun-Hee Ha, Hyesook Park, Yangho Kim, Yun-Chul Hong, Ae-Kyoung Lee, Jong Hwa Kwon, Hyung-Do Choi, Nam Kim, Suejin Kim, Choonghee Park. Neurodevelopment for the first three years following prenatal mobile phone use, radio frequency radiation and lead exposure. Environmental Research, 156:810-817, July 2017.

Highlights

• RFR exposure was measured by mobile phone use questionnaire and 24-h personal exposure meter among pregnant women.
• Child neurodevelopment was assessed by trained examiners at 6, 12, 24, and 36 months of age.
• Associations were not observed between prenatal exposure to RFR and child neurodevelopment during the first three years.
• A potential combined effect of prenatal exposure to lead and mobile phone use was suggested.

Abstract

Background Studies examining prenatal exposure to mobile phone use and its effect on child neurodevelopment show different results, according to child's developmental stages.

Objectives To examine neurodevelopment in children up to 36 months of age, following prenatal mobile phone use and radiofrequency radiation (RFR) exposure, in relation to prenatal lead exposure.

Methods We analyzed 1198 mother-child pairs from a prospective cohort study (the Mothers and Children's Environmental Health Study). Questionnaires were provided to pregnant women at ≤20 weeks of gestation to assess mobile phone call frequency and duration. A personal exposure meter (PEM) was used to measure RFR exposure for 24 h in 210 pregnant women. Maternal blood lead level (BLL) was measured during pregnancy. Child neurodevelopment was assessed using the Korean version of the Bayley Scales of Infant

Development-Revised at 6, 12, 24, and 36 months of age. Logistic regression analysis applied to groups classified by trajectory analysis showing neurodevelopmental patterns over time.

Results The psychomotor development index (PDI) and the mental development index (MDI) at 6, 12, 24, and 36 months of age were not significantly associated with maternal mobile phone use during pregnancy. However, among children exposed to high maternal BLL in utero, there was a significantly increased risk of having a low PDI up to 36 months of age, in relation to an increasing average calling time (p-trend=0.008). There was also a risk of having decreasing MDI up to 36 months of age, in relation to an increasing average calling time or frequency during pregnancy (p-trend=0.05 and 0.007 for time and frequency, respectively). There was no significant association between child neurodevelopment and prenatal RFR exposure measured by PEM in all subjects or in groups stratified by maternal BLL during pregnancy.

Conclusions We found no association between prenatal exposure to RFR and child neurodevelopment during the first three years of life; however, a potential combined effect of prenatal exposure to lead and mobile phone use was suggested.

https://www.ncbi.nlm.nih.gov/pubmed/28511138

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Multiple assessment methods of prenatal exposure to radio frequency radiation from telecommunication in the Mothers and Children's Environmental Health (MOCEH) study

Choi KH, Ha M, Burm E, Ha EH, Park H, Kim Y, Lee AK, Kwon JH, Choi HD, Kim N. Multiple assessment methods of prenatal exposure to radio frequency radiation from telecommunication in the Mothers and Children's Environmental Health (MOCEH) study. Int J Occup Med Environ Health. 2016 Nov 18;29(6):959-972. doi: 10.13075/ijomeh.1896.00803. Epub 2016 Nov 3.

Abstract

OBJECTIVES: To evaluate prenatal exposure to radiofrequency radiation (RFR) from telecommunication using a mobile phone questionnaire, operator data logs of mobile phone use and a personal exposure meter (PEM).

MATERIAL AND METHODS: The study included 1228 mother-infants pairs from the Mothers and Children's Environmental Health (MOCEH) study - a multicenter prospective cohort study ongoing since 2006, in which participants were enrolled at ≤ 20 weeks of pregnancy, with a follow-up of a child birth and growth to assess the association between prenatal environmental exposure and children's health. The questionnaire included the average calling frequency per day and the average calling time per day. An EME Spy 100 PEM was used to measure RFR among 269 pregnant women from November 2007 to August 2010. The operators' log data were obtained from 21 participants. The Spearman's correlation test was performed to evaluate correlation coefficient and 95% confidence intervals between the mobile phone use information from the questionnaire, operators' log data, and data recorded by the PEM.

RESULTS: The operators' log data and information from the self-reported questionnaire showed significantly high correlations in the average calling frequency per day ($\rho = 0.6$, $p = 0.004$) and average calling time per day ($\rho = 0.5$, $p = 0.02$). The correlation between information on the mobile phone use in the self-reported questionnaire and exposure index recorded by the PEM was poor. But correlation between the information of the operators' log data and exposure index for transmission of mobile communication was significantly high: correlation coefficient (p-value) was 0.44 (0.07) for calling frequency per day, and it was 0.49 (0.04) for calling time per day.

CONCLUSIONS: The questionnaire information on the mobile phone use showed moderate to high quality. Using multiple methods for exposure assessment might be better than using only one method.

https://www.ncbi.nlm.nih.gov/pubmed/27869246

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Mobile phone use, blood lead levels, and attention deficit hyperactivity symptoms in children: a longitudinal study

Byun YH, Ha M, Kwon HJ, Hong YC, Leem JH, Sakong J, Kim SY, Lee CG, Kang D, Choi HD, Kim N. Mobile phone use, blood lead levels, and attention deficit hyperactivity symptoms in children: a longitudinal study. PLoS One. 2013;8(3):e59742. doi: 10.1371/journal.pone.0059742.

Abstract

BACKGROUND: Concerns have developed for the possible negative health effects of radiofrequency electromagnetic field (RF-EMF) exposure to children's brains. The purpose of this longitudinal study was to investigate the association between mobile phone use and symptoms of Attention Deficit Hyperactivity Disorder (ADHD) considering the modifying effect of lead exposure.

METHODS: A total of 2,422 children at 27 elementary schools in 10 Korean cities were examined and followed up 2 years later. Parents or guardians were administered a questionnaire including the Korean version of the ADHD rating scale and questions about mobile phone use, as well as socio-demographic factors. The ADHD symptom risk for mobile phone use was estimated at two time points using logistic regression and combined over 2 years using the generalized estimating equation model with repeatedly measured variables of mobile phone use, blood lead, and ADHD symptoms, adjusted for covariates.

RESULTS: The ADHD symptom risk associated with mobile phone use for voice calls but the association was limited to children exposed to relatively high lead.

CONCLUSIONS: The results suggest that simultaneous exposure to lead and RF from mobile phone use was associated with increased ADHD symptom risk, although possible reverse causality could not be ruled out.

Open Access Paper: http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0059742

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Pulsed radiofrequency radiation, and epigenetics: How wireless technologies may affect childhood development

Sage C, Burgio E. Electromagnetic Fields, Pulsed radiofrequency radiation, and epigenetics: How wireless technologies may affect childhood development. Child Development. Published online May 15, 2017.

Abstract

Mobile phones and other wireless devices that produce electromagnetic fields (EMF) and pulsed radiofrequency radiation (RFR) are widely documented to cause potentially harmful health impacts that can be detrimental to young people. New epigenetic studies are profiled in this review to account for some neurodevelopmental and neurobehavioral changes due to exposure to wireless technologies. Symptoms of retarded memory, learning, cognition, attention, and behavioral problems have been reported in numerous studies and are similarly manifested in autism and attention deficit hyperactivity disorders, as a result of EMF and RFR exposures where both epigenetic drivers and genetic (DNA) damage are likely contributors. Technology benefits can be realized by adopting wired devices for education to avoid health risk and promote academic achievement.

Conclusions

Public health implications of wireless technologies are enormous because there has been a very rapid global deployment in homes, education, transportation, and health care in the last two decades. Even a small risk from chronic use wireless technologies may have a profound global health impact. Impacts on the fetus via parental exposures to wireless devices preconception and during in utero development, infant rearing (baby monitors, wireless surveillance, Wi-Fi routers, DECT cordless phones, etc.), and childhood preschool and academic environments all may contribute in incremental ways to a perpetually saturated habitat of wireless emissions, and health impacts from the chronic, stressful body burden of EMF and RFR.

The wide array of pathophysiological effects of EMF and RFR exposures from wireless sources do not require “the breaking of molecular bonds” as done by ionizing radiation in order for physiologically damaging effects to occur. Epigenetic mechanisms alone can change fetal development in profound ways, disrupting health by causing changes in gene activation and expression without change in gene sequences. Environmental epigenetic influences in the fetal and neonatal development (i.e., epigenetic regulation of genes rather than direct genetic effects by gene mutation) have been plausibly established to cause pathophysiological changes that can result in altered neurological development. Symptoms of neurodevelopmental problems in children like retarded memory, learning, cognition, attention, and behavioral aberrations that are similarly expressed in autism and ADHD have been reported in numerous scientific studies to occur as a result of EMF and RFR exposures, where epigenetic drivers are the most likely causes, and persistent exposures contribute to chronic dysfunction, overwhelming adaptive biological responses.

Electronic educational technologies have not resulted in better academic achievement globally and lend support to scientific studies showing adverse health and developmental impacts (OECD, 2015). Reductions in preventable exposures to EMF and RFR should be a top public health and school district priority. Technology benefits can be realized by adopting wired devices for education, to avoid health risk and promote academic achievement. Wider recognition that epigenetic factors are a plausible mechanism for EMF/RFR to regulate expression of DNA and thus impact child development is a critical need. Whether future research can identify safe levels of wireless exposures is unknown, but further investigation of epigenetic markers related to EMF/RFR exposure in child development and disease is warranted.

http://onlinelibrary.wiley.com/doi/10.1111/cdev.12824/abstract

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Effects of Mobile Phones on Children's and Adolescents’ Health: A Commentary

Lennart Hardell. Effects of Mobile Phones on Children's and Adolescents’ Health: A Commentary. Child Development. Published online May 15, 2017.

Abstract

The use of digital technology has grown rapidly during the last couple of decades. During use, mobile phones and cordless phones emit radiofrequency (RF) radiation. No previous generation has been exposed during childhood and adolescence to this kind of radiation. The brain is the main target organ for RF emissions from the handheld wireless phone. An evaluation of the scientific evidence on the brain tumor risk was made in May 2011 by the International Agency for Research on Cancer at World Health Organization. The scientific panel reached the conclusion that RF radiation from devices that emit nonionizing RF radiation in the frequency range 30 kHz–300 GHz is a Group 2B, that is, a "possible" human carcinogen. With respect to health implications of digital (wireless) technologies, it is of importance that neurological diseases, physiological addiction, cognition, sleep, and behavioral problems are considered in addition to cancer. Well-being needs to be carefully evaluated as an effect of changed behavior in children and adolescents through their interactions with modern digital technologies.

http://onlinelibrary.wiley.com/doi/10.1111/cdev.12831/abstract

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Can Non-Ionizing Radiation Cause Cancer?

Magda Havas. Can Non-Ionizing Radiation Cause Cancer? Archives of Physics Research, 2017, 8 (1):1-2.

Abstract

Our exposure to non-ionizing radiation (NIR) has been increasing steadily with our use of electricity, electronic equipment and-more recently-with our use of wireless technology. Concurrently, epidemiological studies have been documenting an increased cancer risk for people who use cell phones for 10 years or more [1,2] and for those who live near cell phone base stations [3,4,5], broadcast antennas [6,7], radar installations [8], or powerlines [9]. Health care authorities and physicists dismiss these studies because non-ionizing radiation doesn't have enough energy to break chemical bonds and, hence cannot cause cancer. Right? Wrong!

Open Access Paper: http://www.scholarsresearchlibrary.com/articles/can-nonionizing-radiation-cause-cancer.pdf

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Increasing levels of saliva alpha amylase in electrohypersensitive (EHS) patients

Andrianome S, Hugueville L, de Seze R, Selmaoui B. Increasing levels of saliva alpha amylase in electrohypersensitive (EHS) patients.Int J Radiat Biol. 2017 May 3:1-24. doi: 10.1080/09553002.2017.1325971. [Epub ahead of print].

Abstract

THE PURPOSE: The objective of this study was to assess the level of various salivary and urinary markers of patients with EHS and to compare them with those of the healthy control group.

MATERIALS AND METHODS: We analyzed samples from 30 EHS individuals and a matched control group of 25 individuals (non EHS) aged between 22 and 66. We quantified cortisol both in saliva and urine, alpha amylase (sAA), immunoglobulin A and C Reactive Protein levels in saliva and neopterin in urine (uNeopterin).

RESULTS: sAA was found to be significantly higher ($p < 0.005$) in the EHS group. uNeopterin and sAA analysis showed a significant difference based on the duration of EHS.

CONCLUSION: Higher level of sAA in EHS participants may suggest that the sympathetic adrenal medullar system is activated. However, most of the analyzed markers of the immune system, sympathetic activity and circadian rhythm did not vary significantly in EHS group. There is a trend to the higher levels of some variables in subgroups according to the EHS duration.

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Long-term exposure to continuous 900 MHz EMF disrupts cerebellar morphology in young adult male rats

Aslan A, İkinci A, Baş O, Sönmez OF, Kaya H, Odacı E. Long-term exposure to a continuous 900 MHz electromagnetic field disrupts cerebellar morphology in young adult male rats. Biotech Histochem. 2017 May 16:1-7. doi: 10.1080/10520295.2017.1310295. [Epub ahead of print]

Abstract

The pathological effects of exposure to an electromagnetic field (EMF) during childhood and adolescence may be greater than those from exposure during adulthood. We investigated possible pathological changes in the cerebellum of adolescent rats exposed to 900 MHz EMF daily for 25 days. We used three groups of six 21-day-old male rats as follows: unexposed control group (Non-EG), sham-exposed group (Sham-EG) and an EMF-exposed group (EMF-EG). EMF-EG rats were exposed to EMF in an EMF cage for 1 h daily from postnatal days 21 through 46. Sham-EG rats were placed in the EMF cage for 1 h daily, but were not subjected to EMF. No procedures were performed on the Non-EG rats. The cerebellums of all animals were removed on postnatal day 47, sectioned and stained with cresyl violet for histopathological and stereological analyses. We found significantly fewer Purkinje cells in the EMF-EG group than in the Non-EG and Sham-EG groups. Histopathological evaluation revealed alteration of normal Purkinje cell arrangement and pathological changes including intense staining of neuron cytoplasm in the EMF-EG group. We found that exposure to continuous 900 MHz EMF for 1 h/day during adolescence can disrupt cerebellar morphology and reduce the number of Purkinje cells in adolescent rats.

https://www.ncbi.nlm.nih.gov/pubmed/28506085

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Ten gigahertz microwave radiation impairs spatial memory, enzymes activity, and histopathology of developing mice brain

Sharma A, Kesari KK, Saxena VK, Sisodia R. Ten gigahertz microwave radiation impairs spatial memory,

enzymes activity, and histopathology of developing mice brain. Mol Cell Biochem. 2017 May 3. doi: 10.1007/s11010-017-3051-8.

Abstract

For decades, there has been an increasing concern about the potential hazards of non-ionizing electromagnetic fields that are present in the environment and alarming as a major pollutant or electro-pollutant for health risk and neuronal diseases. Therefore, the objective of the present study was to explore the effects of 10 GHz microwave radiation on developing mice brain. Two weeks old mice were selected and divided into two groups (i) sham-exposed and (ii) microwave-exposed groups. Animals were exposed for 2 h/day for 15 consecutive days. After the completion of exposure, within an hour, half of the animals were autopsied immediately and others were allowed to attain 6 weeks of age for the follow-up study. Thereafter results were recorded in terms of various biochemical, behavioral, and histopathological parameters. Body weight result showed significant changes immediately after treatment, whereas non-significant changes were observed in mice attaining 6 weeks of age. Several other endpoints like brain weight, lipid peroxidation, glutathione, protein, catalase, and superoxide dismutase were also found significantly ($p < 0.05$) altered in mice whole brain. These significant differences were found immediately after exposure and also in follow-up on attaining 6 weeks of age in microwave exposure group. Moreover, statistically significant ($p < 0.001$) effect was investigated in spatial memory of the animals, in learning to locate the position of platform in Morris water maze test. Although in probe trial test, sham-exposed animals spent more time in searching for platform into the target quadrant than in opposite or other quadrants. Significant alteration in histopathological parameters (qualitative and quantitative) was also observed in CA1 region of the hippocampus, cerebral cortex, and ansiform lobule of cerebellum. Results from the present study concludes that the brain of 2 weeks aged mice was very sensitive to microwave exposure as observed immediately after exposure and during follow-up study at 6 weeks of age.

https://www.ncbi.nlm.nih.gov/pubmed/28470342

Excerpt

All animals were kept in such position, where the head of animals faced the horn antenna. The horn antenna was kept in H (Magnetic field) plane configuration, where electric field was perpendicular to the ground surface. Field was almost uniform because the dimension of the cage was of the order of wavelength. The maximum power density 0.25 mW/cm2 was recorded at the near field distance from the horn antenna. A power meter measured the emitted power of microwaves, which was a peak sensitive device ... The whole body specific absorption rate (SAR) was estimated to be 0.1790 W/kg ... Similar experiment with same number of sham-exposed animals was performed without energizing the microwave exposure system.

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Ameliorative effect of gallic acid on pancreas lesions induced by 2.45 GHz Wi-Fi in young rats

Senay Topsakal, Ozlem Ozmen, Ekrem Cicek, Selcuk Comlekci. The ameliorative effect of gallic acid on pancreas lesions induced by 2.45 GHz electromagnetic radiation (Wi-Fi) in young rats. Journal of Radiation Research and Applied Sciences, Available online 4 May 2017.

Highlights

• Effects of electromagnetic radiation (EMR) on pancreata examined by immunohistochemical level.
• EMR exposure has been caused both endocrine and endocrine pancreas problems.
• Our results indicate that possible relation with EMR and pancreatic lesions in developmental ages.

Abstract

The aim of this study was to investigate the effects of electromagnetic radiation (EMR) on the pancreas tissue of young rats and the ameliorative effect of Gallic acid (GA). Six-week-old, 48 male rats were equally divided into four groups: Sham group, EMR group (2.45 GHz), EMR (2.45 GHz)+GA group (30 mg/kg/daily) orally and GA group (30 mg/kg/daily). After 30 days, serum and pancreatic tissue samples were harvested for biochemical, histopathological and immunohistochemical analysis. Serum amylase, lipase, glucose, and tissue malondialdehyde, total oxidant status and oxidative stress index were increased, whereas total antioxidant status decreased in the EMR group. The histopathological examination of the pancreases indicated slight degenerative changes in some pancreatic endocrine and exocrine cells and slight inflammatory cell infiltrations in the EMR group. At the immunohistochemical examination, marked increase was observed in calcitonin gene related protein and Prostaglandin E2 expressions in pancreatic cells in this group. There were no changes in interleukin-6 expirations. GA ameliorated biochemical and pathological findings in the EMR+GA group. These findings clearly demonstrate that EMR can cause degenerative changes in both endocrine and exocrine pancreas cells in rats during the developmental period and GA has an ameliorative effect.

http://www.sciencedirect.com/science/article/pii/S1687850717300468

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Effects of Intermittent and Continuous Magnetic Fields on Trace Element Levels in Guinea Pigs

Erdem O, Akay C, Cevher SC, Canseven AG, Aydın A, Seyhan N. Effects of Intermittent and Continuous Magnetic Fields on Trace Element Levels in Guinea Pigs.Biol Trace Elem Res. 2017 May 22. doi: 10.1007/s12011-017-1053-8. [Epub ahead of print]

Abstract

Electromagnetic fields (EMFs) can affect living cells due to biochemical changes, followed by changes in levels of trace elements in serum and different organs. This study focuses on the effect of whole body exposure to EMF, presented everywhere in our environment, and on the levels of trace elements in serum, femur, brain, kidney, and liver tissues. The analyses performed on 29 guinea pigs were divided into five groups. Guinea pigs were exposed to a magnetic field of 50 Hz of 1.5 mT. Groups A and B were exposed to the magnetic field for a period of 4 h/day continuously (4 h/day) for 4 and 7 days, respectively. Groups C and D were exposed to the magnetic field for a period of 4 h/day intermittently for 4 and 7 days, respectively. Group E animals were enrolled as control. Copper (Cu), zinc (Zn), calcium (Ca), and magnesium (Mg) levels were determined by atomic absorption spectroscopy in serum, femur, brain, kidney, and liver tissues in all guinea pigs. When compared to the control groups, the changes in the levels of Cu in serum samples, femur, and kidney tissues of the treated groups were statistically significant. The same was also true for the levels of Mg in the brain, kidney, and lung tissues. Our results suggest that in vivo continuous and intermittent exposure to EMF may cause disturbances in homeostasis of bioelements. These effects could be important risk factors for toxic effects of EMF, especially in relation to deterioration of bioelements.

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Preterm birth among women living within 600 meters of high voltage overhead Power Lines: a case-control study

Sadeghi T, Ahmadi A, Javadian M, Gholamian SA, Delavar MA, Esmailzadeh S, Ahmadi B, Hadighi MSH. Preterm birth among women living within 600 meters of high voltage overhead Power Lines: a case-control study. Rom J Intern Med. 2017 Apr 18. [Epub ahead of print]

Abstract

AIM: The issue of preterm birth due to exposure to magnetic fields from power lines is unclear. Exposure to electromagnetic field in uterus has been hypothesized as possible preterm birth. The aim of the present study was to determine whether living closer to high voltage power lines increased the risk of preterm labor.

METHODS: In a nested case-control study, 135 cases of singleton live spontaneous preterm birth in Rohani hospital, Babol, Iran, during the period between 2013 and 2014 were studied. The 150 control subjects were singleton term live birth in the same year of birth and city of residence using randomized-digit dialing. The shortest distance to any of the high voltage power lines to the maternal residence during pregnancy was measured using ArcGIS software for every case and control. To test the association between the preterm births and the residential proximity to power lines, stepwise multiple logistic regression was used.

RESULTS: There were 28 households, 20 cases (14.8%) and 8 controls (5.3%) were situated within 600 meters of a high voltage power lines. The adjusted OR for spontaneous preterm birth and birth defect in women who were living in less than 600 meters from high voltage power lines was higher compared to those living in farther distance (OR=3.28, CI: 1.37 to 7.85) and (OR=5.05, CI: 1.52 to 16.78), respectively.

CONCLUSIONS: Therefore, installing overhead power lines and stations within 600 meters or making overhead underground would be useful in the prevention of the both preterm birth and birth defect.

https://www.ncbi.nlm.nih.gov/pubmed/28422709

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Evaluation of Mobile Phone and Cordless Phone Use and Glioma Risk Using the Bradford Hill Viewpoints from 1965 on Association or Causation

Carlberg M, Hardell L. Evaluation of Mobile Phone and Cordless Phone Use and Glioma Risk Using the Bradford Hill Viewpoints from 1965 on Association or Causation. Biomed Res Int. 2017;2017:9218486. doi: 10.1155/2017/9218486. Epub 2017 Mar 16.

Abstract

Objective. Bradford Hill's viewpoints from 1965 on association or causation were used on glioma risk and use of mobile or cordless phones. Methods. All nine viewpoints were evaluated based on epidemiology and laboratory studies. Results. Strength: meta-analysis of case-control studies gave odds ratio (OR) = 1.90, 95% confidence interval (CI) = 1.31-2.76 with highest cumulative exposure. Consistency: the risk increased with latency, meta-analysis gave in the 10+ years' latency group OR = 1.62, 95% CI = 1.20-2.19. Specificity: increased risk for glioma was in the temporal lobe. Using meningioma cases as comparison group still increased the risk. Temporality: highest risk was in the 20+ years' latency group, OR = 2.01, 95% CI =1.41-2.88, for wireless phones. Biological gradient: cumulative use of wireless phones increased the risk. Plausibility: animal studies showed an increased incidence of glioma and malignant schwannoma in rats exposed to radiofrequency (RF) radiation. There is increased production of reactive oxygen species (ROS) from RF radiation. Coherence: there is a change in the natural history of glioma and increasing incidence. Experiment: antioxidants reduced ROS production from RF radiation. Analogy: there is an increased risk in subjects exposed to extremely low-frequency electromagnetic fields. Conclusion. RF radiation should be

regarded as a human carcinogen causing glioma.

https://www.ncbi.nlm.nih.gov/pubmed/28401165

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Asociación entre las radiaciones de teléfonos móviles y el riesgo tumoral en personas adultas

Bielsa-Fernández P, Rodríguez-Martín B. Asociación entre las radiaciones de teléfonos móviles y el riesgo tumoral en personas adultas. Gaceta Sanitaria, Available online 13 April 2017. (Review paper written in Spanish.)

Abstract

Objective To synthesize and analyse systematic reviews, case-control studies, cohort studies and meta-analysis that investigate the association between exposure to radiofrequency from mobile phones and the appearance of tumours in adults.

Methods A systematic search was conducted in Scopus, Web of Science, The Cochrane Library, Medline and Cinahl of articles published in English and Spanish between January 2005 and February 2016 that analyse the risk of tumour associated with exposure to radiofrequency from mobile phones in adults. The recommendations of the PRISMA Declaration were followed, and the quality of the articles was analysed with the AMSTAR tool and the Newcastle-Ottawa Scale.

Results 1034 studies were found, fourteen of which were included. Most studies agree that it is not possible to determine a relationship in the short term, although long-term (over 10 years) radiofrequency emitted by mobile phones can cause tumour effects, with an increased risk by ipsilateral exposure and latency.

Conclusions Although radiofrequency from mobile phones has tumour effects on humans, the available scientific evidence is not robust. More rigorous follow-up studies with larger sample sizes and broader periods are necessary to learn more about the long-term effects.

http://bit.ly/2qzqnPV

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Acute effects of mobile phone radiation on brain function

Zhang J, Sumich A, Wang GY. Acute effects of radiofrequency electromagnetic field emitted by mobile phone on brain function. Bioelectromagnetics. 2017 Apr 20. doi: 10.1002/bem.22052. [Epub ahead of print]

Abstract

Due to its attributes, characteristics, and technological resources, the mobile phone (MP) has become one of the most commonly used communication devices. Historically, ample evidence has ruled out the substantial short-term impact of radiofrequency electromagnetic field (RF-EMF) emitted by MP on human cognitive performance. However, more recent evidence suggests potential harmful effects associated with MP EMF exposure. The aim of this review is to readdress the question of whether the effect of MP EMF exposure on brain function should be reopened. We strengthen our argument focusing on recent neuroimaging and electroencephalography studies, in order to present a more specific analysis of effects of MP EMF exposure on neurocognitive function. Several studies indicate an increase in cortical excitability and/or efficiency with EMF exposure, which appears to be more prominent in fronto-temporal regions and has been associated with faster reaction time. Cortical excitability might also underpin disruption to sleep. However, several inconsistent

findings exist, and conclusions regarding adverse effects of EMF exposure are currently limited. It also should be noted that the crucial scientific question of the effect of longer-term MP EMF exposure on brain function remains unanswered and essentially unaddressed.

https://www.ncbi.nlm.nih.gov/pubmed/28426166

Conclusion

While several studies suggest an effect of EMF exposure on brain function, there is little evidence of the harmful nature of these effects, and greater understanding is needed of their functional significance. To date, the crucial scientific question of the effect of longer-term MP EMF exposure on brain function remains unanswered and essentially unaddressed. The potential health effects of MP EMF exposure in children and adolescents have been identified by the World Health Organization (WHO) as a high priority research area, since they have longer lifetime exposure to MP [van Deventure et al., 2011]. Prior to establishing a clear picture of a cause-effect relationship on MPs, it is safer to minimize the MP use. It has been suggested to reduce the potential harm induced by MPs by restricting call length, or by using hands-free devices [Valentini et al., 2010]. Furthermore, more people have problems with MP use [Billieux et al., 2015], and addictive consumption styles and problematic behavior have been observed. In order to minimize possible negative consequences caused by excessive usage, further research is required to clarify neurophysiological changes associated with long-term MP EMF exposure and the impact of different behavioral characteristics of MP use on cognitive function.

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Cell phone use may increase the risk of developing parotid gland tumors

Brignardello-Petersen R. Cell phone use may increase the risk of developing parotid gland tumors. J Am Dent Assoc. 2017 May;148(5):e61. doi: 10.1016/j.adaj.2017.02.045.

No Abstract

Also see: de Siqueira EC, de Souza FT, Gomez RS, Gomes CC, de Souza RP. Does cell phone use increase the chances of parotid gland tumor development? A systematic review and meta-analysis [published online ahead of print December 9, 2016]. J Oral Pathol Med. http://dx.doi.org/10.1111/jop.12531.

https://www.ncbi.nlm.nih.gov/pubmed/28449765

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Modeled & Perceived Exposure to RF EMF From Mobile-Phone Base Stations & Development of Symptoms Over Time in General Population Cohort

Martens AL, Slottje P, Timmermans DR, Kromhout H, Reedijk M, Vermeulen RC, Smid T. Modeled and Perceived Exposure to Radio-Frequency Electromagnetic Fields From Mobile-Phone Base Stations and the Development of Symptoms Over Time in a General Population Cohort. Am J Epidemiol. 2017 Apr 7:1-10. doi: 10.1093/aje/kwx041.

Abstract

We assessed associations between modeled and perceived exposure to radio-frequency electromagnetic fields (RF-EMF) from mobile-phone base stations and the development of nonspecific symptoms and sleep

disturbances over time. A population-based Dutch cohort study, the Occupational and Environmental Health Cohort Study (AMIGO) (n = 14,829; ages 31-65 years), was established in 2011/2012 (T0), with follow-up of a subgroup (n = 3,992 invited) in 2013 (T1; n = 2,228) and 2014 (T2; n = 1,740). We modeled far-field RF-EMF exposure from mobile-phone base stations at the home addresses of the participants using a 3-dimensional geospatial model (NISMap). Perceived exposure (0 = not at all; 6 = very much), nonspecific symptoms, and sleep disturbances were assessed by questionnaire. We performed cross-sectional and longitudinal analyses, including fixed-effects regression. We found small correlations between modeled and perceived exposure in AMIGO participants at baseline (n = 14,309; rSpearman = 0.10). For 222 follow-up participants, modeled exposure increased substantially (>0.030 mW/m2) between T0 and T1. This increase in modeled exposure was associated with an increase in perceived exposure during the same time period. In contrast to modeled RF-EMF exposure from mobile-phone base stations, perceived exposure was associated with higher symptom reporting scores in both cross-sectional and longitudinal analyses, as well as with sleep disturbances in cross-sectional analyses.

https://www.ncbi.nlm.nih.gov/pubmed/28398549

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Radiofrequency exposure levels in Amsterdam schools

van Wel L, Vermeulen R, van Eijsden M, Vrijkotte T, Kromhout H, Huss A. Radiofrequency exposure levels in Amsterdam schools. Bioelectromagnetics. 2017 Apr 25. doi: 10.1002/bem.22053.

No Abstract

https://www.ncbi.nlm.nih.gov/pubmed/28444698

This letter to the editor reports the results of RF exposure levels in 102 primary schools in Amsterdam. GSM base stations (900 + 1800 MHz downlink) provided the largest contribution to the total average RF power density (38.0%), followed by DECT cordless phones (27.3%) and GSM mobile devices (11.1%), Although WiFi contributed only 4.5% of the total average power density, the assessments were conducted after school so it was unlikely that any wireless laptops or tablets were being used at the time.

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High RF radiation at Stockholm Old Town: An exposimeter study

Hardell L, Carlberg M, Koppel T, Hedendahl L. High radiofrequency radiation at Stockholm Old Town: An exposimeter study including the Royal Castle, Supreme Court, three major squares and the Swedish Parliament. Mol Clin Oncol. 2017 Apr;6(4):462-476. doi: 10.3892/mco.2017.1180. Epub 2017 Mar 3.

Abstract

Exposure to radiofrequency (RF) radiation was classified as a possible human carcinogen, Group 2B, by the International Agency for Research on Cancer at WHO in 2011. The exposure pattern is changing due to the rapid development of technology. Outdoor RF radiation level was measured during five tours in Stockholm Old Town in April, 2016 using the EME Spy 200 exposimeter with 20 predefined frequencies. The results were based on 10,437 samples in total. The mean level of the total RF radiation was 4,293 μW/m2 (0.4293 μW/cm2). The highest mean levels were obtained for global system for mobile communications (GSM) + universal mobile telecommunications system (UMTS) 900 downlink and long-term evolution (LTE) 2600 downlink (1,558 and 1,265 μW/m2, respectively). The town squares displayed highest total mean levels, with the example of Järntorget square with 24,277 μW/m2 (min 257, max 173,302 μW/m2). These results were in

large contrast to areas with lowest total exposure, such as the Supreme Court, with a mean level of 404 μW/m2 (min 20.4, max 4,088 μW/m2). In addition, measurements in the streets surrounding the Royal Castle were lower than the total for the Old Town, with a mean of 756 μW/m2 (min 0.3, max 50,967 μW/m2). The BioInitiative 2012 Report defined the scientific benchmark for possible health risks as 30-60 μW/m2. Our results of outdoor RF radiation exposure at Stockholm Old Town are significantly above that level. The mean exposure level at Järntorget square was 405-fold higher than 60 μW/m2. Our results were below the reference level on 10,000,000 μW/m2 established by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), which, however, are less credible, as they do not take non-thermal effects into consideration and are not based on sound scientific evaluation. Our highest measured mean level at Järntorget was 0.24% of the ICNIRP level. A number of studies have found adverse, non-thermal (no measurable temperature increase) health effects far below the ICNIRP guidelines.

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Effect of 900 MHz GSM Mobile Phone RF Radiation on Estrogen Receptor Methylation Status in Colon Cells

Mokarram P, Sheikhi M, Mortazavi SMJ, Saeb S, Shokrpour N. Effect of Exposure to 900 MHz GSM Mobile Phone Radiofrequency Radiation on Estrogen Receptor Methylation Status in Colon Cells of Male Sprague Dawley Rats. J Biomed Phys Eng. 2017 Mar 1;7(1):79-86. eCollection 2017.

Abstract

BACKGROUND: Over the past several years, the rapidly increasing use of mobile phones has raised global concerns about the biological effects of exposure to radiofrequency (RF) radiation. Numerous studies have shown that exposure to electromagnetic fields (EMFs) can be associated with effects on the nervous, endocrine, immune, cardiovascular, hematopoietic and ocular systems. In spite of genetic diversity, the onset and progression of cancer can be controlled by epigenetic mechanisms such as gene promoter methylation. There are extensive studies on the epigenetic changes of the tumor suppressor genes as well as the identification of methylation biomarkers in colorectal cancer. Some studies have revealed that genetic changes can be induced by exposure to RF radiation. However, whether or not RF radiation is capable of inducing epigenetic alteration has not been clarified yet. To date, no study has been conducted on the effect of radiation on epigenetic alterations in colorectal cancer (CRC). Several studies have also shown that methylation of estrogen receptor α (ERα), MYOD, MGMT, SFRP2 and P16 play an important role in CRC. It can be hypothesized that RF exposure can be a reason for the high incidence of CRC in Iran. This study aimed to investigate whether epigenetic pattern of ERα is susceptible to RF radiation and if RF radiation can induce radioadaptive response as epigenetic changes after receiving the challenge dose (γ-ray).

MATERIAL AND METHOD: 40 male Sprague-Dawley rats were divided into 4 equal groups (Group I: exposure to RF radiation of a GSM cell phone for 4 hours and sacrificed after 24 hours; Group II: RF exposure for 4 hours, exposure to Co-60 gamma radiation (3 Gy) after 24 hours and sacrificed after 72 hrs; Group III: only 3Gy gamma radiation; Group 4: control group). DNA from colon tissues was extracted to evaluate the methylation status by methylation specific PCR.

RESULTS: Our finding showed that exposure to GSM cell phone RF radiation was capable of altering the pattern of ERα gene methylation compared to that of non-exposed controls. Furthermore, no adaptive response phenomenon was induced in the pattern of ERα gene methylation after exposure to the challenging dose of Co-60 γ-rays.

CONCLUSION: It can be concluded that exposure to RF radiation emitted by GSM mobile phones can lead to epigenetic detrimental changes in ERα promoter methylation pattern.

Open Access Paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5401136/

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Proteomic analysis of continuous 900-MHz RF EMF exposure in testicular tissue: a rat model of human cell phone exposure

Sepehrimanesh M, Kazemipour N, Saeb M, Nazifi S, Davis DL.Proteomic analysis of continuous 900-MHz radiofrequency electromagnetic field exposure in testicular tissue: a rat model of human cell phone exposure. Environ Sci Pollut Res Int. 2017 Apr 10. doi: 10.1007/s11356-017-8882-z.

Abstract

Although cell phones have been used worldwide, some adverse and toxic effects were reported for this communication technology apparatus. To analyze in vivo effects of exposure to radiofrequency-electromagnetic field (RF-EMF) on protein expression in rat testicular proteome, 20 Sprague-Dawley rats were exposed to 900 MHz RF-EMF for 0, 1, 2, or 4 h/day for 30 consecutive days. Protein content of rat testes was separated by high-resolution two-dimensional electrophoresis using immobilized pH gradient (pI 4-7, 7 cm) and 12% acrylamide and identified by MALDI-TOF/TOF-MS. Two protein spots were found differentially overexpressed ($P < 0.05$) in intensity and volume with induction factors 1.7 times greater after RF-EMF exposure. After 4 h of daily exposure for 30 consecutive days, ATP synthase beta subunit (ASBS) and hypoxia up-regulated protein 1 precursor (HYOU1) were found to be significantly up-regulated. These proteins affect signaling pathways in rat testes and spermatogenesis and play a critical role in protein folding and secretion in the endoplasmic reticulum. Our results indicate that exposure to RF-EMF produces increases in testicular proteins in adults that are related to carcinogenic risk and reproductive damage. In light of the widespread practice of men carrying phones in their pockets near their gonads, where exposures can exceed as-tested guidelines, further study of these effects should be a high priority.

https://www.ncbi.nlm.nih.gov/pubmed/28397118

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Exposure to mobile phone (900-1800 MHz) during pregnancy: tissue oxidative stress after childbirth

Bahreyni Toossi MH, Sadeghnia HR, Mohammad Mahdizadeh Feyzabadi M, Hosseini M, Hedayati M, Mosallanejad R, Beheshti F, Alizadeh Rahvar Z.
Exposure to mobile phone (900-1800 MHz) during pregnancy: tissue oxidative stress after childbirth. J Matern Fetal Neonatal Med. 2017 Apr 23:1-6. doi: 10.1080/14767058.2017.1315657. [Epub ahead of print]

Abstract

BACKGROUND: The present study has investigated the effects of mobile phone (900-1800 MHz)-induced electromagnetic radiation on redox status in the heart, liver, kidney, cerebellum, and hippocampus of dams and the offspring mice.

MATERIALS AND METHODS: Pregnant Balb/C were divided into two groups including the control and the experimental group. The experimental group was exposed to mobile phone (900-1800 MHz), during pregnancy (2 h/d for 20 d). The dams and the offspring of both groups were sacrificed and tissues of interest were harvested immediately after delivery. Malondialdehyde (MDA) concentration, total thiol groups (TTG) content, superoxide dismutase (SOD), and catalase (CAT) activities were determined in the tissues.

RESULTS: In the experimental groups, MDA levels were significantly increased, while TTG, SOD, and CAT were significantly decreased in the total tissues of dams and their offspring.

CONCLUSION: Exposure to mobile phone (900-1800 MHz) during pregnancy induced oxidative stress in tissues of dams and their offspring.

https://www.ncbi.nlm.nih.gov/pubmed/28434276

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Postnatal development & behavior effects of in-utero exposure of rats to RF emitted from WiFi devices

Othman H, Ammari M, Rtibi K, Bensaid N, Sakly M, Abdelmelek H. Postnatal development and behavior effects of in-utero exposure of rats to radiofrequency waves emitted from conventional WiFi devices.Environ Toxicol Pharmacol. 2017 Apr 22;52:239-247. doi: 10.1016/j.etap.2017.04.016.

Highlights

• Effects of gestational exposure to 2.45 GHz WiFi signal for 2 h/day along gestation period on the offspring were studied.
• Offspring showed neurodevelopment impairments but no behavior alteration at adult age.
• Cerebral oxidative stress equilibrium as well as cholinesterase activity in brain and serum were altered.

Abstract

The present work investigated the effects of prenatal exposure to radiofrequency waves of conventional WiFi devices on postnatal development and behavior of rat offspring. Ten Wistar albino pregnant rats were randomly assigned to two groups (n=5). The experimental group was exposed to a 2.45GHz WiFi signal for 2h a day throughout gestation period. Control females were subjected to the same conditions as treated group without applying WiFi radiations. After delivery, the offspring was tested for physical and neurodevelopment during its 17 postnatal days (PND), then for anxiety (PND 28) and motricity (PND 40-43), as well as for cerebral oxidative stress response and cholinesterase activity in brain and serum (PND 28 and 43). Our main results showed that the in-utero WiFi exposure impaired offspring neurodevelopment during the first seventeen postnatal days without altering emotional and motor behavior at adult age. Besides, prenatal WiFi exposure induced cerebral oxidative stress imbalance (increase in malondialdehyde level (MDA) and hydrogen peroxide (H2O2) levels and decrease in catalase (CAT) and superoxide dismutase (SOD) activities) at 28 but not 43days old, also the exposure affected acethylcolinesterase activity at both cerebral and seric levels. Thus, the current study revealed that maternal exposure to WiFi radiofrequencies led to various adverse neurological effects in the offspring by affecting neurodevelopment, cerebral stress equilibrium and cholinesterase activity.

https://www.ncbi.nlm.nih.gov/pubmed/28458069

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Effect of long-term exposure of mice to 900 MHz GSM radiation on cutaneous candidiasis

Bayat M, Hemati S, Soleimani-Estyar R, Shahin-Jafari A. Effect of long-term exposure of mice to 900 MHz GSM radiation on experimental cutaneous candidiasis. Saudi Journal of Biological Sciences. 24(4):907-914. May 2017.

Abstract

Mobile phones communicate with base stations using 900 MHz microwaves. The current study was aimed to survey the effects of long-term 900 MHz microwave exposure of mice on experimentally induced cutaneous candidiasis. Forty inbred, male, BALB/c mice were randomly divided into four groups. Cutaneous lesions with Candida albicans were experimentally induced on the lateral-back skin of the 20 mice. One group of the diseased mice were exposed (6 h per day and 7 d per week) to 900 MHz microwave radiation, while the other groups were not exposed. Two unexposed control groups were also included. The skin lesions were regularly monitored and the live candida cell density was enumerated using the colony-forming unit (CFU) assay. The

process was repeated after a one week resting interval. One week later, all mice were challenged through intra tail veins using LD90 dose of C. albicans. Mortality of the mice was recorded and the candida load of the kidney homogenates from died animals was counted. 900 MHz microwave exposed mice had 1.5 day and 3.7 day delays on wound healing in stages two. Live Candida inoculated Wave exposed (LCW) mice also showed higher yeast loads in skin lesions at days 5, 7 and 9 post inoculation. Survival analysis of live candida challenged mice showed the radiation exposed group is prone to death induced by systemic infection and candida enumeration from the kidney homogenates showed radiation exposed animals have had significantly higher yeast load in the tissue. In collection, long-term 900 MHz radiation exposure of mice led to longevity of skin wounds and susceptibility of the animals to systemic challenge and higher incidences of microorganisms in internal tissues.

http://bit.ly/2p8URXX

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RF radiation induced genotoxic & carcinogenic effects on chickpea root tip cells

Qureshi ST , Memon SA, Abassi AR, Sial MA, Bughio FA. Radiofrequency radiations induced genotoxic and carcinogenic effects on chickpea (Cicer arietinum L.) root tip cells. Saudi Journal of Biological Sciences, 24(4):883-391. May 2017.

Abstract

Present study was under taken to predict the possible DNA damages (genotoxicity) and carcinogenicity caused by radiofrequency radiations (RF) to living tissue. Dry seeds of chickpea were treated with GSM cell phone (900 MHz) and laptop (3.31 GHz) as RF source for 24 and 48 h. Untreated seeds were used as (0 h) negative control and Gamma rays (250 Gray) as positive control. Plant chromosomal aberration assay was used as genotoxicity marker. All the treatment of RF inhibits seed germination percentage. 48 h laptop treatment has the most negative effect as compared to untreated control. A decrease was observed in mitotic index (M.I) and increase in abnormality index (A.I) with the increase in exposure duration and frequency in (Hz). Cell membrane damages were also observed only in 48 h exposure of cell phone and laptop (RF). Maximum nuclear membrane damages and ghost cells were again recorded in 48 h exposure of cell phone and laptop. The radiofrequency radiations (900 MHz and 3.31 GHz) are only genotoxic as they induce micronuclei, bi-nuclei, multi-nuclei and scattered nuclei but could be carcinogenic as 48 h incubation of RF induced fragmentation and ghost cells. Therefore cell phones and laptop should not be used unnecessarily to avoid possible genotoxic and carcinogenic effects.

http://bit.ly/2pYJXrU

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Biological effects of exposure to static electric fields in humans and vertebrates: a systematic review

Petri AK, Schmiedchen K, Stunder D, Dechent D, Kraus T, Bailey WH, Driessen S. Biological effects of exposure to static electric fields in humans and vertebrates: a systematic review. Environ Health. 2017 Apr 17;16(1):41. doi: 10.1186/s12940-017-0248-y.

Abstract

BACKGROUND: High-voltage direct current (HVDC) lines are the technology of choice for the transport of large amounts of energy over long distances. The operation of these lines produces static electric fields (EF), but the data reviewed in previous assessments were not sufficient to assess the need for any environmental limit. The aim of this systematic review was to update the current state of research and to evaluate biological

effects of static EF.

METHODS: Using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) recommendations, we collected and evaluated experimental and epidemiological studies examining biological effects of exposure to static EF in humans (n = 8) and vertebrates (n = 40).

RESULTS: There is good evidence that humans and animals are able to perceive the presence of static EF at sufficiently high levels. Hair movements caused by electrostatic forces may play a major role in this perception. A large number of studies reported responses of animals (e.g., altered metabolic, immunologic or developmental parameters) to a broad range of static EF strengths as well, but these responses are likely secondary physiological responses to sensory stimulation. Furthermore, the quality of many of the studies reporting physiological responses is poor, which raises concerns about confounding.

CONCLUSION: The weight of the evidence from the literature reviewed did not indicate that static EF have adverse biological effects in humans or animals. The evidence strongly supported the role of superficial sensory stimulation of hair and skin as the basis for perception of the field, as well as reported indirect behavioral and physiological responses. Physical considerations also preclude any direct effect of static EF on internal physiology, and reports that some physiological processes are affected in minor ways may be explained by other factors. While this literature does not support a level of concern about biological effects of exposure to static EF, the conditions that affect thresholds for human detection and possible annoyance at suprathreshold levels should be investigated.

https://www.ncbi.nlm.nih.gov/pubmed/28416002

Excerpt

The vast majority of the evaluated studies dealt with static EF influences on health and physiological functions in humans and animals. An experimental study in visual display unit users found indications that a combination of static EF exposure and high dust concentrations might induce external facial skin irritation [33]. Two other human studies reported that static EF did not induce facial skin symptoms [32] or impair cardiovascular, hematologic, or psychomotor functions [28]. Neither were adverse health effects reported upon long-term exposure to a HVDC power line [35]. A great many of the animal studies reported effects on metabolic activity [49, 56, 60, 62, 68], collagen synthesis [59, 63, 64, 65], bone density [61], expression of oxidative stress markers [66, 67, 70, 71, 76], hematologic and immunologic blood parameters [41, 42, 43, 50, 69, 70, 71, 72, 74, 75, 76, 77, 78], neurotransmitter concentrations [56], brain activity [58], litter number [52], genotoxicity [69, 79], and tumor regression [37]. However, the results regarding these parameters were not always consistent and partially contradictory. Some studies could not confirm static EF influences on metabolic functions [52], histological appearance of diverse organ systems [43, 50, 69], neurotransmitter concentrations in the brain [38, 40, 57], functions of the immune system [73] or reproductive and developmental parameters [44].

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Absorption of millimeter waves by human beings and its biological implications
A classic paper that has implications for 5G wireless technology

Gandhi OP, Riazi A. Absorption of millimeter waves by human beings and its biological implications. IEEE Transactions on Microwave Theory and Techniques. MTT-34(2):228-235. 1986. http://bit.ly/2oS3rKD

Also see: http://www.saferemr.com/2016/08/is-5g-cellular-technology-harmful-to.html

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Prospects for Millimeter-Wave Compliance Measurement Technologies

Alon L, Gabriel S, Cho GY, Brown R, Deniz CM. Prospects for Millimeter-Wave Compliance Measurement Technologies [Measurements Corner]. IEEE Antennas Propag Mag 2017; 59 (2).

http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7892071

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Maternal cell phone use during pregnancy and child behavioral problems in five birth cohorts

Laura Birks, Mònica Guxens, Eleni Papadopoulou, Jan Alexander, Ferran Ballester, Marisa Estarlich, Mara Gallastegi, Mina Ha, Margaretha Haugen, Anke Huss, Leeka Kheifets et al. Maternal cell phone use during pregnancy and child behavioral problems in five birth cohorts. Environment International. Published online April 7, 2017. http://doi.org/10.1016/j.envint.2017.03.024

"This is the largest study to date to evaluate these associations and to show mostly consistent results across cohorts with retrospectively and prospectively assessed maternal cell phone use."

Highlights

• Largest study to date to use prenatal cell phone use data collected prospectively.
• High prenatal cell phone use linked to hyperactivity/inattention problems in child.
• No prenatal cell phone use linked to low risk for any behavioral problems in child.
• Analysis adjusted for many confounders, but associations cannot be judged causal.
• Future research should adjust for parenting style, maternal hyperactivity, and more.

Introduction Previous studies have reported associations between prenatal cell phone use and child behavioral problems, but findings have been inconsistent and based on retrospective assessment of cell phone use. This study aimed to assess this association in a multi-national analysis, using data from three cohorts with prospective data on prenatal cell phone use, together with previously published data from two cohorts with retrospectively collected cell phone use data.

Methods We used individual participant data from 83,884 mother-child pairs in the five cohorts from Denmark (1996–2002), Korea (2006–2011), the Netherlands (2003–2004), Norway (2004–2008), and Spain (2003–2008). We categorized cell phone use into none, low, medium, and high, based on frequency of calls during pregnancy reported by the mothers. Child behavioral problems (reported by mothers using the Strengths and Difficulties Questionnaire or Child Behavior Checklist) were classified in the borderline/clinical and clinical ranges using validated cut-offs in children aged 5–7 years. Cohort specific risk estimates were meta-analyzed.

Results Overall, 38.8% of mothers, mostly from the Danish cohort, reported no cell phone use during pregnancy and these mothers were less likely to have a child with overall behavioral, hyperactivity/inattention or emotional problems. Evidence for a trend of increasing risk of child behavioral problems through the maternal cell phone use categories was observed for hyperactivity/inattention problems (OR for problems in the clinical range: 1.11, 95% CI 1.01, 1.22; 1.28, 95% CI 1.12, 1.48, among children of medium and high users, respectively). This association was fairly consistent across cohorts and between cohorts with retrospectively and prospectively collected cell phone use data.

Conclusions Maternal cell phone use during pregnancy may be associated with an increased risk for behavioral problems, particularly hyperactivity/inattention problems, in the offspring. The interpretation of these results is unclear as uncontrolled confounding may influence both maternal cell phone use and child behavioral problems.

https://www.ncbi.nlm.nih.gov/pubmed/28392066

Also see:

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Effects of prenatal exposure to WiFi signal on postnatal development and behavior in rat: Influence of maternal restraint

Haifa Othman, Mohamed Ammari, Mohsen Sakly, Hafedh Abdelmelek. Effects of prenatal exposure to WiFi signal (2.45 GHz) on postnatal development and behavior in rat: Influence of maternal restraint. Behavioural Brain Research. 36:291-302. May 2017. http://dx.doi.org/10.1016/j.bbr.2017.03.011

Highlights

• Effects of gestational exposure to WiFi signal and restraint along gestation period on the offspring were studied.
• The pups were evaluated for physical development and neuromotor maturation.
• Gestational WiFi exposure and restraint, adversely affected offspring neurodevelopment and behavior at adulthood.
• Progeny brain oxidative balance and serum biochemistry were disrupted.

Abstract

The present study was carried out to investigate the potential combined influence of maternal restraint stress and 2.45 GHz WiFi signal exposure on postnatal development and behavior in the offspring of exposed rats. 24 pregnant albino Wistar rats were randomly assigned to four groups: Control, WiFi-exposed, restrained and both WiFi-exposed and restrained groups. Each of WiFi exposure and restraint occurred 2 h/day along gestation till parturition. The pups were evaluated for physical development and neuromotor maturation. Moreover, elevated plus maze test, open field activity and stationary beam test were also determined on postnatal days 28, 30 and 31, respectively. After behavioral tests, the rats were anesthetized and their brains were removed for biochemical analysis. Our main findings showed no detrimental effects on gestation progress and outcomes at delivery in all groups. Subsequently, WiFi and restraint, *per se* and mainly *in concert* altered physical development of pups with slight differences between genders. Behaviorally, the gestational WiFi irradiation, restraint and especially the associated treatment affected the neuromotor maturation mainly in male progeny. At adult age, we noticed anxiety, motor deficit and exploratory behavior impairment in male offspring co-exposed to WiFi radiation and restraint, and in female progeny subjected to three treatments. The biochemical investigation showed that, all three treatments produced global oxidative stress in brain of both sexes. As for serum biochemistry, phosphorus, magnesium, glucose, triglycerides and calcium levels were disrupted. Taken together, prenatal WiFi radiation and restraint, alone and combined, provoked several behavioral and biochemical impairments at both juvenile and adult age of the offspring.

http://www.sciencedirect.com/science/article/pii/S0166432816313018

Also see:
Pregnancy & Wireless Radiation Risks

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The effect of cell phone usage on semen quality and fertility among Jordanian males

Nahla Al-Bayyari. Middle East Fertility Society Journal. The effect of cell phone usage on semen quality and fertility among Jordanian males. Published online Apr 7, 2017. http://doi.org/10.1016/j.mefs.2017.03.006

Abstract

Background and objective Cell phones emit radiofrequency electromagnetic radiation are prejudicial to human fertility. The objective was to study the effect of cell phone usage on semen quality and men's fertility.

Materials and methods A cross-sectional observational study conducted on 159 men attending infertility clinics at North, Middle and South Governorates in Jordan and undergoing infertility evaluation were divided into two groups according to their active cell phone use: group A: ≤1 h/day and group B: >1 h/day. No interventions were given to patients and semen samples were collected by masturbation in a sterile container after an abstinence period of 5 days. The main outcome measures were sperm volume, liquefaction time, pH, viscosity, count, motility and morphology.

Results There were no statistical significance differences ($p > 0.05$) between both groups regarding sperm quality parameters according to cell phone use, but there were statistical differences in the frequencies of sperm concentration, volume, viscosity, liquefaction time and means of immotile sperms and abnormal morphology. In addition, time spend on watching television and using wireless phones were significantly ($p \leq 0.05$) associated with decreasing mean percentages of normal morphology. The distance from telecommunication tower was significantly ($p \leq 0.05$) associated with decreasing sperms volume. Meanwhile, the time spend on sending or receiving messages was significantly ($p \leq 0.05$) associated with decreasing sperms count and carrying mobile phone in trouser pocket was significantly associated with increasing means of immotile sperms.

Conclusion Cell phone use might have a negative effect on semen quality parameters and further research is needed.

http://www.sciencedirect.com/science/article/pii/S1110569017300602

Also see:
Effect of Mobile Phones on Sperm Quality

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Behavioral risk factors of breast cancer in Bangui of Central African Republic: A retrospective case-control study

Balekouzou A, Yin P, Afewerky HK, Bekolo C, Pamatika CM, Nambei SW, et al. Behavioral risk factors of breast cancer in Bangui of Central African Republic: A retrospective case-control study. PLoS One. 2017 Feb 8;12(2):e0171154. doi: 10.1371/journal.pone.0171154.

Abstract

Breast cancer is recognized as a major public health problem in developing countries; however, there is very little evidence of behavioral factors associated with breast cancer risk. This study was conducted to identify lifestyles as risk factors for breast cancer among Central African women. A case-control study was conducted with 174 cases confirmed histologically by the pathology unit of the National Laboratory and 348 age-matched controls. Data collection tools included a questionnaire with interviews and medical records of patients. Data were analyzed using SPSS software version 20. Odd ratio (OR) and 95% confidence intervals (95% CI) were obtained by unconditional logistic regression. In total, 522 women were studied with a mean age of 45.8 (SD = 13.4) years. By unconditional logistic regression model, women with breast cancer were more likely to have attained illiterate and elementary education level [11.23 (95% CI, 4.65-27.14) and 2.40 (95% CI, 1.15-4.99)], married [2.09 (95% CI, 1.18-3.71)], positive family history [2.31 (95% CI, 1.36-3.91)], radiation exposure [8.21 (95% CI, 5.04-13.38)], consumption charcuterie [10.82 (95% CI, 2.39-48.90)], fresh fish consumption [4.26 (95% CI, 1.56-11.65)], groundnut consumption [6.46 (95% CI, 2.57-16.27)], soybean consumption [16.74 (95% CI, 8.03-39.84)], alcohol [2.53 (95% CI, 1.39-4.60)], habit of keeping money in bras[3.57 (95% CI, 2.24-5.69)], overweight [5.36 (95% CI, 4.46-24.57)] and obesity [3.11(95% CI, 2.39-20.42)]. However, decreased risk of breast cancer was associated with being employed [0.32 (95% CI, 0.19-0.56)], urban residence [0.16 (95% CI,

0.07-0.37)], groundnut oil consumption [0.05 (95% CI, 0.02-0.14)], wine consumption [0.16 (95% CI, 0.09-0.26)], **non habit of keeping cell phone in bras [0.56 (95% CI, 0.35-0.89)]** and physical activity [0.71(95% CI, 0.14-0.84)]. The study showed that little or no education, marriage, positive family history of cancer, radiation exposure, charcuterie, fresh fish, groundnut, soybean, alcohol, habit of keeping money in bras, overweight and obesity were associated with breast cancer risk among Central African women living in Bangui. Women living in Bangui should be more cautious on the behavioral risk associated with breast cancer.

http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0171154

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Ecological momentary assessments integrating real-time exposure measurements & health assessment using a smartphone application

van Wel L, Huss A, Bachmann P, Zahner M, Kromhout H, Fröhlich J, Vermeulen R. Context-sensitive ecological momentary assessments; integrating real-time exposure measurements, data-analytics and health assessment using a smartphone application. Environ Int. 2017 Mar 25;103:8-12. doi: 10.1016/j.envint.2017.03.016. [Epub ahead of print]

Abstract

INTRODUCTION: Modern sensor technology makes it possible to collect vast amounts of environmental, behavioural and health data. These data are often linked to contextual information on for example exposure sources which is separately collected with considerable lag time, leading to complications in assessing transient and/or highly spatially variable environmental exposures. Context-Sensitive Ecological Momentary Assessments1 (CS-EMAs) could be used to address this. We present a case study using radiofrequency-electromagnetic fields (RF-EMF) exposure as an example for implementing CS-EMA in environmental research.

METHODS: Participants were asked to install a custom application on their own smartphone and to wear an RF-EMF exposimeter for 48h. Questionnaires were triggered by the application based on a continuous data stream from the exposimeter. Triggers were divided into four categories: relative and absolute exposure levels, phone calls, and control condition. After the two days of use participants filled in an evaluation questionnaire.

RESULTS: 74% of all CS-EMAs were completed, with an average time of 31s to complete a questionnaire once it was opened. Participants reported minimal influence on daily activities. There were no significant differences found between well-being and type of RF-EMF exposure.

CONCLUSIONS: We show that a CS-EMA based method could be used in environmental research. Using several examples involving environmental stressors, we discuss both current and future applications of this methodology in studying potential health effects of environmental factors.

https://www.ncbi.nlm.nih.gov/pubmed/28351768

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Tumor-treating fields elicit a conditional vulnerability to ionizing radiation via the downregulation of BRCA1 signaling and reduced DNA double-strand break repair capacity in non-small cell lung cancer cell lines

Karanam NK, Srinivasan K, Ding L, Sishc B, Saha D, Story MD. Tumor-treating fields elicit a conditional vulnerability to ionizing radiation via the downregulation of BRCA1 signaling and reduced DNA double-strand break repair capacity in non-small cell lung cancer cell lines. Cell Death Dis. 2017 Mar 30;8(3):e2711. doi: 10.1038/cddis.2017.136.

Abstract

The use of tumor-treating fields (TTFields) has revolutionized the treatment of recurrent and newly diagnosed glioblastoma (GBM). TTFields are low-intensity, intermediate frequency, alternating electric fields that are applied to tumor regions and cells using non-invasive arrays. The predominant mechanism by which TTFields are thought to kill tumor cells is the disruption of mitosis. Using five non-small cell lung cancer (NSCLC) cell lines we found that there is a variable response in cell proliferation and cell killing between these NSCLC cell lines that was independent of p53 status. TTFields treatment increased the G2/M population, with a concomitant reduction in S-phase cells followed by the appearance of a sub-G1 population indicative of apoptosis. Temporal changes in gene expression during TTFields exposure was evaluated to identify molecular signaling changes underlying the differential TTFields response. The most differentially expressed genes were associated with the cell cycle and cell proliferation pathways. However, the expression of genes found within the BRCA1 DNA-damage response were significantly downregulated ($P<0.05$) during TTFields treatment. DNA double-strand break (DSB) repair foci increased when cells were exposed to TTFields as did the appearance of chromatid-type aberrations, suggesting an interphase mechanism responsible for cell death involving DNA repair. Exposing cells to TTFields immediately following ionizing radiation resulted in increased chromatid aberrations and a reduced capacity to repair DNA DSBs, which were likely responsible for at least a portion of the enhanced cell killing seen with the combination. These findings suggest that TTFields induce a state of 'BRCAness' leading to a conditional susceptibility resulting in enhanced sensitivity to ionizing radiation and provides a strong rationale for the use of TTFields as a combined modality therapy with radiation or other DNA-damaging agents.

https://www.ncbi.nlm.nih.gov/pubmed/28358361

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Are media reports able to cause somatic symptoms attributed to WiFi radiation? An experimental test of the negative expectation hypothesis

Bräscher AK, Raymaekers K, Van den Bergh O, Witthöft M. Are media reports able to cause somatic symptoms attributed to WiFi radiation? An experimental test of the negative expectation hypothesis. Environ Res. 2017 Mar 31;156:265-271. doi: 10.1016/j.envres.2017.03.040.

Abstract

People suffering from idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF) experience numerous non-specific symptoms that they attribute to EMF. The cause of this condition remains vague and evidence shows that psychological rather than bioelectromagnetic mechanisms are at work. We hypothesized a role of media reports in the etiology of IEI-EMF and investigated how somatosensory perception is affected. 65 healthy participants were instructed that EMF exposure can lead to enhanced somatosensory perception. Participants were randomly assigned to watch either a television report on adverse health effects of EMF or a neutral report. During the following experiment, participants rated stimulus intensities of tactile (electric) stimuli while being exposed to a sham WiFi signal in 50% of the trials. Sham WiFi exposure led to increased intensity ratings of tactile stimuli in the WiFi film group, especially in participants with higher levels of somatosensory amplification. Participants of the WiFi group reported more anxiety concerning WiFi exposure than the Control group and tended to perceive themselves as being more sensitive to EMF after the experiment compared to before. Sensational media reports can facilitate enhanced perception of tactile stimuli in healthy participants. People tending to perceive bodily symptoms as intense, disturbing, and noxious seem most vulnerable. Receiving sensational media reports might sensitize people to develop a nocebo effect and thereby contribute to the development of IEI-EMF. By promoting catastrophizing thoughts and increasing symptom-focused attention, perception might more readily be enhanced and misattributed to EMF.

https://www.ncbi.nlm.nih.gov/pubmed/28371755

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Mitochondrial hyperpolarization and cytochrome-c release in microwave-exposed MCF-7 cells

Esmekaya MA, Canseven AG, Kayhan H, Tuysuz MZ, Sirav B, Seyhan N. Mitochondrial hyperpolarization and cytochrome-c release in microwave-exposed MCF-7 cells. Gen Physiol Biophys. 2016 Sep 12. [Epub ahead of print]

Abstract

This study examines the effects of a 2.1-GHz WCDMA-modulated microwave (MW) radiation on apoptotic activity and mitochondrial membrane potential (ΔΨm) in MCF-7 cells. The cells were exposed to the MW at a specific absorption rate (SAR) of 0.528 W/kg for 4 or 24 h. The antiproliferative effect of MW exposure was determined by the MTT test. Cytochrome-c and p53 levels were determined by an ELISA method. The relative ΔΨm was analysed by JC-1 staining using flow cytometer. Apoptotic rate of the cells was measured by Annexin-V-FITC staining. All assays were performed after certain time of incubations (15 min-4 h) following MW exposure. MW-exposed cells showed a significant decrease in viability when compared to unexposed cells. A significantly larger decrease was observed after longer exposure. The percentage of apoptotic cells, amount of cytochrome-c, and relative ΔΨm were significantly higher in MW-exposed cells. The percent of apoptotic cells and relative ΔΨm in 24 h MW-exposed group was significantly higher than those in 4 h MW-exposed group. However, no significant change was observed in p53 levels. These results demonstrated that exposure to 2.1-GHz WCDMA-modulated MW radiation caused hyperpolarization of mitochondria that in turn induced apoptosis in MCF-7 cells.

https://www.ncbi.nlm.nih.gov/pubmed/27615380

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Case-control study on occupational exposure to extremely low-frequency electromagnetic fields and glioma risk

Carlberg M, Koppel T, Ahonen M, Hardell L. Case-control study on occupational exposure to extremely low-frequency electromagnetic fields and glioma risk. Am J Ind Med. 2017 Apr 10. doi: 10.1002/ajim.22707. [Epub ahead of print]

Abstract

BACKGROUND: Exposure to extremely low-frequency electromagnetic fields (ELF-EMF) was in 2002 classified as a possible human carcinogen, Group 2B, by the International Agency for Research on Cancer at WHO.

METHODS: Life time occupations were assessed in case-control studies during 1997-2003 and 2007-2009. An ELF-EMF Job-Exposure Matrix was used for associating occupations with ELF exposure (μT). Cumulative exposure (μT-years), average exposure (μT), and maximum exposed job (μT) were calculated.

RESULTS: Cumulative exposure gave for astrocytoma grade IV (glioblastoma multiforme) in the time window 1-14 years odds ratio (OR) = 1.9, 95% confidence interval (CI) = 1.4-2.6, p linear trend <0.001, and in the time window 15+ years OR = 0.9, 95%CI = 0.6-1.3, p linear trend = 0.44 in the highest exposure categories 2.75+ and 6.59+ μT years, respectively.

CONCLUSION: An increased risk in late stage (promotion/progression) of astrocytoma grade IV for occupational ELF-EMF exposure was found.

https://www.ncbi.nlm.nih.gov/pubmed/28394434

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Occupational exposure and amyotrophic lateral sclerosis in a prospective cohort

Koeman T, Slottje P, Schouten LJ, Peters S, Huss A, Veldink JH, Kromhout H, van den Brandt PA, Vermeulen R. Occupational exposure and amyotrophic lateral sclerosis in a prospective cohort. Occup Environ Med. 2017 Mar 29. pii: oemed-2016-103780. doi: 10.1136/oemed-2016-103780.

Abstract

OBJECTIVE: To prospectively study suspected occupational risk factors for amyotrophic lateral sclerosis (ALS).

METHODS: For this case-cohort analysis within the prospective Netherlands Cohort Study, 58 279 men and 62 573 women aged 55-69 years at enrollment in 1986 were followed up for 17.3 years on ALS mortality. Information on occupational history and potential confounders were collected at baseline through a self-administered questionnaire and entered for a random subcohort (2092 men and 2074 women) and ALS deaths (76 men and 60 women). Occupational exposure to solvents, pesticides, metals, extremely low frequency magnetic fields (ELF-MFs) and electrical shocks was estimated by means of job exposure matrices (JEMs). Associations between ever/never occupationally exposed and cumulative exposure and ALS mortality were analysed by gender using Cox regression.

RESULTS: Occupational exposure to ELF-MF showed a possible association with ALS mortality among men: HR for ever holding a job with high exposure versus background 2.19 (95% (CI): 1.02 to 4.73) and HR for the highest tertile of cumulative exposure versus background 1.93 (95% CI 1.05 to 3.55).

INTERPRETATION: These results strengthen the evidence suggesting a positive association between ELF-MF exposure and ALS. We did not replicate earlier positive findings for other occupational exposures.

https://www.ncbi.nlm.nih.gov/pubmed/28356332

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Parkinson's disease and occupational exposures: a systematic literature review and meta-analyses

Gunnarsson LG, Bodin L. Parkinson's disease and occupational exposures: a systematic literature review and meta-analyses.
Scand J Work Environ Health. 2017 Apr 5. pii: 3641. doi: 10.5271/sjweh.3641.

Abstract

Objectives We conducted a systematic literature review to identify studies fulfilling good scientific epidemiological standards for use in meta-analyses of relevant risk factors for Parkinson's disease. Methods Our search identified 103 original publications on associations between work and Parkinson's disease. GRADE guidelines were used to ensure high scientific quality, and reliable guidelines were applied to classify the papers. Of the 103 articles, 47 fulfilled good scientific standards while 56 were methodologically deficient and thus excluded from our meta-analyses. Results A total of 23 publications concerned work exposure to pesticides. The weighted relative risk estimate was 1.67 (95% confidence interval 1.42-1.97). A funnel plot and bias test indicated that some publication bias concerning smaller studies might have been present. The risk estimate was not influenced by study design (case-control, cohort, or cross-sectional study) or gender. Higher estimates were found when there was a hereditary taint or onset below age 60. Studies on exposure to metals or electromagnetic fields did not show increased risk. Conclusions Using an elaborated quality protocol, there

is now strong evidence that exposure to any pesticide involves a ≥50% increased risk for developing Parkinson's disease.

https://www.ncbi.nlm.nih.gov/pubmed/?term=28379585

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ELF EMF promotes astrocytic differentiation of human bone marrow stem cells by modulating SIRT1 expression

Jeong WY, Kim JB, Kim HJ, Kim CW. Extremely low-frequency electromagnetic field promotes astrocytic differentiation of human bone marrow mesenchymal stem cells by modulating SIRT1 expression. Biosci Biotechnol Biochem. 2017 Mar 29:1-7. doi: 10.1080/09168451.2017.1308243.

Abstract

It has been shown that extremely low-frequency electromagnetic fields (ELFMF) affect regulation of cell fate and differentiation. Thus, the aim of this study was to investigate the role of ELFMFs in the enhancement of astrocytic differentiation. ELFMF exposure reduced the rate of proliferation and enhanced astrocytic differentiation. The ELFMF-treated cells showed increased levels of the astrocyte marker (GFAP), while those of the early neuronal marker (Nestin) and stemness marker (OCT3/4) were downregulated. The reactive oxygen species (ROS) level was observed to be significantly elevated after ELFMF exposure, which strengthens the modulatory role of SIRT1 and SIRT1 downstream molecules (TLE1, HES1, and MASH1) during astrocytic differentiation. After nicotinamide (5 mM) mediated inhibition of SIRT1, levels of TLE1, HES1, and MASH1 were examined; TLE1 was significantly upregulated and MASH1 was downregulated. These results suggest that ELFMFs induce astrocytic differentiation through activation of SIRT1 and SIRT1 downstream molecules.

https://www.ncbi.nlm.nih.gov/pubmed/28351214

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ELF EMF exposure enhances inflammatory response and inhibits effect of antioxidant in RAW 264.7 cells

Kim SJ, Jang YW, Hyung KE, Lee DK, Hyun KH, Jeong SH, Min KH, Kang W, Jeong JH, Park SY, Hwang KW. Extremely low-frequency electromagnetic field exposure enhances inflammatory response and inhibits effect of antioxidant in RAW 264.7 cells. Bioelectromagnetics. 2017 Mar 29. doi: 10.1002/bem.22049. [Epub ahead of print]

Abstract

In recent years there has been a dramatic increase in the number and variety of electronic devices that emit electromagnetic waves. Because people live and work in close proximity to these pieces of electrical equipment, there is growing concern surrounding the destruction of homeostasis by electromagnetic field exposure. In the present study, the effects of 60 Hz 0.8 mT extremely low-frequency electromagnetic fields (ELF-EMF) on a macrophage cell line (RAW 264.7) were examined. Under defined ELF-EMF exposure conditions, the production of nitric oxide and pro-inflammatory cytokines, TNF-α, IL-1β, and IL-6, were increased in RAW 264.7 cells and the expression of those genes was also upregulated. However, cell proliferation was not altered. Translocation of NF-κB (nuclear factor kappa B), molecules that act downstream of the pro-inflammatory cytokines, were increased to the nucleus under ELF-EMF exposure conditions. In addition, we found that ELF-EMF exposure elevated activation of nuclear factor of activated T cells (NFAT) 2, as well as positively affected the influx of calcium. Furthermore, with both the presence of a potent antioxidant (Resveratrol) and downregulation of the antioxidant-related gene Prx-1 (Peroxiredoxin-1), ELF-EMF was

associated with higher inflammatory responses of macrophages. These results suggest that an ELF-EMF amplifies inflammatory responses through enhanced macrophage activation and can decrease the effectiveness of antioxidants.

https://www.ncbi.nlm.nih.gov/pubmed/28370033

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ELF EMF induces neural differentiation of hBM-MSCs through regulation of (Zn)-metallothionein-3

Aikins AR, Hong SW, Kim HJ, Yoon CH, Chung JH, Kim M, Kim CW. Extremely low-frequency electromagnetic field induces neural differentiation of hBM-MSCs through regulation of (Zn)-metallothionein-3. Bioelectromagnetics. 2017 Mar 29. doi: 10.1002/bem.22046.

Abstract

Extremely low-frequency electromagnetic field (ELFEMF) can stimulate neural differentiation in human bone marrow-derived mesenchymal cells (hBM-MSCs), and this provides an opportunity for research on neurodegenerative diseases such as Alzheimer's disease (AD). Metallothionein-3 (MT3), an isoform of the metal-binding proteins, metallothioneins, involved in maintaining intracellular zinc (Zn) homeostasis and the deregulation of zinc homeostasis, has separately been implicated in AD. Here, we investigated the effect of ELFEMF-induced neural differentiation of hBM-MSCs on Zn-MT3 homeostatic interaction. Exposure to ELFEMF induced neural differentiation of hBM-MSCs, which was characterized by decreased proliferation and enhanced neural-like morphology. We observed expression of neuronal markers such as β-tubulin3, pleiotrophin, and neurofilament-M at the mRNA level and MAP2 at the protein level. ELFEMF-induced neural differentiation correlated with decreased expression of metal-response element-transcription factor 1 and MT3, as well as decreased intracellular Zn concentration. In addition, upregulation of dihydropyrimidinase-related protein 2 was observed, but there was no change in γ-enolase expression. These data indicate a possible regulatory mechanism for MT3 during neural differentiation. Our findings provide considerable insight into molecular mechanisms involved in neural differentiation, which is useful for developing new treatments for neurodegenerative diseases.

https://www.ncbi.nlm.nih.gov/pubmed/28370392

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Effects of 50 Hz MF exposure on DNA damage and cellular functions in various neurogenic cells

Su L, Yimaer A, Wei X, Xu Z, Chen G. The effects of 50 Hz magnetic field exposure on DNA damage and cellular functions in various neurogenic cells.J Radiat Res. 2017 Mar 21:1-13. doi: 10.1093/jrr/rrx012.

Abstract

Epidemiological studies have indicated a possible association between extremely low-frequency magnetic field (ELF-MF) exposure and the risk of nervous system diseases. However, laboratory studies have not provided consistent results for clarifying this association, despite many years of studies. In this study, we have systematically investigated the effects of 50 Hz MF exposure on DNA damage and cellular functions in both neurogenic tumor cell lines (U251, A172, SH-SY5Y) and primary cultured neurogenic cells from rats (astrocytes, microglia, cortical neurons). The results showed that exposure to a 50 Hz MF at 2.0 mT for up to 24 h did not influence γH2AX foci formation (an early marker of DNA double-strand breaks) in any of six different neurogenic cells. Exposure to a 50 Hz MF did not affect cell cycle progression, cell proliferation or cell viability in neurogenic tumor U251, A172 or SH-SY5Y cells. Furthermore, the MF exposure for 24 h did not significantly affect the secretion of cytokines (TNF-α, IL-6 or IL-1β) in astrocytes or microglia, or the phagocytic activity of microglia. In addition, MF exposure for 1 h per day did not significantly influence expression levels of

microtubule-associated protein tau, microtubule-associated protein 2, postsynaptic density 95 or gephyrin in cortical neurons, indicating an absence of effects of MF exposure on the development of cortical neurons. In conclusion, our data suggest that exposure to a 50 Hz MF at 2.0 mT did not elicit DNA damage effects or abnormal cellular functions in the neurogenic cells studied.

https://www.ncbi.nlm.nih.gov/pubmed/28369556

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Electric Fields and Enzyme Catalysis

Fried SD, Boxer SG. Electric Fields and Enzyme Catalysis. Annu Rev Biochem. 2017 Mar 24. doi: 10.1146/annurev-biochem-061516-044432

Abstract

What happens inside an enzyme's active site to allow slow and difficult chemical reactions to occur so rapidly? This question has occupied biochemists' attention for a long time. Computer models of increasing sophistication have predicted an important role for electrostatic interactions in enzymatic reactions, yet this hypothesis has proved vexingly difficult to test experimentally. Recent experiments utilizing the vibrational Stark effect make it possible to measure the electric field a substrate molecule experiences when bound inside its enzyme's active site. These experiments have provided compelling evidence supporting a major electrostatic contribution to enzymatic catalysis. Here, we review these results and develop a simple model for electrostatic catalysis that enables us to incorporate disparate concepts introduced by many investigators to describe how enzymes work into a more unified framework stressing the importance of electric fields at the active site.

https://www.ncbi.nlm.nih.gov/pubmed/28375745

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Is electromagnetism one of the causes of Colony Collapse Disorder? A work plan for testing this hypothesis

Marie-Claire Cammaerts. Is electromagnetism one of the causes of the CCD? A work plan for testing this hypothesis. Journal of Behavior. 2(1): 1006. Published Mar 28, 2017.

Abstract

The decline of domestic bees all over the world is an important problem still not well understood by scientists and beekeepers, and far from being solved. Its reasons are numerous: among others, the use of pesticides and insecticides, the decrease of plant diversity, and bee's parasites. Besides these threats, there is a potential adverse factor little considered: manmade electromagnetism. The production of electromagnetic waves by human settlements, cellphones relay and power lines largely increases nowadays. Bees are very sensitive to this electromagnetism. The present paper suggests two simple experimental protocols for bringing to the fore the potential adverse effect of electromagnetism on bees and to act consequently. The first one is the observation of bees' avoidance of a wireless apparatus; the second one is the assessment of colonies' strength and of the intensity of the electromagnetism field (EMF) surrounding them. If bees avoid a wireless apparatus, if hives in bad health are located in EMF of a rather high intensity, it can be presumed that bees are affected by manmade electromagnetism. This should enable searching for palliative measures.

https://www.jscimedcentral.com/Behavior/behavior-2-1006.php

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Zebra finches have a light-dependent magnetic compass similar to migratory birds

Pinzon-Rodriguez A, Muheim R. Zebra finches have a light-dependent magnetic compass similar to migratory birds. J Exp Biol. 2017 Apr 1;220(Pt 7):1202-1209. doi: 10.1242/jeb.148098.

Abstract

Birds have a light-dependent magnetic compass that provides information about the spatial alignment of the geomagnetic field. It is proposed to be located in the avian retina and mediated by a light-induced, radical-pair mechanism involving cryptochromes as sensory receptor molecules. To investigate how the behavioural responses of birds under different light spectra match with cryptochromes as the primary magnetoreceptor, we examined the spectral properties of the magnetic compass in zebra finches. We trained birds to relocate a food reward in a spatial orientation task using magnetic compass cues. The birds were well oriented along the trained magnetic compass axis when trained and tested under low-irradiance 521 nm green light. In the presence of a 1.4 MHz radio-frequency electromagnetic (RF)-field, the birds were disoriented, which supports the involvement of radical-pair reactions in the primary magnetoreception process. Birds trained and tested under 638 nm red light showed a weak tendency to orient ~45 deg clockwise of the trained magnetic direction. Under low-irradiance 460 nm blue light, they tended to orient along the trained magnetic compass axis, but were disoriented under higher irradiance light. Zebra finches trained and tested under high-irradiance 430 nm indigo light were well oriented along the trained magnetic compass axis, but disoriented in the presence of a RF-field. We conclude that magnetic compass responses of zebra finches are similar to those observed in nocturnally migrating birds and agree with cryptochromes as the primary magnetoreceptor, suggesting that light-dependent, radical-pair-mediated magnetoreception is a common property for all birds, including non-migratory species.

https://www.ncbi.nlm.nih.gov/pubmed/28356366

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Evaluation of children exposure to electromagnetic fields of mobile phones using age-specific head models with age-dependent dielectric properties

Mohammed B, Jin J, Abbosh A, Bialkowski K, Manoufali M, Crozier S. Evaluation of children exposure to electromagnetic fields of mobile phones using age-specific head models with age-dependent dielectric properties. IEEE Access. PP(99). 2017

Abstract

Given the rapid introduction of mobile phones and other portable wireless devices into society, and the increased possibility of young children using or being exposed to electromagnetic (EM) fields, a study of specific absorption rate (SAR) in the head of young children is becoming increasingly relevant. To accurately evaluate the exposure of children to electromagnetic fields, realistic head models, which consider the age-specific anatomical structure and age-dependent tissues dielectric properties, are developed. During postnatal development of human tissues, the number and size of cells increase while the proportion of water content decreases. Such changes result generally in significant changes in the dielectric properties of tissues. The SAR levels for different ages are investigated using the developed child's head models when young children or their parents use a standard mobile phone.

The results show that the maximum SAR levels in brain tissues of young children (3 months) are higher by up to 61% and 78% than adults at the lowest (700 MHz) and highest (2600 MHz) investigated frequencies, respectively. The percentage absorption power in the heads of young children (3 months) is higher by up to 40.6% and 24% than the values for adults at 700 MHz and 2600 MHz, respectively.

Our investigation shows that previous studies, which used scaled head models without considering the age-dependent variations in the head anatomy and/or age-dependent tissues' dielectric properties, underestimated SAR levels in the children's heads. **The obtained results using the developed realistic head models indicate that for young children, a lower limit on radiated power might be required to meet the acceptable dosimetry levels.**

http://ieeexplore.ieee.org/document/8086149/

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An international prospective cohort study of mobile phone users and health (COSMOS): Factors affecting validity of self-reported mobile phone use

Toledano MB, Auvinen A, Tettamanti G, Cao Y, Feychting M, Ahlbom A, Fremling K, Heinävaara S, Kojo K, Knowles G, Smith RB, Schüz J, Johansen C, Poulsen AH, Deltour I, Vermeulen R, Kromhout H, Elliott P, Hillert L. An international prospective cohort study of mobile phone users and health (COSMOS): Factors affecting validity of self-reported mobile phone use. Int J Hyg Environ Health. 2017 Sep 20. pii: S1438-4639(17)30321-8. doi: 10.1016/j.ijheh.2017.09.008.

Highlights

• Agreement for self-reported phone use was higher for call duration than frequency.
• Subjects tended to underestimate rather than overestimate mobile phone use.
• Agreement for self-reported call frequency was higher in men and older subjects.
• Subjects who reported symptoms were more likely to overestimate low call duration.

Abstract

This study investigates validity of self-reported mobile phone use in a subset of 75 993 adults from the COSMOS cohort study. Agreement between self-reported and operator-derived mobile call frequency and duration for a 3-month period was assessed using Cohen's weighted Kappa (κ). Sensitivity and specificity of both self-reported high (≥10 calls/day or ≥4h/week) and low (≤6 calls/week or <30min/week) mobile phone use were calculated, as compared to operator data. For users of one mobile phone, agreement was fair for call frequency (κ=0.35, 95% CI: 0.35, 0.36) and moderate for call duration (κ=0.50, 95% CI: 0.49, 0.50). Self-reported low call frequency and duration demonstrated high sensitivity (87% and 76% respectively), but for high call frequency and duration sensitivity was lower (38% and 56% respectively), reflecting a tendency for greater underestimation than overestimation. Validity of self-reported mobile phone use was lower in women, younger age groups and those reporting symptoms during/shortly after using a mobile phone. This study highlights the ongoing value of using self-report data to measure mobile phone use. Furthermore, compared to continuous scale estimates used by previous studies, categorical response options used in COSMOS appear to improve validity considerably, most likely by preventing unrealistically high estimates from being reported.

https://www.ncbi.nlm.nih.gov/pubmed/29056311

Excerpts

The target population for COSMOS was adult mobile phone users, aged 18–69 years, in 5 European countries: Denmark, Finland, the Netherlands, Sweden and the UK, and recently a 6th cohort has been initiated in France.

This analysis focuses on participants recruited into the study in Finland, Sweden and the UK between 2007 and 2010.

Participants were asked to report frequency and duration of mobile phone voice calls for the preceding three months via the following two questions:

"Over the last three months, how often did you talk on a mobile phone?" with the response options: <1 call per week (Finland and Sweden only; the UK web-based questionnaire filtered out these respondents in a previous question), 1–6 calls per week, 1–9 calls per day, ≥10 calls per day.

"Over the last three months, on average, how much time per week did you spend talking on a mobile phone?" with the response options: <5 min, 5–29 min, 30–59 min, 1–3 h, 4–6 h, >6 h.

Participants were asked if they experienced symptoms ("no symptoms, headache, dizziness, numbness in hands, nausea, hearing loss, tinnitus/ringing sound in ear, warming sensation on face and/or ear") whilst using, or shortly after using, a mobile phone.

Approximately 20% of participants spent at least 4 h per week on calls and/or made at least 10 calls per day, and were thus defined as having high mobile phone use (Table 1).

We found that a considerable proportion of respondents misclassified their mobile phone use (approximately 60% and 40% for call duration and frequency, respectively) (Table 2, Supplementary Tables 1 & 2). Approximately a third of the participants underestimated their mobile phone call duration and frequency. The proportion of participants overestimating mobile phone use was much lower (23% for duration and 5% for call frequency among one- phone users) (Table 2).

Agreement between self-reported and operator call duration was significantly lower among those who reported experiencing symptoms whilst (or shortly after) using a mobile phone ($\kappa = 0.44$ (95% CI: 0.43, 0.46)) compared with those without symptoms ($\kappa = 0.50$ (95% CI: 0.49, 0.50)), primarily because those with symptoms were more likely to overestimate low call duration (sensitivity = 65% (95% CI: 62%, 67%) vs. 78% (95% CI: 77%, 79%) for those with and without symptoms respectively) (Table 4). A similar pattern was observed for call frequency, but the differences were smaller.

In this largest validation study to date, we found fair to moderate agreement between self-reported and operator-derived data on mobile phone use. The sensitivity of self-report was generally high for correctly identifying those with the smallest amount of mobile phone use, but lower for identifying heavy mobile phone use, in line with our observation that respondents in this study were more likely to underestimate than overestimate their mobile phone use.

Our findings demonstrate that those who experience symptoms when using a mobile phone are more likely to overestimate light mobile phone use, particularly call duration, compared to those without symptoms. This suggests that an individual's experience and/or perception of their health may influence the self-reporting of mobile phone use, likely affecting the validity of such exposure assessments. More specifically, it is possible that rumination bias (a form of information bias), whereby those with symptoms overestimate (consciously or subconsciously) their phone use in an effort to explain their symptoms, could be occurring in this subset of individuals. This finding has potential implications for the interpretation of previous cross-sectional studies investigating associations between mobile phone use and the symptoms reported here (Mortazavi et al., 2007; Soderqvist et al., 2008; Sandstrom et al., 2001). Overestimation of mobile phone use among those who report such symptoms would likely bias cross-sectional risk estimates away from the null, even if a true association does not exist (Armstrong, 1998), thus potentially distorting any observed associations.

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Total recall in the SCAMP cohort: Validation of self-reported mobile phone use in the smartphone era

Mireku MO, Mueller W, Fleming C, Chang I, Dumontheil I, Thomas MSC, Eeftens M, Elliott P, Röösli M, Toledano MB. Total recall in the SCAMP cohort: Validation of self-reported mobile phone use in the

smartphone era. Environ Res. 2017 Oct 30;161:1-8. doi: 10.1016/j.envres.2017.10.034. [Epub ahead of print]

Abstract

Mobile phone use, predominantly smartphones, is almost ubiquitous amongst both adults and children. However adults and children have different usage patterns. A major challenge with research on mobile phone use is the reliability of self-reported phone activity for accurate exposure assessment.

We investigated the agreement between self-reported mobile phone use data and objective mobile operator traffic data in a subset of adolescents aged 11-12 years participating in the Study of Cognition, Adolescents and Mobile Phones (SCAMP) cohort. We examined self-reported mobile phone use, including call frequency, cumulative call time duration and text messages sent among adolescents from SCAMP and matched these data with records provided by mobile network operators (n = 350). The extent of agreement between self-reported mobile phone use and mobile operator traffic data use was evaluated using Cohen's weighted Kappa (κ) statistics. Sensitivity and specificity of self-reported low (< 1 call/day, ≤ 5min of call/day or ≤ 5 text messages sent/day) and high (≥ 11 calls/day, > 30min of call/day or ≥ 11 text messages sent /day) use were estimated.

Agreement between self-reported mobile phone use and mobile operator traffic data was highest for the duration spent talking on mobile phones per day on weekdays (38.9%) and weekends (29.4%) compared to frequency of calls and number of text messages sent. Adolescents overestimated their mobile phone use during weekends compared to weekdays. Analysis of agreement showed little difference overall between the sexes and socio-economic groups. Weighted kappa between self-reported and mobile operator traffic data for call frequency during weekdays was κ = 0.12, 95% CI 0.06-0.18. Of the three modes of mobile phone use measured in the questionnaire, call frequency was the most sensitive for low mobile phone users on weekdays and weekends (77.1, 95% CI: 69.3-83.7 and 72.0, 95% CI: 65.0-78.4, respectively). Specificity was moderate to high for high users with the highest for call frequency during weekdays (98.4, 95% CI: 96.4-99.5).

Despite differential agreement between adolescents' self-reported mobile phone use and mobile operator traffic data, our findings demonstrate that self-reported usage adequately distinguishes between high and low use.

The greater use of mobile smartphones over Wi-Fi networks by adolescents, as opposed to mobile phone networks, means operator data are not the gold standard for exposure assessment in this age group. This has important implications for epidemiologic research on the health effects of mobile phone use in adolescents.

https://www.ncbi.nlm.nih.gov/pubmed/29096315

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Long term variations measurement of electromagnetic field exposures in Alcalá de Henares (Spain)

Sánchez-Montero R, Alén-Corderoa C, López-Espí PL, Rigelsford JM, Aguilera-Benavente F, J.Alpuente-Hermosilla J. Long term variations measurement of electromagnetic field exposures in Alcalá de Henares (Spain). Science of the Total Environment. 598: 657-668. Nov 2017. https://doi.org/10.1016/j.scitotenv.2017.03.131.

Highlights

• The evolution of EMF exposure for Alcalá de Henares over a 2006–2015 is presented.
• Measurements take into account all the sources and their evolution in a 35 km2 area.
• A statistical and spatial analysis and their variations are also analysed.

• We have measured lower EMF levels where the population has remained unaltered.
• New areas have demanded new resources and it has led to an increase of the EMF.

Abstract

Electromagnetic radiowave exposure is a major concern in most countries due to possible adverse health effects. Over the last 10 years, many technological changes (digital television, mobile technologies, wireless networks…) have led to variations in the electromagnetic field (EMF) levels.

A large number of studies devoted to the analysis of EMF levels with personal dosimeters or computer models of the exposure of mobile stations have been conducted. However, the study of the exposure values, taking into account all the existing sources, and their evolution in a wide area, using measurements, has rarely been performed.

In this paper, we provide a comparison of the EMF exposure levels for the city of Alcalá de Henares (Spain) over a ten-year period using a broadband isotropic probe in the range from 100 kHz to 3 GHz. A statistical and spatial analysis of the measurements and their variations are also presented for the study of the global and local variations.

The measured values in the period from 2006 to 2015 were ranging from 0.02 to 2.05 V/m. Our global results show a moderate increase from 2006 to 2010 and they are almost invariant from 2010 to 2015. Although the whole dataset does not have relevant statistical difference, we have found marked local differences. In the city areas where the population density has remained unaltered, we have measured lower exposure levels. Conversely, new urban and industrial developments have demanded new resources, which have potentially contributed to the observed increase in the measured electric field levels within these areas.

Conclusions

This work considers the long term evolution of radio frequency electric field values from 2006 to 2015 for the city of Alcalá de Henares, Spain. This study has been based on 78 measurement locations across a 35 km2 area of the city, providing an average sample density of 2.2 points per square km. During the period considered, officially published statistical data shows a greater use of the radio electric spectrum for television and especially for mobile phones and wireless technologies. At the same time, significant technological changes have been introduced and widely adopted, such as the switch to digital television broadcasting and the proliferation of Wi-Fi. In 2006, the measured mean electric field value was 0.277 V/m, in 2010 this increased to 0.406 V/m and finally, in 2015 this was 0.395 V/m. The greatest increase in the exposure level of electric field strength occurred between 2006 and 2010. This general trend is largely consistent with the increase of radio resources at that time.

The statistical analysis of the measured data shows that it fits a lognormal distribution with a confidence greater than 95%. These results show a moderate increase of the global mean values from 2006 to 2010 and that they are almost invariant from 2010 to 2015. Using this statistical analysis, we can conclude that the probability of finding a value of 14 V/m (half of the prescribed public exposure limit) is less than 0.01% and the probability of finding a value of 28 V/m is negligible.

A narrowband measurement based study could help to a better understanding of the actual influence of the different sources (radio, TV, Mobile, WiFi etc.) in the observed exposure values.

http://www.sciencedirect.com/science/article/pii/S0048969717306502?via%3Dihub

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IEC/IEEE International Standard - Determining SAR in the human body from wireless communications devices, 30 MHz to 6 GHz

IEC/IEEE International Standard - Determining the peak spatial-average specific absorption rate (SAR) in the human body from wireless communications devices, 30 MHz to 6 GHz - Part 1: General requirements for using the finite difference time domain (FDTD) method for SAR calculations (IEEE Std. 62704-1-2017). No authors listed, IEEE, 2017, ISBN 9781504442596

http://ieeexplore.ieee.org/document/8088404/

IEC/IEEE International Standard - Determining the peak spatial-average specific absorption rate (SAR) in the human body from wireless communications devices, 30 MHz to 6 GHz - Part 2: Specific requirements for finite difference time domain (FDTD) modelling of exposure from vehicle mounted antennas (IEEE Std. 62704-2-2017). No authors listed, IEEE, 2017, ISBN 9781504441162

http://ieeexplore.ieee.org/document/7964816/

IEC/IEEE International Standard - Determining the peak spatial-average specific absorption rate (SAR) in the human body from wireless communications devices, 30 MHz to 6 GHz - Part 3: Specific requirements for using the finite difference time domain (FDTD) method for SAR calculations of mobile phones (IEEE Std. 62704-3-2017) No authors listed, IEEE, 2017, ISBN 9781504442619

http://ieeexplore.ieee.org/document/8089724/

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Combined effects of varicocele and cell phones on semen and hormonal parameters

Schauer I, Mohamad Al-Ali B. Combined effects of varicocele and cell phones on semen and hormonal parameters. Wien Klin Wochenschr. 2017 Oct 13. doi: 10.1007/s00508-017-1277-9.

Abstract

BACKGROUND: The objective of this study was to evaluate if there is a combined effect of varicocele and cell phone storage in trousers pockets on semen and hormonal parameters.

METHODS: A retrospective analysis of 468 men attending an infertility clinic from 1993-2007 was performed. Varicoceles were determined by clinical examination and patients were questioned on cell phone usage and storage fashion. Semen samples were analyzed according to the World Health Organization (WHO) guidelines of 1999. Serum testosterone, luteinizing hormone (LH) and follicle stimulating hormone (FSH) were assessed.

RESULTS: There was a significant effect of cell phone storage in trousers pockets and varicocele in multivariate analysis (both $p < 0.001$). Varicocele showed an effect on sperm concentration ($p = 0.003$), LH ($p = 0.014$) and testosterone ($p = 0.003$). Compared to grade 1, grade 2 varicoceles showed a difference in sperm concentration ($p = 0.004$). Regarding testosterone differences were shown for grade 3 versus grade 1 ($p = 0.002$) and grade 3 compared to grade 2 ($p = 0.003$). Cell phone storage in trousers pockets showed an influence on the percentage of normal sperm morphology and LH (both $p < 0.001$). Varicocele and cell phone storage in trousers pockets did not show a combined effect ($p = 0.76$).

CONCLUSIONS: This analysis showed an inverse relation between sperm concentration and degree of varicocele, with lower concentrations in higher grade varicoceles. Testosterone was significantly higher in higher grade varicoceles, which could reflect a compensatory mechanism to the impaired testicular function. Cell phone storage in trousers pockets showed an effect on LH and sperm morphology. A combined effect of varicocele and cell phone storage in trousers pockets was not detected.

https://www.ncbi.nlm.nih.gov/pubmed/29030685

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Biological effects of cell-phone radiofrequency waves exposure on fertilization in mice; an in vivo and in vitro study

Fatehi D, Anjomshoa M, Mohammadi M, Seify M, Rostamzadeh A. Biological effects of cell-phone radiofrequency waves exposure on fertilization in mice; an in vivo and in vitro study. Middle East Fertility Society Journal, Available online 23 October 2017.

Abstract

Increasing use of cell-phone is one of the most important risk factors for population health. We designed an experimental study aimed at evaluating the effects of cell-phone radiofrequency (RF) waves exposure on fertilization in mice. Two hundred male and female NMRI-mice were used. One hundred males divided in five groups (n = 20) as control and exposed groups. Those irradiated with cell-phone RF in "Standby-mode" 1, 5 and 10 h daily named groups II, III and IV; respectively. Group V irradiated with cell-phone on "Active-mode" one hour daily. After 30 days irradiation, 50 males and 50 females were kept 24 h to assess their embryos. Fifty males were scarified to evaluate both in vitro and in vivo parameters, and 50 females received PMSG & HCG for both quantitative and qualitative evaluation. Comparing groups III, IV and V with control-group showed significantly decreased in the number of two-cell embryos (p = .000); however, a significant increase was found in the number of dead embryos (p = .000). Furthermore, 5 h daily irradiation significantly decreased grade-A embryos (p = .015); while, it significantly increased grade-B, C and D embryos (p-values = 0.026, 0.007, 0.006; respectively). Moreover, comparing groups IV and V to control-group, significant increase was found in pregnancy duration (p = .005, p = .009; respectively). However, in the mentioned groups a significant decrease was seen in number of newborn mice (p = .001, p = .004; respectively). In conclusion our findings showed that the cell-phone radiation can affect development of embryos as well as the number of newborn and pregnancy duration in NMRI-mouse, which might be a significant cause of reproductive failure.

Conclusions

The results of this study indicate that cell-phone RF waves decreases the quantity of two cells embryos as well as embryos with grade-A quality at the developmental process; while it increases the fragmentation of IVF-derived cells as well as grade-C and D cells in the NMRI-mouse. Cell-phone RF waves also reduces the number of newborn mice, where it increases the pregnancy duration which result in fertility failure in NMRI-mouse.

http://www.sciencedirect.com/science/article/pii/S1110569017301875

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Interaction between pancreatic β cell and EMF: A systematic study toward finding the natural frequency spectrum of β cell system

Farashi S. Interaction between pancreatic β cell and electromagnetic fields: A systematic study toward finding the natural frequency spectrum of β cell system. Electromagn Biol Med. 2017 Oct 31:1-16. doi: 10.1080/15368378.2017.1389751. [Epub ahead of print]

Abstract

Interaction between biological systems and environmental electric or magnetic fields has gained attention during the past few decades. Although there are a lot of studies that have been conducted for investigating such interaction, the reported results are considerably inconsistent. Besides the complexity of biological systems, the important reason for such inconsistent results may arise due to different excitation protocols that have been applied in different experiments. In order to investigate carefully the way that external electric or

magnetic fields interact with a biological system, the parameters of excitation, such as intensity or frequency, should be selected purposefully due to the influence of these parameters on the system response. In this study, pancreatic β cell, the main player of blood glucose regulating system, is considered and the study is focused on finding the natural frequency spectrum of the system using modeling approach. Natural frequencies of a system are important characteristics of the system when external excitation is applied. The result of this study can help researchers to select proper frequency parameter for electrical excitation of β cell system. The results show that there are two distinct frequency ranges for natural frequency of β cell system, which consist of extremely low (or near zero) and 100-750 kHz frequency ranges. There are experimental works on β cell exposure to electromagnetic fields that support such finding.

https://www.emf-portal.org/en/article/33742

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In vitro non-thermal oxidative stress response after 1800 MHz radiofrequency radiation

Marjanovic Cermak AM, Pavicic I, Tariba Lovakovic B, Pizent A, Trosic I. In vitro non-thermal oxidative stress response after 1800 MHz radiofrequency radiation. General Physiology and Biophysics. 36(4):407-414. Oct 2017.

Abstract

In this study possible connection between radiofrequency exposure (RF) and development of oxidative stress was investigated by measuring impairment in cellular oxidation-reduction balance immediately after RF exposure. Fibroblast cells V79 were exposed for 10, 30 and 60 minutes to 1800 MHz RF radiation. Electric field strength was 30 V/m and specific absorption rate (SAR) was calculated to be 1.6 W/kg. Electromagnetic field was generated within Gigahertz Transversal Electromagnetic Mode cell (GTEM) equipped by signal generator, amplifier and modulator. Cell viability was determined by CCK-8 colorimetric assay and level of reactive oxygen species (ROS) was detected by dihydroethidium staining. Reduced glutathione (GSH) and glutathione peroxidase (GSH-Px) were used to assess cell antioxidant activity while lipid oxidative damage was evaluated measuring concentration of malondialdehyde. Viability of V79 cells remained within normal physiological values regardless of exposure time. Increased level of superoxide radicals was detected after 60-min exposure. Significantly higher GSH level was observed immediately after 10-min exposure with higher but insignificant activity of GSH-Px. Lipid oxidative damage in exposed cell samples was not observed. Short-term RF exposure revealed transient oxidation-reduction imbalance in fibroblast cells following adaptation to applied experimental conditions.

https://www.ncbi.nlm.nih.gov/pubmed/28836500

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Involvement of the p38 MAPK signaling cascade in stress response of RAW 264.7 macrophages

Novoselova EG, Glushkova OV, Khrenov MO, Parfenyuk SB, Lunin SM, Vinogradova EV, Novoselova TV, Fesenko EE. Involvement of the p38 MAPK signaling cascade in stress response of RAW 264.7 macrophages. Dokl Biol Sci. 2017 Sep;476(1):203-205. doi: 0.1134/S0012496617050015. Epub 2017 Nov 4.

Abstract

The role of the p38 MAPK signaling cascade was studied in stress response of RAW 264.7 macrophages to extremely low-intensity centimeter microwaves. Irradiation stimulated production of a number of cytokines (IL-1, IL-6, TNF-α, INF-γ and IL-10), as well as induced activation of the signaling cascades NF- κB and p38 MAPK, and enhanced expression of Hsp72 heat shock protein. In the presence of the cascade p38 MAPK inhibitor (p38 MAP kinase inhibitor XI), the stimulating effects of electromagnetic waves were abrogated either completely (for NF-κB and Hsp72) or partially (for p38 MAPK and cytokines). The results obtained are indicative of a high sensitivity of the signaling cascade p38 MAPK to the effect of low-intensity physical fields.

https://www.ncbi.nlm.nih.gov/pubmed/29101623

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Cellular Response to ELF-MF and Heat: Evidence for a Common Involvement of Heat Shock Proteins?

Zeni O, Simkó M, Scarfi MR, Mattsson MO. Cellular Response to ELF-MF and Heat: Evidence for a Common Involvement of Heat Shock Proteins? Front Public Health. 2017 Oct 18;5:280. doi: 10.3389/fpubh.2017.00280.

Abstract

It has been shown that magnetic fields in the extremely low frequency range (ELF-MF) can act as a stressor in various in vivo or in vitro systems, at flux density levels below those inducing excitation of nerve and muscle cells, which are setting the limits used by most generally accepted exposure guidelines, such as the ones published by the International Commission on Non-Ionizing Radiation Protection. In response to a variety of physiological and environmental factors, including heat, cells activate an ancient signaling pathway leading to the transient expression of heat shock proteins (HSPs), which exhibit sophisticated protection mechanisms. A number of studies suggest that also ELF-MF exposure can activate the cellular stress response and cause increased HSPs expression, both on the mRNA and the protein levels. In this review, we provide some of the presently available data on cellular responses, especially regarding HSP expression, due to single and combined exposure to ELF-MF and heat, with the aim to compare the induced effects and to detect possible common modes of action. Some evidence suggest that MF and heat can act as costressors inducing a kind of thermotolerance in cell cultures and in organisms. The MF exposure might produce a potentiated or synergistic biological response such as an increase in HSPs expression, in combination with a well-defined stress, and in turn exert beneficial effects during certain circumstances.

Summary

In summary, on the basis of the available data dealing with single exposure to ELF-MF showing HSP expression modulations, no (co)relation to MF-dose, specific exposure conditions, or cell type could be identified. The data regarding coexposures to MF and heat are very similar, and we cannot derive any consistent clue regarding a possible common mode of action. There is some evidence that MF and heat might act as costressors inducing thermotolerance in cell cultures and in organisms. The MF exposure might produce a potentiated biological response, such as the increase in HSPs expression in combination with a well-defined stress, and in turn exerts beneficial effects. It is also possible that ELF-MF exposure protects the cells *via* desensitization against heat stress, and so from secondary effects. Since the mode of action is not clear, we can only speculate if the applied temperature or the MF parameters or the cell type used (cell receptors and metabolic state, culture media, serum, etc.) is a relevant factor influencing the outcome, or if all together are important players in the biological response. Since systematic investigations are not available, we have to consider that beside the physical parameters used, more knowledge is needed about metabolic status and the absolute basal HSP levels of the cell models. Experiments, carried out under strictly controlled conditions from both electromagnetic and biological point of view, are needed to address specifically the underlying mechanisms involving HSPs and cellular responses to ELF-MF and heat.

Open Access Paper: https://www.frontiersin.org/articles/10.3389/fpubh.2017.00280/full

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Magnetic Fields and Reactive Oxygen Species

Wang H, Zhang X. Magnetic Fields and Reactive Oxygen Species. Int J Mol Sci. 2017 Oct 18;18(10). pii:

E2175. doi: 10.3390/ijms18102175

Abstract

Reactive oxygen species (ROS) ubiquitously exist in mammalian cells to participate in various cellular signaling pathways. The intracellular ROS levels are dependent on the dynamic balance between ROS generation and elimination. In this review, we summarize reported studies about the influences of magnetic fields (MFs) on ROS levels. Although in most cases, MFs increased ROS levels in human, mouse, rat cells, and tissues, there are also studies showing that ROS levels were decreased or not affected by MFs. Multiple factors could cause these discrepancies, including but not limited to MF type/intensity/frequency, exposure time and assay time-point, as well as different biological samples examined. It will be necessary to investigate the influences of different MFs on ROS in various biological samples systematically and mechanistically, which will be helpful for people to get a more complete understanding about MF-induced biological effects. In addition, reviewing the roles of MFs in ROS modulation may open up new scenarios of MF application, which could be further and more widely adopted into clinical applications, particularly in diseases that ROS have documented pathophysiological roles.

Open Access Paper: http://www.mdpi.com/1422-0067/18/10/2175

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Mobile phones, cordless phones and rates of brain tumors in different age groups in the Swedish National Inpatient Register and the Swedish Cancer Register during 1998-2015

Hardell L, Carlberg M. Mobile phones, cordless phones and rates of brain tumors in different age groups in the Swedish National Inpatient Register and the Swedish Cancer Register during 1998-2015. PLoS One. 12(10): e0185461. Published online Oct 4, 2017.

Abstract

We used the Swedish Inpatient Register (IPR) to analyze rates of brain tumors of unknown type (D43) during 1998–2015. Average Annual Percentage Change (AAPC) per 100,000 increased with +2.06%, 95% confidence interval (CI) +1.27, +2.86% in both genders combined. A joinpoint was found in 2007 with Annual Percentage Change (APC) 1998–2007 of +0.16%, 95% CI -0.94, +1.28%, and 2007–2015 of +4.24%, 95% CI +2.87, +5.63%. Highest AAPC was found in the age group 20–39 years. In the Swedish Cancer Register the age-standardized incidence rate per 100,000 increased for brain tumors, ICD-code 193.0, during 1998–2015 with AAPC in men +0.49%, 95% CI +0.05, +0.94%, and in women +0.33%, 95% CI -0.29, +0.45%. The cases with brain tumor of unknown type lack morphological examination. Brain tumor diagnosis was based on cytology/histopathology in 83% for men and in 87% for women in 1980. This frequency increased to 90% in men and 88% in women in 2015. During the same time period CT and MRI imaging techniques were introduced and morphology is not always necessary for diagnosis. If all brain tumors based on clinical diagnosis with CT or MRI had been reported to the Cancer Register the frequency of diagnoses based on cytology/histology would have decreased in the register. The results indicate underreporting of brain tumor cases to the Cancer Register. The real incidence would be higher. Thus, incidence trends based on the Cancer Register should be used with caution. Use of wireless phones should be considered in relation to the change of incidence rates.

http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0185461

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Recent advances in the effects of microwave radiation on brains

Wei-Jia Zhi, Li-Feng Wang, Xiang-Jun Hu. Recent advances in the effects of microwave radiation on brains. Military Medical Research. December 2017, 4:29. Published online: 21 September 2017.

Abstract

This study concerns the effects of microwave on health because they pervade diverse fields of our lives. The brain has been recognized as one of the organs that is most vulnerable to microwave radiation. Therefore, in this article, we reviewed recent studies that have explored the effects of microwave radiation on the brain, especially the hippocampus, including analyses of epidemiology, morphology, electroencephalograms, learning and memory abilities and the mechanisms underlying brain dysfunction. However, the problem with these studies is that different parameters, such as the frequency, modulation, and power density of the radiation and the irradiation time, were used to evaluate microwave radiation between studies. As a result, the existing data exhibit poor reproducibility and comparability. To determine the specific dose-effect relationship between microwave radiation and its biological effects, more intensive studies must be performed.

Open Access Review Paper: https://link.springer.com/article/10.1186/s40779-017-0139-0

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Mobile Phone Use and The Risk of Headache: A Systematic Review and Meta-analysis of Cross-sectional Studies

Wang J, Su H1, Xie W, Yu S. Mobile Phone Use and The Risk of Headache: A Systematic Review and Meta-analysis of Cross-sectional Studies. Sci Rep. 2017 Oct 3;7(1):12595. doi: 10.1038/s41598-017-12802-9.

Abstract

Headache is increasingly being reported as a detrimental effect of mobile phone (MP) use. However, studies aimed to investigate the association between MP use and headache yielded conflicting results. To assess the consistency of the data on the topic, we performed a systematic review and meta-analysis of the available cross-sectional studies. Published literature from PubMed and other databases were retrieved and screened, and 7 cross-sectional studies were finally included in this meta-analysis. The pooled odds ratio (OR) and 95% confidence interval (CI) were calculated. We found that the risk of headache was increased by 38% in MP user compared with non-MP user (OR, 1.38; 95% CI, 1.18-1.61, $p < 0.001$). Among MP users, the risk of headache was also increased in those who had longer daily call duration (2-15 min vs. <2 min: OR, 1.62; 95% CI, 1.34-1.98, $p < 0.001$; >15 min vs. <2 min: OR, 2.50; 95% CI, 1.76-3.54, $p < 0.001$) and higher daily call frequency (2-4 calls vs. <2 calls: OR, 1.37; 95% CI, 1.07-1.76, $p < 0.001$; >4 calls vs. <2 calls: OR, 2.52; 95% CI, 1.78-3.58, $p < 0.001$). Our data indicate that MP use is significantly associated with headache, further epidemiologic and experimental studies are required to affirm and understand this association.

https://www.ncbi.nlm.nih.gov/pubmed/28974725

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Effects of electromagnetic waves emitted from 3G+wi-fi modems on human semen analysis

Kamali K, Atarod M, Sarhadi S, Nikbakht J, Emami M, Maghsoudi R, Salimi H, Fallahpour B, Kamali N, Momtazan A, Ameli M. Effects of electromagnetic waves emitted from 3G+wi-fi modems on human semen analysis. Urologia. 2017 Sep 14:0. doi: 10.5301/uj.5000269.

Abstract

OBJECTIVE: The purpose of this study was to evaluate the effects of 3G+wifi modems on human sperm quality.A total of 40 semen specimens were gathered between March and September 2015, from healthy adult men.

METHODS: The sperm samples were divided into two groups - 3G+wi-fi exposed and unexposed groups. In the unexposed group, the specimens were shielded by aluminum foil in three layers and put into an incubator at a temperature of 37°C for 50 minutes. The exposed group was positioned in another room in an incubator at a temperature of 37°C for 50 minutes. A 3G+wi-fi modem was put into the same incubator and a laptop computer was connected to the modem and was downloading for the entire 50 minutes.Semen analysis was done for each specimen and comparisons between parameters of the two groups were done by using Kolmogorov-Smirnov study and a paired t-test.

RESULTS: Mean percentage of sperm with class A and B motility were not significantly different in two groups ($p = 0.22$ and 0.54, respectively). In class C, it was significantly lower in the exposed group ($p = 0.046$), while in class D it was significantly higher ($p = 0.022$). Velocity curvilinear, velocity straight line, velocity average path, mean angular displacement, lateral displacement and beat cross frequency were significantly higher in the unexposed group. The limitation was the in vitro design.

CONCLUSIONS: Electromagnetic waves (EMWs) emitted from 3G+wi-fi modems cause a significant decrease in sperm motility and velocity, especially in non-progressive motile sperms. Other parameters of semen analysis did not change significantly.EMWs, which are used in communications worldwide, are a suspected cause of male infertility. Many studies evaluated the effects of cell phones and wi-fi on fertility. To our knowledge, no study has yet been done to show the effects of EMWs emitted from 3G+wi-fi modems on fertility.Our study revealed a significant decrease in the quality of human semen after exposure to EMWs emitted from 3G+wi-fi modems.

https://www.ncbi.nlm.nih.gov/pubmed/28967061

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Electromagnetic fields in neonatal incubators: the reasons for an alert

Bellieni CV, Nardi V, Buonocore G, Di Fabio S, Pinto I, Verrotti A. Electromagnetic fields in neonatal incubators: the reasons for an alert. J Matern Fetal Neonatal Med. 2017 Oct 8:1-11. doi: 10.1080/14767058.2017.1390559.

Abstract

BACKGROUND: Neonatal incubators are important tools for sick newborns in the first few days of life. Nevertheless, their electric engine, often very close to the newborn's body, emits electromagnetic fields (EMF) to which newborns are exposed. Aim of this paper is to review the available literature on EMF exposure in incubators, and the effects of such exposures on newborns that have been investigated.

METHODS: We carried out a systematic review of studies about EMF emissions produced by incubators, using Medline and Embase databases from 1993 to 2017.

RESULTS: We retrieved 15 papers that described the EMF exposure in incubators and their biological effects on babies. EMF levels in incubators appear to be between 2 and 100 mG, depending on the distance of the mattress from the electric engine. In some cases they exceed this range. These values interfere with melatonin production or with vagal tone. Even caregivers are exposed to high EMF, above 200 mG, when working at close contact with the incubators.

CONCLUSION: EMF have been described as potentially hazardous for human health, and values reported in this review are an alert to prevent babies' and caregivers' exposure when close to the incubators. A precautionary approach should be adopted in future incubator design, to prevent high exposures of newborns in incubators and of caregivers as well.

https://www.ncbi.nlm.nih.gov/pubmed/28988507

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Cellphone electromagnetic radiation damages the testicular ultrastructure of male rats

Gao XH, Hu HR, Ma X2, Chen J, Zhang GH. [Cellphone electromagnetic radiation damages the testicular ultrastructure of male rats]. [Article in Chinese]. Zhonghua Nan Ke Xue. 2016 Jun;22(6):491-495.

Abstract

OBJECTIVE: To investigate the influence of cellphone electromagnetic radiation (CER) on the testicular ultrastructure and the apoptosis of spermatogenic cells in male rats.atability, feasibility, applicability, and controllability in the construction of experimental animal models, we compared the major anatomic features of the penis of 20 adult beagle dogs with those of 10 adult men. Using microsurgical techniques, we performed cross-transplantation of the penis in the 20 (10 pairs) beagle dogs and observed the survival rate of the transplanted penises by FK506+MMF+MP immune induction. We compared the relevant indexes with those of the 10 cases of microsurgical replantation of the amputated penis.

METHODS: Thirty adult male SD rats were equally randomized into a 2 h CER, a 4 h CER, and a normal control group, the former two groups exposed to 30 days of 900 MHz CER for 2 and 4 hours a day, respectively, while the latter left untreated. Then the changes in the ultrastructure of the testis tissue were observed under the transmission electron microscope and the apoptosis of the spermatogenic cells was determined by TUNEL.

RESULTS: Compared with the normal controls, the rats of the 2 h CER group showed swollen basement membrane of seminiferous tubules, separated tight junction of Sertoli cells, increased cell intervals, apparent vacuoles and medullization in some mitochondria, and increased apoptosis of spermatogenic cells, mainly the apoptosis of primary spermatocytes ($P<0.05$). In comparison with the 2 h CER group, the animals of the 4 h CER group exhibited swollen basement membrane of seminiferous tubules, more separated tight junction of Sertoli cells, wider cell intervals, incomplete membrane of spermatogonial cells, fragments of cytoplasm, nuclear pyknosis and notch, slight dilation of perinuclear space, abnormalities of intracellular mitochondria with vacuoles, fuzzy structure, and fusion or disappearance of some cristae, and increased damage of mitochondria and apoptosis of spermatogenic cells, including the apoptosis of spermatogonial cells, primary spermatocytes,

and secondary spermatocytes (P<0.05).

CONCLUSIONS: CER can damage the testicular ultrastructure and increase the apoptosis of spermatogenic cells of the male rat in a time-dependent manner, and the apoptosis of spermatogenic cells may be associated with the damage to mitochondria.

https://www.ncbi.nlm.nih.gov/pubmed/28963835

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Cardiovascular disease: Time to identify emerging environmental risk factors

Bandara P, Weller S. Cardiovascular disease: Time to identify emerging environmental risk factors. Eur J Prev Cardio. October 3, 2017.

No Abstract

Excerpts

In our latest review, 242 RF-EMR studies that investigated experimental endpoints related to oxidative stress (OS)16 were identified. A staggering 216 (89%) of them found significant effects related to OS, similar to a previous review.17 These are being further analysed following presentation at the recent Australasian Radiation Protection Society conference.18 Mostly in-vivo animal studies and in-vitro studies have demonstrated increased markers of endogenous OS and/or affected antioxidant levels in different tissue/cell types upon exposure to RF-EMR. Some studies have further demonstrated amelioration of RF-induced OS upon treatment with various antioxidants. Limited human studies at this stage complement these studies demonstrating OS and/or reduced antioxidant status upon acute radiofrequency exposure under experimental settings,19 in mobile phone users20 and residents near mobile phone base stations.21 Renowned physical scientists have recently presented experimental evidence and a theoretical explanation on how low-intensity RF-EMR can generate OS .22

OS is known to be implicated in CVD 23,24 and therefore RF-EMR, a new ubiquitous environmental exposure, may contribute to CVD by maintaining chronic OS, and thereby causing oxidative damage to cellular constituents and altering signal transduction pathways.

Although a few western countries have recently taken steps to reduce public exposure to RF-EMR, particularly of children, such as discouraging the use of wireless devices by children and banning/restricting WiFi in schools, 38,39 there is largely inaction at this stage. Intriguingly, a professor in public health at the University of California recently went to court and accessed the cell phone safety ‘fact sheet’ (on health risks with instructions to reduce exposure) prepared by the Californian Department of Public Health.40 It is reported that this document, originally prepared in 2009 and revised 27 times up to 2014, was abandoned due to influences from vested interests. Meanwhile in France, a physician took legal action to access data from government testing of mobile phones 41 revealing that most phones would not even pass the entirely thermally based (tissue heating) current exposure standards if held directly against the body, such as in a garment pocket.

It is clearly time to investigate the potential role of RF-EMR exposure from common wireless device use on CVD. Noting that existing research findings are influenced by the funding source, 42 fresh directives are necessary for objective high quality research to expand current primary and secondary prevention strategies. 43

http://journals.sagepub.com/doi/full/10.1177/2047487317734898

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Nonlinearity, coherence and complexity: Biophysical aspects related to health and disease

Foletti A, Brizhik L. Nonlinearity, coherence and complexity: Biophysical aspects related to health and disease. Electromagnetic Biology and Medicine. Published online 22 Sep 2017.

Abstract

Biological organisms are complex open dissipative systems whose dynamical stability is sustained due to the exchange of matter, energy and information. Dynamical stability occurs through a number of mechanisms that sustain efficient adaptive dynamics. Such properties of living matter can be the consequence of a self-consistent state of matter and electromagnetic field (EMF). Based on the soliton model of charge transport in redox processes, we describe a possible mechanism of the origin of endogenous EMF and coherence. Solitons are formed in polypeptides due to electron–lattice interaction. Solitons experience periodical potential barrier, as a result of which their velocity oscillates in time, and, hence, they emit electromagnetic radiation (EMR). Under the effect of such radiation from all other solitons, the synchronization of their dynamics takes place, which significantly increases the intensity of the general EMF. The complex structure of biological molecules, such as helical structure, is not only important for “structure-function” relations, but also the source of the stability of biophysical processes, e.g. effectiveness of energy and charge transport on macroscopic distances. Such a complex structure also provides the framework for the spatiotemporal structure of the endogenous EMF. The highly hierarchical organization of living organisms is a manifestation of their complexity, even at the level of simple unicellular organisms. This complexity increases the dynamical stability of open systems and enhances the possibility of information storage and processing. Our findings provide a qualitative overview of a possible biophysical mechanism that supports health and disease adaptive dynamics.

https://www.ncbi.nlm.nih.gov/pubmed/28937829

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Simplified Assessment Method for Population RF Exposure Induced by a 4G Network

Huang Y, Wiart J. Simplified Assessment Method for Population RF Exposure Induced by a 4G Network. IEEE Journal of Electromagnetics, RF and Microwaves in Medicine and Biology. PP(99). 18 Sep 2017. DOI:10.1109/JERM.2017.2751751.

Abstract

This article presents a simplified method, based on surrogate modeling, to evaluate the day-to-day global population exposure to radio frequency (RF) electromagnetic fields (EMF) induced by a 4G network, from both uplink and downlink radio emissions in a typical urban city. The uncertainties of 4G-induced RF-EMF exposure of an entire population were characterized for the first time taking into account the variability linked to urban propagation environment, information and communication technology usage, EMF respectively from personal wireless devices and Evolved Node B (eNB), as well as uplink throughput. In addition, the study focuses on a sensitivity analysis in order to assess the influence of these parameters on RF-EMF exposure. Globally, results show that the 4G-induced RF-EMF exposure follows a Generalized Extreme Value distribution with an average value of 1.19×10 W/kg. Moreover, authors show that, contrary to what have been observed in the 3G-induced

RF-EMF exposure, that is, the exposure is dominated by uplink radio emissions, results have highlighted the importance of received power density from eNB to the issue of 4G-induced RF-EMF exposure. In 4G, the uplink exposure from mobiles accounts for only 25% of global exposure, resulting from the high speed of uplink throughput.

http://ieeexplore.ieee.org/document/8039247/

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Time-averaged Realistic Maximum Power Levels for Assessment of RF Exposure for 5G Radio Base Stations

Thors B, Furuskär A, Colombi D, Törnevik C. Time-averaged Realistic Maximum Power Levels for the Assessment of Radio Frequency Exposure for 5G Radio Base Stations using Massive MIMO. IEEE Access. PP(99), 18 Sep 2017.

Abstract

In this paper a model for time-averaged realistic maximum power levels for the assessment of radio frequency (RF) electromagnetic field (EMF) exposure for the fifth generation (5G) radio base stations (RBS) employing massive MIMO is presented. The model is based on a statistical approach and developed to provide a realistic conservative RF exposure assessment for a significant proportion of all possible downlink exposure scenarios (95th percentile) in-line with requirements in a recently developed International Electrotechnical Commission (IEC) standard for RF EMF exposure assessments of radio base stations (RBS). Factors such as RBS utilization, time-division duplex (TDD), scheduling time, and spatial distribution of users within a cell are considered. The model is presented in terms of a closed-form equation. For an example scenario corresponding to an expected 5G RBS product, the largest realistic maximum power level was found to be less than 15% of the corresponding theoretical maximum. For far-field exposure scenarios, this corresponds to a reduction in RF EMF limit compliance distance with a factor of about 2.6. Results are given for antenna arrays of different sizes and for scenarios with beamforming in both azimuth and elevation.

http://ieeexplore.ieee.org/document/8039290/

Excerpt

In this paper, a theoretical model was presented to estimate the time-averaged realistic maximum power levels for the assessment of RF EMF exposure for 5G Radio Base Stations using Massive MIMO. The model was based on realistic conservative assumptions of a 5G mobile communication system and made use of a statistical approach to distribute the transmitted energy within the cell to obtain results that may be used in context with the ‘actual maximum exposure conditions’ in the international RF EMF exposure assessment standard for radio base stations IEC 62232:2017.

A key parameter of the model is how the users are assumed to be distributed within the cell. For all UDS considered, the time-averaged realistic maximum power levels was found to be significantly below the theoretical maximum. Even for very large degrees of system utilization, the time-averaged realistic maximum was found to take values between 7% - 22% of the theoretical maximum. This translates to reduced compliance distances and may be used to facilitate installation of 5G RBS products. The obtained results provide valuable input to standardization of RF EMF exposure assessments in the vicinity of RBS.

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Magnetic field exposure to wireless charging stations for mobile phones

Fröhlich, J., Zahner, M. and Dürrenberger, G. (2017), Magnetic field exposure to wireless charging stations for mobile phones. Bioelectromagnetics. doi:10.1002/bem.22087

No Abstract

Excerpts

This brief communication presents measurement and simulation data about magnetic field levels of, and human exposure to, wireless charging devices for smart phones, respectively. Most transmitters for inductive charging operate within a frequency window from 110 up to 205 kHz. The highest instantaneous field levels can be measured in stand-by mode. Peak and rms values amount to a few 100 μT, which is above the reference level. However, simulation results showed that the basic restrictions (defined in terms of electric field levels, V/m, in tissue and power absorption, specific absorption rate [SAR]), were met. From a regulatory point of view, inductive charging systems for small electronic devices like cell phones comply with safety standards, but worst-case induced electrical fields may come close to basic restrictions. Therefore, maximum currents for all specific implementations have to be restricted.

Currently, inductive charging is the only commercialized wireless charging technology. In the near future, devices for resonant power transfer will be available, too. Two standards for inductive charging exist: Qi and AirFuel. Qi is dominating the market. Some key technical characteristics of the Qi inductive charging standard are given in Table 1.

Conclusion

The dosimetric characterization showed that inductive charging stations comply with basic restrictions recommended by ICNIRP and IEEE, albeit the incident magnetic flux densities exceed the reference values by factors of tens, roughly. For internal electric fields, the margin was below a factor of 10. For SAR, in contrast, the margin amounted to three orders of magnitude. The study (i) affirmed that checking basic restrictions in case of local exposures that exceed reference values is necessary; (ii) showed that **exposure levels of current smartphone wireless charging systems may exploit ICNIRP basic restrictions on induced electric fields up to 30%, roughly, and are far from recommended maximum SAR levels**; and (iii) indicated that increasing the allowed maximum power for charging systems (as already outlined in the standard) has to be carefully evaluated regarding instantaneous values of induced electric fields.

http://onlinelibrary.wiley.com/doi/10.1002/bem.22087/full

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Evaluation of the mobile phone electromagnetic radiation on serum iron parameters in rats

Çetkin M, Demirel C, Kızılkan N, Aksoy N, Erbağcı H. Evaluation of the mobile phone electromagnetic radiation on serum iron parameters in rats.
Afr Health Sci. 2017 Mar;17(1):186-190. doi: 10.4314/ahs.v17i1.23.

Abstract

BACKGROUND: Electromagnetic fields (EMF) created by mobile phones during communication have harmful effects on different organs.

OBJECTIVES: It was aimed to investigate the effects of an EMF created by a mobile phone on serum iron level, ferritin, unsaturated iron binding capacity and total iron binding capacity within a rat experiment model.

METHODS: A total of 32 male Wistar albino rats were randomly divided into the control, sham, mobile phone speech (2h/day) and stand by (12 h/day) groups. The speech and stand by groups were subjected to the EMF for a total of 10 weeks.

RESULTS: No statistically significant difference was observed between the serum iron and ferritin values of the rats in the speech and stand by groups than the control and sham groups ($p>0.05$). The unsaturated iron binding capacity and total iron capacity values of the rats in the speech and stand by groups were significantly lower in comparison to the control group ($p<0.01$).

CONCLUSION:It was found that exposure to EMF created by mobile phones affected unsaturated iron binding capacity and total iron binding capacity negatively.

Open Access Paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5636244/

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Electromagnetic fields with frequencies of 5, 60 and 120 Hz affect the cell cycle and viability of human fibroblast BJ in vitro

Koziorowska A, Romerowicz-Misielak M Filipek A, Koziorowski M. Electromagnetic fields with frequencies of 5, 60 and 120 Hz affect the cell cycle and viability of human fibroblast BJ in vitro. J Biol Regul Homeost Agents. 2017 Jul-Sep;31(3):725-730.

Abstract

The impact of electromagnetic field (EMF) on humans has been described in numerous studies, but many questions are still unanswered. The aim of the experiment described in this study was to evaluate the effect of EMF on the viability of human fibroblast BJ in vitro and the percentage of cells in different phases of the cell cycle (G1/G0, S, G2/M) after 2 hours of exposure to sinusoidal continuous and pulsed EMFs with frequency of 5 Hz, 60 Hz and 120 Hz at a magnetic induction of 2,5 mT. The viability of BJ cells exposed to an EMF was estimated immediately after completion of exposure and after 24 hours. Metabolic activity of cells was assessed by MTT assay and compared to a control culture not exposed to EMFs. Cell cycle analysis was performed by BrdU incorporation. The analysis of the viability demonstrated significant differences in field efficiency, depending on its nature. Exposure of cells to pulse EMFs resulted in a decrease in their viability for each of the analyzed frequencies. Reduced viability was maintained for a further 24 hours after the end of exposure of cells to pulsed EMF. In the case of continuous field, reduced BJ cell viability was observed only at the highest applied frequency - 120Hz, and this effect maintained for the next 24 hours. Although there was no significant effect on cell viability (metabolic activity) of cells immediately after exposure to continuous EMF with

a frequency of 5Hz, a significant increase was observed after 24 hours of incubation.

https://www.ncbi.nlm.nih.gov/pubmed/28956424

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Activation of Signaling Cascades by Weak Extremely Low Frequency Electromagnetic Fields

Kapri-Pardes E, Hanoch T, Maik-Rachline G, Murbach M, Bounds PL, Kuster N, Seger R. Activation of Signaling Cascades by Weak Extremely Low Frequency Electromagnetic Fields. Cell Physiol Biochem. 2017 Oct 16;43(4):1. doi: 10.1159/000481977.

Abstract

BACKGROUND/AIMS: Results from recent studies suggest that extremely low frequency magnetic fields (ELF-MF) interfere with intracellular signaling pathways related to proliferative control. The mitogen-activated protein kinases (MAPKs), central signaling components that regulate essentially all stimulated cellular processes, include the extracellular signal-regulated kinases 1/2 (ERK1/2) that are extremely sensitive to extracellular cues. Anti-phospho-ERK antibodies serve as a readout for ERK1/2 activation and are able to detect minute changes in ERK stimulation. The objective of this study was to explore whether activation of ERK1/2 and other signaling cascades can be used as a readout for responses of a variety of cell types, both transformed and non-transformed, to ELF-MF.

METHODS: We applied ELF-MF at various field strengths and time periods to eight different cell types with an exposure system housed in a tissue culture incubator and followed the phosphorylation of MAPKs and Akt by western blotting.

RESULTS: We found that the phosphorylation of ERK1/2 is increased in response to ELF-MF. However, the phosphorylation of ERK1/2 is likely too low to induce ELF-MF-dependent proliferation or oncogenic transformation. The p38 MAPK was very slightly phosphorylated, but JNK or Akt were not. The effect on ERK1/2 was detected for exposures to ELF-MF strengths as low as 0.15 μT and was maximal at ∼10 μT. We also show that ERK1/2 phosphorylation is blocked by the flavoprotein inhibitor diphenyleneiodonium, indicating that the response to ELF-MF may be exerted via NADP oxidase similar to the phosphorylation of ERK1/2 in response to microwave radiation.

CONCLUSIONS: Our results further indicate that cells are responsive to ELF-MF at field strengths much lower than previously suspected and that the effect may be mediated by NADP oxidase. However, the small increase in ERK1/2 phosphorylation is probably insufficient to affect proliferation and oncogenic transformation. Therefore, the results cannot be regarded as proof of the involvement of ELF-MF in cancer in general or childhood leukemia in particular.

https://www.ncbi.nlm.nih.gov/pubmed/29035881

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Geomagnetic storm under laboratory conditions: randomized experiment

Gurfinkel YI, Vasin AL, Pishchalnikov RY, Sarimov RM, Sasonko ML, Matveeva TA. Geomagnetic storm under laboratory conditions: randomized experiment. Int J Biometeorol. 2017 Oct 13. doi: 10.1007/s00484-017-1460-8.

Abstract

The influence of the previously recorded geomagnetic storm (GS) on human cardiovascular system and microcirculation has been studied under laboratory conditions. Healthy volunteers in lying position were exposed under two artificially created conditions: quiet (Q) and storm (S). The Q regime playbacks a noise-free magnetic field (MF) which is closed to the natural geomagnetic conditions on Moscow's latitude. The S regime playbacks the initially recorded 6-h geomagnetic storm which is repeated four times sequentially. The cardiovascular response to the GS impact was assessed by measuring capillary blood velocity (CBV) and blood pressure (BP) and by the analysis of the 24-h ECG recording. A storm-to-quiet ratio for the cardio intervals (CI) and the heart rate variability (HRV) was introduced in order to reveal the average over group significant differences of HRV. An individual sensitivity to the GS was estimated using the autocorrelation function analysis of the high-frequency (HF) part of the CI spectrum. The autocorrelation analysis allowed for detection a group of subjects of study which autocorrelation functions (ACF) react differently in the Q and S regimes of exposure.

https://www.ncbi.nlm.nih.gov/pubmed/29030697

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NTP Cell Phone Radiation Study

Evaluation of Genotoxicity of Cell Phone Radiation in Male & Female Rats & Mice Following Subchronic Exposure

Smith-Roe SL, Wyde, ME, Stout MD, Winters JW, Hobbs CA, Shepard KG, Green AS, Kissing GA, Tice RR, Bucher JR, Witt KL. Evaluation of the Genotoxicity of Cell Phone Radiofrequency Radiation in Male and Female Rats and Mice Following Subchronic Exposure. Presentation at at annual meeting of Environmental Mutagenesis and Genomics Society held in Raleigh, North Carolina from September 9-13, 2017.

I don't know if a paper or slides are available. The abstract for this presentation is available at http://bitly.com/NTPsaferemr

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Dosimetric Assessment for Mice & Rats Exposed in Reverberation Chambers for the Two-Year NTP Cancer Bioassay Study on Cell Phone Radiation

Gong, YJ, Capstick, MH; Kuehn, S ; Wilson, PF; Ladbury, JM ; Koepke, G; McCormick, DL ; Melnick, RL Kuster, N.Life-Time Dosimetric Assessment for Mice and Rats Exposed in Reverberation Chambers for the Two-Year NTP Cancer Bioassay Study on Cell Phone Radiation. IEEE Transactions on Electromagnetic Compatibility. 59(6):1798-1808. DOI: 10.1109/TEMC.2017.2665039. Dec 2017.

Abstract

In this paper, we present the detailed life-time dosimetry analysis for rodents exposed in the reverberation

exposure system designed for the two-year cancer bioassay study conducted by the National Toxicology Program of the National Institute of Environmental Health Sciences. The study required the well-controlled and characterized exposure of individually housed, unrestrained mice at 1900 MHz and rats at 900 MHz, frequencies chosen to give best uniformity exposure of organs and tissues. The wbSAR, the peak spatial SAR, and the organ specific SAR as well as the uncertainty and variation due to the exposure environment, differences in the growth rates, and animal posture were assessed. Compared to the wbSAR, the average exposure of the high-water-content tissues (blood, heart, lung) were higher by similar to 4 dB, while the low-loss tissues (bone and fat) were less by similar to 9 dB. The maximum uncertainty over the exposure period for the SAR was estimated to be <49% (k = 2) for the rodents whereas the relative uncertainty between the exposure groups was < 14% (k = 1). The instantaneous variation (averaged over 1 min) was < 13% (k = 1), which is small compared to other long term exposure research projects. These detailed dosimetric results empowers comparison with other studies and provides a reference for studies of long-term biological effects of exposure.

http://ieeexplore.ieee.org/abstract/document/7880616/

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A History of the International Commission on Non-Ionizing Radiation Protection

Repacholi MH. A History of the International Commission on Non-Ionizing Radiation Protection. Health Phys. 2017 Oct;113(4):282-300. doi: 10.1097/HP.0000000000000699.

Abstract

Concern about health risks from exposure to non-ionizing radiation (NIR) commenced in the 1950s after tracking radars were first introduced during the Second World War. Soon after, research on possible biological effects of microwave radiation in the former Soviet Union and the U.S. led to public and worker exposure limits being much lower in Eastern European than in Western countries, mainly because of different protection philosophies. As public concern increased, national authorities began introducing legislation to limit NIR exposures from domestic microwave ovens and workplace devices such as visual display units. The International Radiation Protection Association (IRPA) was formed in 1966 to represent national radiation protection societies. To address NIR protection issues, IRPA established a Working Group in 1974, then a Study Group in 1975, and finally the International NIR Committee (INIRC) in 1977. INIRC's publications quickly became accepted worldwide, and it was logical that it should become an independent commission. IRPA finally established the International Commission on Non-Ionizing Radiation Protection (ICNIRP), chartering its remit in 1992, and defining NIR as electromagnetic radiation (ultraviolet, visible, infrared), electromagnetic waves and fields, and infra- and ultrasound. ICNIRP's guidelines have been incorporated into legislation or adopted as standards in many countries. While ICNIRP has been subjected to criticism and close scrutiny by the public, media, and activists, it has continued to issue well-received, independent, science-based protection advice. This paper summarizes events leading to the formation of ICNIRP, its key activities up to 2017, ICNIRP's 25th anniversary year, and its future challenges.

https://www.ncbi.nlm.nih.gov/pubmed/28846587

Excerpts

"At the Budapest meeting, Repacholi advised that since he had established the International EMF Project at WHO, and as ICNIRP was now working closely with this project, it was a conflict of interest for him to remain as Chairman or as a member of ICNIRP. As such, he resigned."

"While the independence of ICNIRP members is clearly required in its Charter and Statutes, it had become an issue of public and political interest in some countries. At its meeting in Bordeaux (September 2003), it was decided that a conflict of interest declaration by all current and new members should not only be kept on file

but also posted on ICNIRP's website. A "Declaration of Personal Interest" completed by all Commission and Scientific Expert Group members is now posted on the ICNIRP website as a demonstration of the independence of its members, openness and transparency. These declarations of personal interest were made more stringent following discussions at the annual meeting in Thessaloniki (Greece, June 2013) and more detailed information was required from Commission and Scientific Expert Group members."

"Recommendations on exposure limits have been and continue to be based purely on the science and only minor changes or fine-tuning to these limits have been necessary over the years. Many national authorities have adopted ICNIRP guidelines into their own guidance or legislation. The stability of the limits over many years, because there has not been any research providing evidence of harm from exposures below the guideline limits, provides reassurance to national authorities about the adequacy of the protection the limits provide."

"ICNIRP members have taken a leading role in assisting WHO's International EMF Project with its first systematic review of the scientific literature to determine whether there are any health consequences from exposure to radiofrequency fields. The results and conclusions of this Environmental Health Criteria monograph will form a basis for the updated ICNIRP guidelines on high frequency EMF. An important aspect of this WHO review is that, not only WHO Task Group members, but all members of any working groups contributing to each chapter, including ICNIRP members, must complete a form detailing any conflict of interest for review and approval by the WHO Legal Department.Given the huge amount of work this systematic review involves, it is anticipated that this monograph should now be published in 2018. Much of ICNIRP's future work will be done in collaboration with WHO's EMF Project."

"ICNIRP published its general philosophy of NIR protection 15 y ago (ICNIRP 2002), but this needs updating and more detail added. ICNIRP is currently working on this update since it views the protection principles as fundamental to the development of all its guidelines and statements. In addition, such principles provide consistency in protection for future publications."

"Possible health effects of EMF have been of concern for a long time and so ICNIRP has been subjected to significant public and political scrutiny. To its credit, by
steadfastly remaining a purely scientific Commission and not entering the politics of NIR issues, ICNIRP has successfully weathered all storms to become the most recognized agency for producing independent authoritative advice on NIR protection issues."

"The authors declare no conflicts of interest."

My note: In recent years, many professional journals require authors to disclose conflicts of interest (COIs). However, it is extremely rare that anyone discloses their COIs. Thus, this requirement which relies on self reporting COIs has been largely a sham.

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Increasing levels of saliva alpha amylase in electrohypersensitive (EHS) patients

Andrianome S, Hugueville L, de Seze R, Selmaoui B.Increasing levels of saliva alpha amylase in electrohypersensitive (EHS) patients.Int J Radiat Biol. 2017 Aug;93(8):841-848. doi: 10.1080/09553002.2017.1325971. Epub 2017 May 17.

Abstract

PURPOSE: To assess the level of various salivary and urinary markers of patients with electromagnetic hypersensitivity (EHS) and to compare them with those of a healthy control group.

MATERIALS AND METHODS: We analyzed samples from 30 EHS individuals and a matched control group of

25 individuals (non-EHS) aged between 22 and 66. We quantified cortisol both in saliva and urine, alpha amylase (sAA), immunoglobulin A and C Reactive Protein levels in saliva and neopterin in urine (uNeopterin).

RESULTS: sAA was found to be significantly higher ($p < 0.005$) in the EHS group. uNeopterin and sAA analysis showed a significant difference based on the duration of EHS.

CONCLUSION: Higher levels of sAA in EHS participants may suggest that the sympathetic adrenal medullar system is activated. However, most of the analyzed markers of the immune system, sympathetic activity and circadian rhythm did not vary significantly in the EHS group. There is a trend to the higher levels of some variables in subgroups according to the EHS duration.

https://www.ncbi.nlm.nih.gov/pubmed/28466664

Excerpts

sAA activity was significantly different ($p < 0.0001$) between the control and EHS group. The EHS group showed a significantly higher level of sAA (Figure 2(a)).

Figure 2. Salivary concentration of α-amylase (a) and IgA (b) in the control (black line) and EHS group (grey line) during experimentation (from bedtime to 16:30 h). Data expressed as mean ± SEM. Significant difference between groups for α-amylase ($p < 0.0001$); significant effect of time for α-amylase ($p = 0.0001$) and IgA ($p < 0.0001$).

The mean of sIgA showed a tendency to be positively correlated with EHS duration ($r = 0.141$, $p = 0.010$); sAA was also slightly but positively correlated with EHS duration ($r = 0.254$, $p < 0.001$).

Besides, the salivary enzyme α-amylase has been proposed as a marker for the stress-induced activity of the sympathetic nervous system (SNS), or more precisely of the sympathetic adrenomedullary (SAM) system, which is also involved in the secretion of adrenaline and noradrenaline (Chatterton et al. 1996 Chatterton RT Jr, Vogelsong KM, Lu YC, Ellman AB, Hudgens GA. 1996. Salivary alpha-amylase as a measure of endogenous adrenergic activity. Clin Physiol. 16:433–448.[Crossref], [PubMed], [Google Scholar]; Rohleder & Nater 2009 Rohleder N, Nater UM. 2009. Determinants of salivary alpha-amylase in humans and methodological considerations. Psychoneuroendocrinology. 34:469–485.[Crossref], [PubMed], [Web of Science ®], [Google Scholar]). Unlike cortisol, saliva alpha amylase levels were found to be significantly higher in the EHS group, in comparison to the control group. The question that arises here is whether this change in α-amylase activity was a result of outside exposure to EMF or simply a consequence of chronic stress.

.. in the present study, sAA levels were shown to be constantly elevated in EHS individuals, even during their stay (from 09:00 to 16:30 h) in the EMF-shielded room in our laboratory. The role of EMF on the increase of AA is still to be proven. However, our results indicated that the EHS population seems to have higher levels of sAA than the control group. And the cause of this increase is to be yet determined.

Moreover, a significant and positive correlation was shown between sAA levels and the duration of EHS. Indeed, the longer the duration of EHS, the higher the level of sAA. This may suggest that the longer they are EHS, the more they react. One may speculate that this could be due to a degraded system in patients presenting EHS for a long time.

Besides, a study has shown that exposure to radiofrequency electromagnetic fields (RF-EMF) emitted by mobile phone base stations affected salivary α-amylase in healthy participants (Augner et al. 2010 Augner C, Hacker GW, Oberfeld G, Florian M, Hitzl W, Hutter J, Pauser G. 2010. Effects of exposure to GSM mobile phone base station signals on salivary cortisol, alpha-amylase, and immunoglobulin A. Biomed Environ Sci BES. 23:199–207.[Crossref], [PubMed], [Web of Science ®], [Google Scholar]). In addition, a study of people living next to phone base stations, self-declaring base-station neighbors (distance to base station ≤100 m), had higher levels of α-amylase accompanied by a higher general strain (Augner & Hacker 2009 Augner C, Hacker

GW. 2009. Are people living next to mobile phone base stations more strained? Relationship of health concerns, self-estimated distance to base station, and psychological parameters. Indian J Occup Environ Med. 13:141–145.[Crossref], [PubMed], [Google Scholar]; Augner et al. 2010 Augner C, Hacker GW, Oberfeld G, Florian M, Hitzl W, Hutter J, Pauser G. 2010. Effects of exposure to GSM mobile phone base station signals on salivary cortisol, alpha-amylase, and immunoglobulin A. Biomed Environ Sci BES. 23:199–207.[Crossref], [PubMed], [Web of Science ®], [Google Scholar]). This may suggest that people self-reporting EHS could share similarities with this population, but whether this is due to actual exposure to EMF or to other underlying factors is not clear. In our study, unfortunately, recordings of exposure field density before entering the study (outside the experimental lab) were not available.

In summary, an exploration of selected and measurable markers of EHS was conducted in our study to understand this condition. Our finding indicates that markers of the circadian rhythm and immune system were not affected in EHS compared to non-EHS individuals. Our results suggest different profiles of EHS according to the duration of the syndrome. Furthermore, the mechanism underlying the higher expression of α-amylase should be focused on. These findings could be new elements in the understanding, explanation and comprehension of the physiopathology of EHS.

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Maternal cell phone use in early pregnancy & child's language, communication & motor skills at 3 & 5 years: Norwegian mother child cohort study

Papadopoulou E, Haugen M, Schjølberg S, Magnus P, Brunborg G, Vrijheid M, Alexander J. Maternal cell phone use in early pregnancy and child's language, communication and motor skills at 3 and 5 years: the Norwegian mother and child cohort study (MoBa). BMC Public Health. 2017 Sep 5;17(1):685. doi: 10.1186/s12889-017-4672-2.

Abstract

BACKGROUND: Cell phone use during pregnancy is a public health concern. We investigated the association between maternal cell phone use in pregnancy and child's language, communication and motor skills at 3 and 5 years.

METHODS: This prospective study includes 45,389 mother-child pairs, participants of the MoBa, recruited at mid-pregnancy from 1999 to 2008. Maternal frequency of cell phone use in early pregnancy and child language, communication and motor skills at 3 and 5 years, were assessed by questionnaires. Logistic regression was used to estimate the associations.

RESULTS: No cell phone use in early pregnancy was reported by 9.8% of women, while 39%, 46.9% and 4.3% of the women were categorized as low, medium and high cell phone users. Children of cell phone user mothers had 17% (OR = 0.83, 95% CI: 0.77, 0.89) lower adjusted risk of having low sentence complexity at 3 years, compared to children of non-users. The risk was 13%, 22% and 29% lower by low, medium and high maternal cell phone use. Additionally, children of cell phone users had lower risk of low motor skills score at 3 years, compared to children of non-users, but this association was not found at 5 years. We found no association between maternal cell phone use and low communication skills.

CONCLUSIONS: We reported a decreased risk of low language and motor skills at three years in relation to prenatal cell phone use, which might be explained by enhanced maternal-child interaction among cell phone users. No evidence of adverse neurodevelopmental effects of prenatal cell phone use was reported.

https://www.ncbi.nlm.nih.gov/pubmed/28870201

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Use of non-ionizing electromagnetic fields for the treatment of cancer

Jimenez H, Blackman C, Lesser G, Debinski W, Chan M, Sharma S, Watabe K, Lo HW, Thomas A, Godwin D, Blackstock W, Mudry A, Posey J, O'Connor R, Brezovich I, Bonin K, Kim-Shapiro D, Barbault A, Pasche B. Use of non-ionizing electromagnetic fields for the treatment of cancer. Front Biosci (Landmark Ed). 2018 Jan 1;23:284-297.

Abstract

Cancer treatment and treatment options are quite limited in circumstances such as when the tumor is inoperable, in brain cancers when the drugs cannot penetrate the blood-brain-barrier, or when there is no tumor-specific target for generation of effective therapeutic antibodies. Despite the fact that electromagnetic fields (EMF) in medicine have been used for therapeutic or diagnostic purposes, the use of non-ionizing EMF for cancer treatment is a new emerging concept. Here we summarize the history of EMF from the 1890's to the novel and new innovative methods that target and treat cancer by non-ionizing radiation.

https://www.ncbi.nlm.nih.gov/pubmed/28930547

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Efficacy and Safety of Treating Glioblastoma With Tumor-Treating Fields Therapy

Saria MG, Kesari S. Efficacy and Safety of Treating Glioblastoma With Tumor-Treating Fields Therapy. Clin J Oncol Nurs. 2016 Oct 1;20(5):S9-S13. doi: 10.1188/16.CJON.S1.9-13.

Abstract

BACKGROUND: Glioblastoma (GBM) is a highly aggressive astrocytoma with a dismal prognosis. Since 1976, only three chemotherapeutic agents have been approved for the treatment of GBM. Tumor-treating fields (TTFields) therapy, delivered via a noninvasive device, is a new therapy approved for use in patients with recurrent GBM and in combination with temozolomide for the treatment of newly diagnosed GBM.

OBJECTIVES: This article reviews the mechanism of action and findings from preclinical and clinical studies supporting the use of TTFields for patients with newly diagnosed and recurrent GBM.

METHODS: This article provides an overview of published literature on the efficacy and safety of treating GBM with TTFields.

FINDINGS: For the first time in more than a decade, patients with GBM have a noninvasive treatment option that has been shown to increase progression-free survival and overall survival with minimal adverse events.

https://www.ncbi.nlm.nih.gov/pubmed/27668388

Excerpts

Compared with historic cancer treatment modalities, TTFields have an innovative mechanism of action. Nonbiochemical and nonablative, TTFields use frequency-specific, low-intensity, alternating electric fields to disrupt structures within the cancer cell during mitosis, leading to apoptosis. Specifically, TTFields technology takes advantage of the special characteristics, geometric shape, and the rate of dividing cancer cells, which make them susceptible to the effects of TTFields. TTFields alter tumor cell polarity at an intermediate frequency (100–300 kHz). The frequency used for TTFields is specific to the target cell type (e.g., 200 kHz for gliomas). TTFields have been shown to disrupt the normal assembly of the microtubule spindle by exerting directional forces on polar intracellular elements, such as macromolecules and organelles. These processes

lead to physical disruption of the cell membrane and to programmed cell death (Giladi et al., 2015) (see Figure 1).

The pivotal, randomized phase III study leading to the FDA approval of Optune for recurrent GBM and the subsequent prospective, multicenter, open-label, randomized, controlled trial leading to the approval of Optune for patients with newly diagnosed GBM demonstrate that the addition of TTFields to maintenance TMZ chemotherapy significantly improves survival without increasing toxicities in patients with glioblastoma. The introduction of the second-generation device, which weighs about 50% less than the original device, is expected to improve GBM patient compliance. Trials are evaluating the safety and efficacy of TTFields in low-grade gliomas, solid tumor brain metastases, non-small cell lung cancer, pancreatic cancer, and other solid malignancies.

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Evaluation of Electromagnetic Exposure During 85 kHz Wireless Power Transfer for Electric Vehicles

SangWook Park. Evaluation of Electromagnetic Exposure During 85 kHz Wireless Power Transfer for Electric Vehicles. IEEE Transactions on Magnetics. Volume: PP, Issue: 99. Sep 1, 2017. 10.1109/TMAG.2017.2748498

Abstract

The external fields in the proximity of electric vehicle (EV) wireless power transfer (WPT) systems requiring high power may exceed the limits of international safety guidelines. This study presents dosimetric results of an 85 kHz WPT system for electric vehicles. A WPT system for charging EVs is designed and dosimetry for the system is evaluated for various exposure scenarios: a human body in front of the WPT system without shielding, with shielding, with alignment and misalignment between transmitter and receiver, and with a metal plate on the system for vehicle mimic floor pan. The minimum accessible distances in compliance are investigated for various transmitting powers. The maximum allowable transmitting power are also investigated with the limits of international safety guidelines and the dosimetric results.

http://ieeexplore.ieee.org/document/8024022/

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Effect of 2G and 3G Cell Phone Radiation on Developing Liver of Chick Embryo - Comparative Study

D'Silva MH, Swer RT, Anbalagan J, Rajesh B. Effect of Radiofrequency Radiation Emitted from 2G and 3G Cell Phone on Developing Liver of Chick Embryo - A Comparative Study. J Clin Diagn Res. 2017 Jul;11(7):AC05-AC09. doi: 10.7860/JCDR/2017/26360.10275. Epub 2017 Jul 1.

Abstract

INTRODUCTION: The increasing scientific evidence of various health hazards on exposure of Radiofrequency Radiation (RFR) emitted from both the cell phones and base stations have caused significant media attention and public discussion in recent years. The mechanism of interaction of RF fields with developing tissues of children and fetuses may be different from that of adults due to their smaller physical size and variation in tissue electromagnetic properties. The present study may provide an insight into the basic mechanisms by which RF fields interact with developing tissues in an embryo.

AIM: To evaluate the possible tissue and DNA damage in developing liver of chick embryo following chronic exposure to Ultra-High Frequency/Radiofrequency Radiation (UHF/RFR) emitted from 2G and 3G cell phone.

MATERIALS AND METHODS: Fertilized chick embryos were incubated in four groups. Group A-experimental group exposed to 2G radiation (60 eggs), Group B- experimental group exposed to 3G radiation (60 eggs), Group C- sham exposed control group (60 eggs) and Group D- control group (48 eggs). On completion of scheduled duration, the embryos were collected and processed for routine histological studies to check structural changes in liver. The nuclear diameter and karyorrhexis changes of hepatocytes were analysed using oculometer and square reticule respectively. The liver procured from one batch of eggs from all the four groups was subjected to alkaline comet assay technique to assess DNA damage. The results were compared using one-way ANOVA test.

RESULTS: In our study, the exposure of developing chick embryos to 2G and 3G cell phone radiations caused structural changes in liver in the form of dilated sinusoidal spaces with haemorrhage, increased vacuolations in cytoplasm, increased nuclear diameter and karyorrhexis and significantly increased DNA damage.

CONCLUSION: The chronic exposure of chick embryo liver to RFR emitted from 2G and 3G cell phone resulted in various structural changes and DNA damage. The changes were more pronounced in 3G experimental group. Based on these findings it is necessary to create awareness among public about the possible ill effects of RFR exposure from cell phone.

Open Access: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5583901/

Excerpts

The first four batches (48 eggs) were grouped as control (Group–D) and they were incubated without any external factors interfering with their developmental process. Next five batches (60 eggs) were treated as sham exposed group (Group-C). They were incubated along with a popular brand cell phone with the SAR of 0.310 watts/kilogram hung from above with 5 cm distance separating the egg and kept in null status (switched off)....

The experimental group, Group–A (exposed to 2G cell phone radiation) and Group–B (exposed to 3G cell phone radiation), were also incubated (60+60 eggs) in a similar manner with the cell phone kept in silent operative mode with head phone plugged in (switched on). This arrangement ensured that the cell phone got activated automatically each time it received a call and the intensity of radio frequency waves were measured using radiofrequency meter (RF meter, Less EMF Inc, USA) [Table/Fig-1].

A popular brand cell phone hand set and a service provider were used for network connection for both 2G and 3G exposure. For exposure activation, the cell phone was rung from another cell phone for duration of three minutes each, every half an hour, with the first exposure given at 12th hour of incubation (4.30 am-4.30 pm). The total exposure for a 12 hour period was 75 minutes followed by 12 hour of exposure-free period. This was repeated daily up to 12th day of incubation.

From our experimental outcome, we conclude that the chronic exposure of chick embryo liver to RFR emitted from 2G and 3G cell phone resulted in various structural changes and DNA damage. The changes were more pronounced in 3G experimental group. Many researchers now opine that cell phones may turn out to be the cigarettes of 21st century as their effects or interactions with biological tissues on long term exposure are yet to be explored especially in foetuses and children. Hence, children and pregnant women should use the cell phone with caution. Introduction of new generation phones, 4G and 5G, open a vast potential for future research and whether these changes observed due to RFR exposure are reversible or not on withdrawing the exposure is another arena which warrants further research.

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Effects of Combined Exposure to Microwave and Heat on Gene Expression and Sperm Parameters in Mice

Gohari FA, Saranjam B, Asgari M, Omidi L, Ekrami H, Moussavi-Najarkola SA.An Experimental Study of the Effects of Combined Exposure to Microwave and Heat on Gene Expression and Sperm Parameters in Mice. J Hum Reprod Sci. 2017 Apr-Jun;10(2):128-134. doi: 10.4103/jhrs.JHRS_136_16.

Abstract

OBJECTIVES: Separate exposure to microwaves (MWs) or heat had effects on expression levels of Bax and Bcl-2 and sperm parameters in studied group.

AIMS: The objectives of this research were to determine the effects of separate and combined exposure to 900-MHz MW (as representative of cell phone radiation) and heat on gene expression and spermogram of male mice.

SETTINGS AND DESIGN: This experimental animal study was conducted in the school of public health.

MATERIALS AND METHODS: The study was done on 12 male mice randomly divided into four groups (21-23 g): control, test group 1 with separate exposure to 900-MHz MW, test group 2 with separate exposure to hot and sultry climate, and test group 3 with simultaneous whole body exposures to 900-MHz MW and hot and sultry climate. In all studied groups, gene expression and sperm parameters were measured.

RESULTS: Tissue samples in all test groups showed integrity of the seminiferous tubule followed by all types of germ line cells. Significant increases in the number of dead sperms in mice with separate exposure to heat were observed in comparison with the other studied groups ($P < 0.05$). The ratio of Bax expression was elevated to 0.015 ± 0.006 in mice after combined exposures to 900-MHz MW and heat.

CONCLUSION: Separate and combined exposure to 900-MHz MW and heat may induce adverse effects on sperm parameters and gene expression of studied male mice.

https://www.ncbi.nlm.nih.gov/pubmed/28904503

Note: limited statistical power -- 12 mice randomly divided into 4 groups

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Residential magnetic fields exposure and childhood leukemia: a population-based case-control study in California

Kheifets L, Crespi CM, Hooper C, Cockburn M, Amoon AT, Vergara XP. Residential magnetic fields exposure and childhood leukemia: a population-based case-control study in California. Cancer Causes Control. 2017 Sep 12. doi: 10.1007/s10552-017-0951-6. [Epub ahead of print]

Abstract

PURPOSE: Studies have reported an increased risk of childhood leukemia associated with exposure to magnetic fields. We conducted a large records-based case-control study of childhood leukemia risk and exposure to magnetic fields from power lines in California.

METHODS: The study included 5,788 childhood leukemia cases (born in and diagnosed in California 1986-2008) matched to population-based controls on age and sex. We calculated magnetic fields at birth addresses using geographic information systems, aerial imagery, historical information on load and phasing, and site visits.

RESULTS: Based on unconditional logistic regression controlling for age, sex, race/ethnicity, and

socioeconomic status using subjects geocoded to a basic standard of accuracy, we report a slight risk deficit in two intermediate exposure groups and a small excess risk in the highest exposure group (odds ratio of 1.50 (95% confidence interval [0.70, 3.23])). Subgroup and sensitivity analyses as well as matched analyses gave similar results. All estimates had wide confidence intervals.

CONCLUSION: Our large, statewide, record-based case-control study of childhood leukemia in California does not in itself provide clear evidence of risk associated with greater exposure to magnetic fields from power lines, but could be viewed as consistent with previous findings of increased risk.

https://www.ncbi.nlm.nih.gov/pubmed/28900736

Excerpts

Over 35 epidemiologic studies have investigated the association of childhood leukemia with residential low-frequency magnetic fields or physical surrogates of magnetic fields [1]. Three pooled analyses have found an increased risk of childhood leukemia for relatively high estimated residential magnetic field exposure [2, 3, 4]. The consistent association found between childhood leukemia and average magnetic field exposure above 0.3–0.4 μT could be due to chance, selection bias, misclassification, other factors which confound the association, or true causal relationship. As explanation for both individual results and pooled efforts is lacking, selection bias seems as the most likely explanation, but uncertainty remains and other explanations outlined above are possible. This study aims to address this uncertainty by minimizing bias, misclassification, and chance.

The California Power Line Study is funded by the Electric Power Research Institute.

The authors declare no conflicts of interest.

[The estimates of leukemia risk for 0.4 or greater microTesla exposure ranged from 1.48 - 1.55 (all p-values > .25). There were only 17 cases and 11 controls in this subgroup so the study has limited statistical power.]

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Power frequency magnetic field promotes a more malignant phenotype in neuroblastoma cells via redox-related mechanisms

Falone S, Santini S Jr, Cordone V, Cesare P, Bonfigli A, Grannonico M, Di Emidio G, Tatone C, Cacchio M, Amicarelli F. Power frequency magnetic field promotes a more malignant phenotype in neuroblastoma cells via redox-related mechanisms.Sci Rep. 2017 Sep 13;7(1):11470. doi: 10.1038/s41598-017-11869-8.

Abstract

In accordance with the classification of the International Agency for Research on Cancer, extremely low frequency magnetic fields (ELF-MF) are suspected to promote malignant progression by providing survival advantage to cancer cells through the activation of critical cytoprotective pathways. Among these, the major antioxidative and detoxification defence systems might be targeted by ELF-MF by conferring cells significant resistance against clinically-relevant cytotoxic agents. We investigated whether the hyperproliferation that is induced in SH-SY5Y human neuroblastoma cells by a 50 Hz, 1 mT ELF magnetic field was supported by improved defence towards reactive oxygen species (ROS) and xenobiotics, as well as by reduced vulnerability against both H2O2 and anti-tumor ROS-generating drug doxorubicin. ELF-MF induced a proliferative and survival advantage by activating key redox-responsive antioxidative and detoxification cytoprotective pathways that are associated with a more aggressive behavior of neuroblastoma cells. This was coupled with the upregulation of the major sirtuins, as well as with increased signaling activity of the erythroid 2-related nuclear transcription factor 2 (NRF2). Interestingly, we also showed that the exposure to 50 Hz MF as low as 100 μT may still be able to alter behavior and responses of cancer cells to clinically-relevant drugs.

https://www.ncbi.nlm.nih.gov/pubmed/28904402

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Modified health effects of non-ionizing EMR combined with other agents reported in the biomedical literature

Kostoff RN, Lau CGY. Modified health effects of non-ionizing electromagnetic radiation combined with other agents reported in the biomedical literature. In C.D. Geddes (ed.), Microwave Effects on DNA and Proteins. Switzerland: Springer, pp. 97-158.DOI 10.1007/978-3-319-50289-2. 2017.

Abstract

Ionizing and non-ionizing electromagnetic field (EMF) radiation, either stand-alone or in combination with other agents, exert health effects on biological systems. The present chapter examines the scope of non-ionizing EMF radiation combined effects; i.e., identifies effects on biological systems from combined exposure to non-ionizing electromagnetic fields/radiation and at least one other agent. Only articles in which the presence of non-ionizing EMF radiation had some effect (beneficial or adverse) on the biological system were selected. A comprehensive and novel query was developed using an iterative hybrid approach, whereby articles related by common text and by citation linkages were retrieved. This retrieved literature was: (1) clustered algorithmically into 32 biomedical sub-themes (assigned by the authors); (2) grouped through factor analysis into 32 factors; and (3) subsequently grouped manually (by the authors) into an effects-based taxonomy. The common principles within each thematic cluster/group that accounted for the combined effects were identified. Non-ionizing EMF radiation plays a supportive role in a wide range of beneficial and adverse effects. Major beneficial effects include (1) accelerated healing of wounds and injuries in concert with other agents and (2) treatment of cancer by combining chemotherapy with radiation. Major adverse effects, on the other hand, include (1) enhanced carcinogenesis, (2) enhanced cellular or genetic mutations, and (3) teratogenicity. It should be noted that community consensus (unanimity among papers published in peer-reviewed journals) does not exist on these potential effects, either beneficial or adverse, although there is substantial credible scientific evidence supporting the above effects (as described in this chapter).

Open access chapter: http://stip.gatech.edu/wp-content/uploads/2017/03/371048_1_En_4_Chapter_OnlinePDF.pdf

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Multiple sclerosis and environmental risk factors: a case-control study in Iran

Abbasi M, Nabavi SM, Fereshtehnejad SM, Jou NZ, Ansari I, Shayegannejad V, Mohammadianinejad SE, Farhoudi M, Noorian A, Razazian N, Abedini M, Faraji F. Multiple sclerosis and environmental risk factors: a case-control study in Iran. Neurol Sci. 2017 Aug 10. doi: 10.1007/s10072-017-3080-9.

Abstract

Studies have shown an increase in the incidence of MS in Iran. The aim of our study was to evaluate the relationship between environmental exposure and MS in Iran. This case-control study was conducted on 660 MS patients and 421 controls. Many environmental factors are compared between the two groups. Our findings demonstrated that prematurity ([OR = 4.99 (95% CI 1.34-18.68), P = 0.017]), history of measles and mumps

([OR = 1.60 (95% CI 1.05-2.45), P = 0.029; OR = 1.85 (95% CI 1.22-2.78), P = 0.003, respectively]), breast feeding [OR = 2.90 (95% CI 1.49-5.65), P = 0.002], head trauma in childhood ([OR = 8.21 (95% CI 1.56-43.06), P = 0.013]), vaccination in adulthood ([OR = 4.57 (95% CI 1.14-18.41), P = 0.032, respectively]), migraine ([OR = 3.50 (95% CI 1.61-7.59), P = 0.002]), family history of MS, IBD, migraine, and collagen vascular diseases ([OR = 2.73 (95% CI 1.56-4.78), P < 0.001], [OR = 3.14 (95% CI 1.460-6.78), P = 0.004; OR = 3.18 (95% CI 1.83-5.53), P < 0.001; OR = 1.81 (95% CI 1.03-3.20), P = 0.040, respectively]), stressful events ([OR = 32.57 (95% CI 17.21-61.64), P < 0.001]), and **microwave exposure ([OR = 3.55 (95% CI 2.24-5.63)**, P ≤0.001]) were more in the MS group. Sun exposure ([OR = 0.09 (95% CI 0.02-0.38), P = 0.001]), dairy and calcium consumption ([OR = 0.44 (95% CI 0.27-0.71), P = 0.001]), diabetes mellitus ([OR = 0.11 (95% CI 0.01-00.99), P = 0.049], and complete vaccination during childhood appeared to decreased MS risk. Our results investigated many risk factors and protective factors in Iran.

https://www.ncbi.nlm.nih.gov/pubmed/28799006

Excerpts

[44.3% of the MS cases used a microwave oven more than 3 times a week compared to 19.9% of the controls (adjusted OR = 3.55, 95% CI= 2.24 - 5.63)].

Conclusions
It seems that the increase in MS prevalence is due to environmental factors. As a result of disability and high cost, prevention of environmental risk factors is important. The result demonstrated that the most modifiable risk factors in Iranian population were stressful event and microwave exposure. Also, the most protective modifiable factors were sun exposure and calcium supplement consumption. However, more studies are required to evaluate the potential risk factors in a geographical area such as Iran with increasing prevalence in MS.

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Human exposure to pulsed fields in the frequency range from 6 to 100 GHz

Laakso I, Morimoto R, Heinonen J, Jokela K, Hirata A. Human exposure to pulsed fields in the frequency range from 6 to 100 GHz. Phys Med Biol. 2017 Aug 9;62(17):6980-6992. doi: 10.1088/1361-6560/aa81fe.

Abstract

Restrictions on human exposure to electromagnetic waves at frequencies higher than 3-10 GHz are defined in terms of the incident power density to prevent excessive temperature rise in superficial tissue. However, international standards and guidelines differ in their definitions of how the power density is interpreted for brief exposures. This study investigated how the temperature rise was affected by exposure duration at frequencies higher than 6 GHz. Far-field exposure of the human face to pulses shorter than 10 s at frequencies from 6 to 100 GHz was modelled using the finite-difference time-domain method. The bioheat transfer equation was used for thermal modelling. We investigated the effects of frequency, polarization, exposure duration, and depth below the skin surface on the temperature rise. The results indicated limitations in the current human exposure guidelines and showed that radiant exposure, i.e. energy absorption per unit area, can be used to limit temperature rise for pulsed exposure. The data are useful for the development of human exposure guidelines at frequencies higher than 6 GHz.

https://www.ncbi.nlm.nih.gov/pubmed/28791963

Excerpts

Figure 2 shows that the hotspot locations depend on the frequency and polarization and often appear in and around fine structures such as the eyelids. However, they can also appear in other locations, most notably in

the eyes and cheeks. Future studies should investigate the differences in the absorption pattern and temperature rise in multiple anatomically different individuals. The investigation should also take into account the extent of opening between the eyelids,

.. our results showed that relatively long exposure averaging times used in current ICNIRP guidelines may not provide adequate protection in the case of brief, intense pulsed exposure (figure 4). An additional limit defined for the maximum radiant exposure could provide protection from short pulse exposure. It is important to note that the effect of exposure duration diminishes as the frequency decreases (figure 5). Therefore, separate consideration for pulsed exposure is relevant only at frequencies higher than 10 GHz.

In conclusion, this study addressed the issue of pulsed exposure, which is currently treated differently in different international guidelines and standards. The results showed the effects of non-uniform energy absorption, exposure duration, and frequency on the temperature rise, and are useful for the development of human exposure guidelines at frequencies higher than 6 GHz.

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Assessment of fetal exposure to 4G LTE tablet in realistic scenarios: Effect of position, gestational age and frequency

Chiaramello E, Parazzini M, Fiocchi S, Ravazzani P, Wiart J. Assessment of fetal exposure to 4G LTE tablet in realistic scenarios: Effect of position, gestational age and frequency. IEEE Journal of Electromagnetics, RF and Microwaves in Medicine and Biology. PP:90. 2017.

Abstract

The continuous development of Radio-Frequency (RF) devices used in every-day life highlights the need of conducting appropriate health risk assessment due to Radio- Frequency Electromagnetic Fields (RF-EMF) exposure, especially for the fetal exposure in realistic scenarios. In this study, we used stochastic dosimetry, an approach that combines electromagnetic computational techniques and statistics, to assess the fetal exposure to a 4G LTE tablet in realistic scenarios, assessing the influence of the position of the tablet, the gestational age of the fetus and the frequency of the emitting antenna. Results showed that the exposure in terms of Specific Absorption Rate (SAR) was within the limits of the ICNIRP 1998 general public Guidelines in all the considered scenarios. The position of the tablet was very influential for the induced SAR in the fetus, resulting in Quartile Coefficient of Dispersion always higher than 40%. The level of exposure for the later pregnancy was found to be higher than those for the early pregnancy. As to the effect of the emitting frequency of the tablet, we found that the higher the frequency, the lower the induced SAR in the fetus.

http://ieeexplore.ieee.org/document/8000304/

Excerpt

Fig.2 shows, as example, some preliminary results referred to the exposure of the 9-months GA fetus to the 4G LTE tablet in a generic position among those described in Fig.1. All the reported SAR values have been normalized to a radiated power equal to 1 W. In this specific position, among all fetal tissues, adrenal gland, gallbladder and kidney showed SARWT values slightly higher than 5 mW/kg. Considering the pSAR1gT values, among all tissues skin, small intestine, muscle and kidney showed values higher than 10 mW/kg (with maximum of 22 mW/kg in the skin tissue).

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Nature relatedness is connected with modern health worries and electromagnetic hypersensitivity

Dömötör Z, Szemerszky R, Köteles F. Nature relatedness is connected with modern health worries and

electromagnetic hypersensitivity. J Health Psychol. 2017 Mar 1:1359105317699681. doi: 10.1177/1359105317699681.

Abstract

Although nature relatedness is considered a positive characteristic, its relationship to constructs involving worries about the negative effects of artificial environmental factors is also feasible. A questionnaire assessing modern health worries, electrosensitivity, somatosensory amplification, spirituality, and nature relatedness was completed by 510 individuals. Nature relatedness was related to electrosensitivity, modern health worries, and spirituality. In a binary logistic regression analysis, somatosensory amplification, modern health worries, and nature relatedness were associated with electrosensitivity, and nature relatedness moderated the connection between modern health worries and electrosensitivity. In naive representations, "natural" might be associated with health, whereas "modern" and "artificial" evoke negative associations.

https://www.ncbi.nlm.nih.gov/pubmed/28810440

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Thermal mapping on male genital and skin tissues of laptop thermal sources and electromagnetic interaction

Safari M, Mosleminiya N, Abdolali A. Thermal mapping on male genital and skin tissues of laptop thermal sources and electromagnetic interaction. Bioelectromagnetics. 2017 Aug 11. doi: 10.1002/bem.22068.
Abstract

Since the development of communication devices and expansion of their applications, there have been concerns about their harmful health effects. The main aim of this study was to investigate laptop thermal effects caused by exposure to electromagnetic fields and thermal sources simultaneously; propose a nondestructive, replicable process that is less expensive than clinical measurements; and to study the effects of positioning any new device near the human body in steady state conditions to ensure safety by U.S. and European standard thresholds. A computer simulation was designed to obtain laptop heat flux from SolidWorks flow simulation. Increase in body temperature due to heat flux was calculated, and antenna radiation was calculated using Computer Simulation Technology (CST) Microwave Studio software. Steady state temperature and specific absorption rate (SAR) distribution in user's body, and heat flux beneath the laptop, were obtained from simulations. The laptop in its high performance mode caused 420 (W/m2) peak two-dimensional heat flux beneath it. The cumulative effect of laptop in high performance mode and 1 W antenna radiation resulted in temperatures of 42.9, 38.1, and 37.2 °C in lap skin, scrotum, and testis, that is, 5.6, 2.1, and 1.4 °C increase in temperature, respectively. Also, 1 W antenna radiation caused 0.37 × 10-3 and 0.13 × 10-1.

https://www.ncbi.nlm.nih.gov/pubmed/28799651

Excerpts

Findlay and Dimbylow [2010] carried out one such study on SAR in the body of a sitting 10-year-old at 2.4 and 5 GHz. They found maximum peak localized three-dimensional (3D) SAR of 3.99 × 10−3 (W/kg) in the torso area.

It should be specified that this study only considered thermal effects on men; however, laptop antenna could have non-thermal effects on the user's body or pregnant women, including DNA fraction [Nagaoka et al., 2007; Zoppetti et al., 2011; Avendano et al., 2012], but such non-thermal effects are not considered in the present paper.

Since maximum allowed power consumption for an array of antennas designed for this purpose is 1 W and

there were two antennas, each one consumed up to 0.5 W of power. However, in normal conditions, Wireless Local Area Network (WLAN) antennas can radiate using only 10 mW [Guterman et al., 2009].

It should be noted that the given values of SAR were normalized to 1 W peak antenna power output, while typically a WLAN antenna radiates about 10 mW; therefore, for a real world operating system, maximum SAR of 0.37×10^{-3} and 0.18×10^{-3} (W/kg) is expected for 2 and 1 active antennas, respectively, which are 10^4 times lower than the European safety limit (2 W/kg) [IEEE Standard for Safety Levels with Respect to Humans, 2005].

Also, maximum SAR of 0.13×10^{-3} (W/kg) is expected for a WLAN antenna radiation power of about 10 mW operating at 5 GHz, which is still lower than safety limits.

... maximum temperature on surface of scrotum skin of the laptop user in the studied position was 38.1 °C, which was 2.1 °C higher than normal temperature in absence of the laptop in the simulation.

It can be inferred from the aforementioned works that increase in scrotal temperature can result in reduction of sperm motility, which consequently enhances the probability of infertility, lessens sperm production, decreases sperm concentration by 56% [Hjollund et al., 2002], increases ROS, and negatively affects sperm morphology, increasing the number of sperm with physical dimensions different from those of normal sperm.

A method of simulating thermal mapping of positioning laptop on laps of an adult man was developed. To tackle this problem, we exploited computer simulation and, to make the simulation close to the actual problem, we created 3D models of an actual laptop (Sony FW 590 Gab), antennas, and human phantom with inhomogeneous body, large number of tissues, and dispersion properties. We employed a commercial laptop Wi-Fi antenna at 2.4 GHz and a dipole antenna at 5 GHz, thermal sources with radiation powers, and human body voxel consisting of 97 tissues which were described previously. In the simulation, maximum SAR in human body was calculated 0.37×10^{-3} and 0.13×10^{-1} (W/kg) at 2.4 and 5 GHz, respectively, which was negligible according to IEEE standards; thus, the major calculated temperature elevation was due to laptop thermal sources. The temperature in glans penis, lap skin, lap muscles, and testes increased up to 37.8, 42.9, 38.8, and 37.2 °C, respectively, which was in line with clinical studies of thermal effect. Hence, the proposed method can be replicated for other scenarios. It is worth noting that the presented result cannot be easily generalized to other devices or human models. However, the whole method is replicable for similar phenomena. The recommended subject for future works can be used with the presented method for determining the effect of laptop and other devices on adult pregnant women and similar cases.

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Comparative analysis of downlink signal levels emitted by GSM 900, GSM 1800, UMTS, and LTE base stations

Ibrani M, Hamiti E, Ahma L, Halili R, Dragusha B. Comparative analysis of downlink signal levels emitted by GSM 900, GSM 1800, UMTS, and LTE base stations. Ad Hoc Networking Workshop (Med-Hoc-Net), 2017 16th Annual Mediterranean.28-30 June 2017.

Abstract

Determination of exposure levels is considered as one of the parameters of planning and optimization of green cellular networks. While moving towards 5G technology and standardization, the results of comparative exposure levels induced by 2G, 3G and 4G networks are of interest. We present the results of in-situ determination of downlink signal levels [jn Kosovo] emitted by GSM 900, GSM 1800, UMTS, and LTE networks in urban areas. The measurements are conducted with calibrated spectrum analyzer NARDA SRM 3006 at outdoor and indoor spots, including LOS and NLOS positions. The highest measured value is 2.82 V/m registered in outdoor LOS position for GSM 900. The results of comparative research highlight GSM 900 as the biggest contributor to the overall cellular systems downlink signal level, followed with UMTS, GSM 1800

and LTE. Obtained results are compared with the ICNIRP reference levels as well as with downlink signal levels emitted by cellular systems in other countries.

http://ieeexplore.ieee.org/document/8001655/

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Cancer occurrences in laboratory rats from exposure to RF and microwave radiation

Lin JC. Cancer Occurrences in Laboratory Rats from Exposure to RF and Microwave Radiation. IEEE Journal of Electromagnetics, RF and Microwaves in Medicine and Biology. Aug 2, 2017. PP:99.

Health effects of radio frequency (RF) and microwave radiation have been a subject of scientific inquiry and public interest of late because of widespread global usage of mobile communication devices by billions of people everywhere. A minute increase in health risks such as cancer from RF radiation might lead to significant consequences for health of the general public. A recent U.S. government announcement of discovery of rare cancers in rats exposed to RF radiation is an important occurrence. Note that any new or single report should not be viewed in isolation. The U.S. government project was organized to confront the weaknesses of prior laboratory rodent studies on the potential of RF exposure to impact human health such as cancer in controlled environments. Indeed, several published reports on animal cancer investigations involving prolonged exposures to RF radiation are contentious and perplexing. The discrepancies have presented ambiguity in assessing public health threats from RF exposure. It is the objective of this review to provide a critical and analytical synopsis and assessment on current progress in cancers in rats exposed, lifelong, to RF and microwave radiation. Its focus is on laboratory studies involving cancer production and promotion, and survival of experimental rats. Of special interest is carcinogenesis in the head—cancer development in the head. The question of whether RF exposure from wireless and mobile devices and systems poses a health risk would likely remain equivocal and controversial for some time to come.

http://ieeexplore.ieee.org/document/8000308/

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Mobile phone (1800MHz) radiation impairs female reproduction in mice through stress induced inhibition of ovarian & uterine activity

Shahin S, Singh SP, Chaturvedi CM. Mobile Phone (1800MHz) Radiation Impairs Female Reproduction in Mice, Mus musculus, through Stress Induced Inhibition of Ovarian and Uterine Activity. Reprod Toxicol. 2017 Aug 2. pii: S0890-6238(17)30167-3. doi: 10.1016/j.reprotox.2017.08.001. [Epub ahead of print]

Highlights

• Mice exposed to mobile phone radiation (MPR) in different operative modes.
• Ovarian & uterine histopathology, steroidogenesis & stress parameters were checked.
• Degenerative changes & reduced follicle count were observed in MPR exposed ovary.
• MPR resulted significant decrease in ovarian steroidogenic proteins & sex steroids.
• MPR induced oxidative & nitrosative stress impairs reproductive functions in mice.

Abstract

Present study investigated the long-term effects of mobile phone (1800MHz) radiation in stand-by, dialing and receiving modes on the female reproductive function (ovarian and uterine histo-architecture, and steroidogenesis) and stress responses (oxidative and nitrosative stress). We observed that mobile phone radiation induces significant elevation in ROS, NO, lipid peroxidation, total carbonyl content and serum

corticosterone coupled with significant decrease in antioxidant enzymes in hypothalamus, ovary and uterus of mice. Compared to control group, exposed mice exhibited reduced number of developing and mature follicles as well as corpus lutea. Significantly decreased serum levels of pituitary gonadotrophins (LH, FSH), sex steroids (E2 and P4) and expression of SF-1, StAR, P-450scc, 3β-HSD, 17β-HSD, cytochrome P-450 aromatase, ER-α and ER-β were observed in all the exposed groups of mice, compared to control. These findings suggest that mobile phone radiation induces oxidative and nitrosative stress, which affects the reproductive performance of female mice.

https://www.ncbi.nlm.nih.gov/pubmed/28780396

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The effects of electromagnetic radiation (2450 MHz wireless devices) on the heart and blood tissue: role of melatonin

Gumral N, Saygin M, Asci H, Uguz AC, Celik O, Doguc DK, Savas HB, Comlekci S.The effects of electromagnetic radiation (2450 MHz wireless devices) on the heart and blood tissue: role of melatonin. Bratisl Lek Listy. 2016;117(11):665-671. doi: 10.4149/BLL_2016_128.

Abstract

OBJECTIVE: This study was designed to investigate the effects of 2450 MHz EMR on the heart and blood in rat and possible ameliorating effects of melatonin.

MATERIAL AND METHOD: Thirty-two female Wistar Albino rats were randomly grouped (by eight in each group) as follows: Group I: cage-control group (dimethysulfoxide (DMSO), 10mg/kg/day i.p. without stress and EMR. Group II: sham-control rats stayed in restrainer without EMR and DMSO (10mg/kg/day i.p.). Group III: rats exposed to 2450 MHz EMR. Group IV: treated group rats exposed to 2450 MHz EMR+melatonin (MLT) (10mg/kg/day i.p.).

RESULTS: In the blood tissue, there was no significant difference between the groups in respect of erythrocytes GSH, GSH-Px activity, plasma LP level and vitamin A concentration ($p > 0.05$). However, in the Group IV, erythrocytes' LP levels ($p < 0.05$) were observed to be significantly decreased while plasma vitamin C, and vitamin E concentrations ($p < 0.05$) were found to be increased when compared to Group III. In the heart tissues, MDA and NO levels significantly increased in group III compared with groups I and II ($p < 0.05$). Contrary to these oxidant levels, CAT and SOD enzyme activities decreased significantly in group III compared with groups I and II (p 0.05). Besides, MLT treatment lowered the MDA and NO levels compared with group III.

DISCUSSION: In conclusion, these results demonstrated that contrary to its effect on the heart, the wireless (2450 MHz) devices cause slight oxidative-antioxidative changes in the blood of rats, and a moderate melatonin supplementation may play an important role in the antioxidant system (plasma vitamin C and vitamin E). However, further investigations are required to clarify the mechanism of action of the applied 2450 MHz EMR exposure (Tab. 3, Fig. 1, Ref. 49).

https://www.ncbi.nlm.nih.gov/pubmed/28125893

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Effect of 2G and 3G cell phone radiation on developing liver of chick embryo – A comparative study

Mary Hydrina D'Silva MH, Swer RT, Anbalagan J, Rajesh B. Effect of Radiofrequency Radiation Emitted from 2G and 3G Cell Phone on Developing Liver of Chick Embryo – A Comparative Study. J Clinical Diagnostic Research. 11(7):AC05-AC09. Jul 2017

Introduction: The increasing scientific evidence of various health hazards on exposure of Radiofrequency Radiation (RFR) emitted from both the cell phones and base stations have caused significant media attention and public discussion in recent years. The mechanism of interaction of RF fields with developing tissues of children and fetuses may be different from that of adults due to their smaller physical size and variation in tissue electromagnetic properties. The present study may provide an insight into the basic mechanisms by which RF fields interact with developing tissues in an embryo.

Aim: To evaluate the possible tissue and DNA damage in developing liver of chick embryo following chronic exposure to ultra-high frequency/radiofrequency radiation (UHF/RFR) emitted from 2G and 3G cell phone.

Materials and Methods: Fertilized chick embryos were incubated in four groups. Group A-experimental group exposed to 2G radiation (60 eggs), Group B- experimental group exposed to 3G radiation (60 eggs), Group C-sham exposed control group (60 eggs) and Group D– control group (48 eggs). On completion of scheduled duration, the embryos were collected and processed for routine histological studies to check structural changes in liver. The nuclear diameter and karyorrhexic changes of hepatocytes were analysed using oculometer and square reticule respectively. The liver procured from one batch of eggs from all the four groups was subjected to alkaline comet assay technique to assess DNA damage. The results were compared using one-way ANOVA test.

Results: In our study, the exposure of developing chick embryos to 2G and 3G cell phone radiations caused structural changes in liver in the form of dilated sinusoidal spaces with haemorrhage, increased vacuolations in cytoplasm, increased nuclear diameter and karyorrhexis and significantly increased DNA damage.

Conclusion: The chronic exposure of chick embryo liver to RFR emitted from 2G and 3G cell phone resulted in various structural changes and DNA damage. The changes were more pronounced in 3G experimental group. Based on these findings it is necessary to create awareness among public about the possible ill effects of RFR exposure from cell phone.

http://www.jcdr.net/article_abstract.asp?issn=0973-709x&year=2017&month=July&volume=11&issue=7&page=AC05-AC09&id=10275

Excerpts

The experimental group, Group–A (exposed to 2G cell phone radiation) and Group–B (exposed to 3G cell phone radiation), were also incubated (60+60 eggs) in a similar manner with the cell phone kept in silent operative mode with head phone plugged in (switched on). This arrangement ensured that the cell phone got activated automatically each time it received a call ...

A popular brand cell phone hand set and a service provider were used for network connection for both 2G and 3G exposure. For exposure activation, the cell phone was rung from another cell phone for duration of three minutes each, every half an hour, with the first exposure given at 12th hour of incubation (4.30 am-4.30 pm). The total exposure for a 12 hour period was 75 minutes followed by 12 hour of exposure-free period. This was repeated daily up to 12th day of incubation.

From our experimental outcome, we conclude that the chronic exposure of chick embryo liver to RFR emitted from 2G and 3G cell phone resulted in various structural changes and DNA damage. The changes were more pronounced in 3G experimental group. Many researchers now opine that cell phones may turn out to be the cigarettes of 21st century as their effects or interactions with biological tissues on long term exposure are yet to be explored especially in foetuses and children. Hence children and pregnant women should use the cell phone with caution. Introduction of new generation phones, 4G and 5G, open a vast potential for future research and whether these changes observed due to RFR exposure are reversible or not on withdrawing the exposure is another arena which warrants further research.

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Disturbing honeybees' behavior with EMF: a methodology

Danial Favre. Disturbing honeybees' behavior with electromagnetic waves: A methodology.J Behav 2(2): 1010 (2017).

Abstract

Mobile phone companies and policy makers point to studies with contradictory results and usually claim that there is a lack of scientific proof of adverse effects of electromagnetic fields on animals. The present perspective article describes an experiment on bees, which clearly shows the adverse effects of electromagnetic fields on these insects' behavior. The experiment should be reproduced by other researchers so that the danger of man-made electromagnetism (for bees, nature and thus humans) ultimately appears evident to anyone.

https://www.jscimedcentral.com/Behavior/behavior-2-1010.php

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Effect of DECT cordless phone radiation on exposed, laboratory cultivated maize plants

Stefia AL, Margaritis LH, Christodoulakis NS. The effect of the non-ionizing radiation on exposed, laboratory cultivated maize (Zea mays L.) plants. Flora. 223: 23-20. Aug 2017. https://doi.org/10.1016/j.flora.2017.05.008

Highlights

• Young corn plants exposed to long term radiation from a DECT base-unit.
• No biomass reduction was observed for the exposed plants, after two weeks.
• Photosynthetic pigment content seems unaltered.
• After two weeks, mesophyll chloroplast structure seems not to be affected.
• Bundle sheath chloroplasts severely affected, apprehending repression of a major advantage.

Abstract

A series of experiments was carried out to investigate possible structural or biochemical effects on young *Zea mays* plants after a long-term exposure to non-ionizing, continuous radiation emitted from the base unit of a cordless DECT system. Exposed plants, compared to their normal counterparts, do not seem to be affected concerning their sprouting potential, biomass production for both the above ground part and the root, leaf structure, photosynthetic pigment content and their absorbance. The structural profile of the exposed plants seems almost identical to those of the control ones. Biomass production, photosynthetic pigments, leaf structure and chloroplast arrangement do not differ in exposed plants. What seems to be affected is the structure of the chloroplasts accommodated in the bundle sheath cells of the exposed leaves. They suffer a slight swelling of their thylakoids and an undulation of some of the thylakoid membranes. Scarcely a disruption of chloroplast envelope can be observed.

http://www.sciencedirect.com/science/article/pii/S0367253017332176

Excerpts

In the middle of one of the two cages, the base unit of a DECT telephone apparatus (General, Model 123) was appropriately positioned (Fig. 2). The DECT base was in a 24 h a day, 7 days a week, pulsed transmission mode, at 1882 MHz, as described elsewhere (Margaritis et al., 2014) while the light/dark programme of the

chamber was adjusted to a 16/8 cycle (Stefi et al., 2016, 2017).

Radiation was measured in the two cages, while the DECT device was transmitting within one of them, with a NARDA SRM3000 (Germany) spectrum analyzer. The corresponding electrical field intensity (average and peak), in each experimental setup, was measured for a 6-min period according to ICNIRP (1998) guidelines as in Table 1. Supplementary, low precision measurements were made in the control cage with a broadband field meter (TES-92, 50 MHz–3.5 GHz, Electromagnetic radiation detector – TES Electrical Electronic Corp. Taipei, Taiwan, R.O.C.) at the value of 490.1 mV/m. In the nearby cage (exposed), radiation reached the value of 27.46 V/m (27.460 mV/m, at 1882 MHz) (55 fold higher).

Concluding, we could say that non-ionizing radiation emitted from devices of everyday use such as mobile phones, DECT phones, tablets, Wi-Fi routers etc, can by no means be considered as “innocent”. Our current results, recent papers for the effects on Arabidopsis thaliana and Gossypium hirsutum (Stefi et al., 2016, 2017), numerous reports from epidemiological researches correlating exposure and clinical disorders such as sleep disorders on children that use mobile phone before sleep (Van den Bulck 2007), promotion of lymphomas and leukemias in adults and children (Hardell et al., 2014) are serious reasons for further consideration.

Moreover, the effects of non-ionizing electromagnetic radiation on behavior (Divan et al., 2012), cardiovascular system (Celik and Hascalik 2004), reproduction and development (Margaritis et al., 2014), oxidative stress induction (Esmekaya et al., 2011; Manta et al., 2014), memory deficits (Fragopoulou et al., 2010, Ntzouni et al., 2011) and cancer provocation (Hardell and Carlberg 2009), strongly support the aspect that the problem is far more than serious and public anxiety seems justified.

Taking in to account that:

• The function of the C_4 chloroplasts is uniquely associated with the function of stomata (Ghannoum, 2008).
• Stomata of *Z. mays* are of the dumbbell – shape type. This type of stomata appears only in Graminae and is unique in structure and function.
• The total yield in our experiments was almost similar for both control and exposed plants.
• The photosynthetic pigment content, as measured with the UV/Vis Specol photometer, was more or less similar in both control and exposed plants.
• Taking into consideration that maize plants are fully mature and pistillate female flowers appear after about two months while corns are harvested three months after sprouting,
We may conclude that the differences between control and exposed plants are negligible in spite of the significant structural deformations of the agranal BSC chloroplasts. Moreover, stomatal function seems not to be affected and photosynthesis (even the C_4) not to be disturbed by radiation, until this stage of the plant’s life. Finally, we may point out that the deformations observed in the chloroplasts may affect the mature plant by suspending the great advantage of the C_4 photosynthesis.

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Effect of DECT cordless phone radiation on exposed, laboratory cultivated upland cotton plants

Stefi AL, Margaritis LH, Christodoulakis NS. The effect of the non ionizing radiation on exposed, laboratory cultivated upland cotton (Gossypium hirsutum L.) plants. Flora: Morphology, Distribution, Functional Ecology of Plants [Internet]. 2017;226:55 - 64.

Abstract

A series of experiments was carried out to investigate possible structural or biochemical alterations in Gossypium hirsutum plants after a long term (21 days) exposure to non ionizing radiation (1882 MHz) emitted from the base unit of a cordless DECT system. Exposed plants, compared to the negative (matched) controls, seem to be seriously affected. Notably lower biomass production for the above ground part and the root was

recorded. Reduction of the photosynthetic pigments and severe damage of the chloroplast structure were also observed. It seems that non ionizing radiation can be noxious for plant life functions.

https://www.scopus.com/record/display.uri?eid=2-s2.0-84997817372&doi=10.1016%2fj.flora.2016.11.009&origin=inward&txGid=2a0c5f11e55ffcd3b656cd415c1041ac

Excerpt

[same exposure setup as the maize study]

The effect of the non-ionizing radiation at the microwave band, on the Gossypium hirsutum young plants, after a long termexposure, can be considered as significant. The disastrous effect on chloroplast structure, the reduction of the photosynthetic pigments and the suppression of the photosynthetic potential, are the main causes for the significant reduction of the primary productivity. Moreover, a serious effect on the underground part of the plant was recorded but this cannot be evaluated yet.

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The aftermath of long-term exposure to non-ionizing radiation on laboratory cultivated pine plants

Stefi AL, Margaritis LH, Christodoulakis NS. The aftermath of long-term exposure to non-ionizing radiation on laboratory cultivated pine plants (Pinus halepensis M.). Flora. 234: 173-186. September 2017. https://doi.org/10.1016/j.flora.2017.07.016

Highlights

• Young pine plants exposed to long term radiation from a DECT base-unit.
• Significant biomass reduction was observed for the exposed plants, after seven weeks.
• Photosynthetic pigment content decreased in the exposed leaves.
• Cotyledon, leaf, stem and root structure seem unaffected.
• Many mesophyll cells severely affected with extensive damages to their chloroplasts.

Abstract

Sprouts of Pinus halepensis were incubated and cultured in the laboratory under controlled conditions to investigate their response to a long-term exposure to continuous, non-ionizing radiation emitted from the base unit of a cordless DECT system. Exposed plants, compared to their control counterparts, seem to be affected since they exhibit lower sprouting potential, minor fresh weight and biomass for both the above ground part and the root, reduction of their photosynthetic pigments and significantly increased ROS levels. Cotyledon, juvenile leaf, primary shoot and root structure seem similar in both control and exposed plants. What seems to be affected is the structure of chloroplasts in the exposed leaves. Many cells of the exposed leaves possess severely deformed chloroplasts with dilated or destructed thylakoid membranes although disruption of chloroplast envelopes was not observed.

http://www.sciencedirect.com/science/article/pii/S0367253017332760

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Impact of RFR on DNA damage & antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations

Zothansiama, Zosangzuali M, Lalramdinpuii M, Jagetia GC. Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations. Electromagn Biol Med. 2017 Aug 4:1-11. doi: 10.1080/15368378.2017.1350584.

Abstract

Radiofrequency radiations (RFRs) emitted by mobile phone base stations have raised concerns on its adverse impact on humans residing in the vicinity of mobile phone base stations. Therefore, the present study was envisaged to evaluate the effect of RFR on the DNA damage and antioxidant status in cultured human peripheral blood lymphocytes (HPBLs) of individuals residing in the vicinity of mobile phone base stations and comparing it with healthy controls.

The study groups matched for various demographic data including age, gender, dietary pattern, smoking habit, alcohol consumption, duration of mobile phone use and average daily mobile phone use.

The RF power density of the exposed individuals was significantly higher ($p < 0.0001$) when compared to the control group. The HPBLs were cultured and the DNA damage was assessed by cytokinesis blocked micronucleus (MN) assay in the binucleate lymphocytes. The analyses of data from the exposed group ($n = 40$), residing within a perimeter of 80 meters of mobile base stations, showed significantly ($p < 0.0001$) higher frequency of micronuclei (MN) when compared to the control group, residing 300 meters away from the mobile base station/s.

The analysis of various antioxidants in the plasma of exposed individuals revealed a significant attrition in glutathione (GSH) concentration ($p < 0.01$), activities of catalase (CAT) ($p < 0.001$) and superoxide dismutase (SOD) ($p < 0.001$) and rise in lipid peroxidation (LOO) when compared to controls. Multiple linear regression analyses revealed a significant association among reduced GSH concentration ($p < 0.05$), CAT ($p < 0.001$) and SOD ($p < 0.001$) activities and elevated MN frequency ($p < 0.001$) and LOO ($p < 0.001$) with increasing RF power density.

https://www.ncbi.nlm.nih.gov/pubmed/28777669

My note: All of the recorded RFR power density values in this study were well below the Federal Communication Commission's maximum permissible exposure limits in the U.S. for the general population. These limits are are 6,000 mW/m^2 [milliwatts per square meter] for 900 MHz and 10,000 mW/m^2 for 1800 MHz radiofrequency radiation. In contrast, the highest recorded value in this study was 7.52 mW/m^2 of RFR. The "exposed individuals" who resided within 80 meters of a cell antenna received an average of 5.00 mW/m^2 of RFR in their bedrooms.

To see excerpts from this study and related research: **Cell Tower Health Effects** or **http://bit.ly/saferemrcelltower**

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Mobile phone RF exposure has no effect on DNA double strand breaks in human lymphocytes

Danese E, Lippi G, Buonocore R, Benati M, Bovo C, Bonaguri C, Salvagno GL, Brocco G, Roggenbuck D, Montagnana M. Mobile phone radiofrequency exposure has no effect on DNA double strand breaks (DSB) in human lymphocytes. Ann Transl Med. 2017 Jul;5(13):272. doi: 10.21037/atm.2017.04.35.

Abstract

BACKGROUND: The use of mobile phones has been associated with an increased risk of developing certain

type of cancer, especially in long term users. Therefore, this study was aimed to investigate the potential genotoxic effect of mobile phone radiofrequency exposure on human peripheral blood mononuclear cells in vitro.

METHODS: The study population consisted in 14 healthy volunteers. After collection of two whole blood samples, the former was placed in a plastic rack, 1 cm from the chassis of a commercial mobile phone (900 MHz carrier frequency), which was activated by a 30-min call. The second blood sample was instead maintained far from mobile phones or other RF sources. The influence of mobile phone RF on DNA integrity was assessed by analyzing γ-H2AX foci in lymphocytes using immunofluorescence staining kit on AKLIDES.

RESULTS: No measure of γ-H2AX foci was significantly influenced by mobile phone RF exposure, nor mobile phone exposure was associated with significant risk of genetic damages in vitro (odds ratio comprised between 0.27 and 1.00).

CONCLUSIONS: The results of this experimental study demonstrate that exposure of human lymphocytes to a conventional 900 MHz RF emitted by a commercial mobile phone for 30 min does not significantly impact DNA integrity.

https://www.ncbi.nlm.nih.gov/pubmed/28758098

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Effects of Long-Term Exposure to 60 GHz Millimeter-Wavelength Radiation on Genotoxicity & Heat Shock Protein Expression of Cells Derived from Human Eye

Koyama S, Narita E, Shimizu Y, Suzuki Y, Shiina T, Taki M, Shinohara N, Miyakoshi J.Effects of Long-Term Exposure to 60 GHz Millimeter-Wavelength Radiation on the Genotoxicity and Heat Shock Protein (Hsp) Expression of Cells Derived from Human Eye. Int J Environ Res Public Health. 2016 Aug 8;13(8). pii: E802. doi: 10.3390/ijerph13080802.

Abstract

Human corneal epithelial (HCE-T) and human lens epithelial (SRA01/04) cells derived from the human eye were exposed to 60 gigahertz (GHz) millimeter-wavelength radiation for 24 h. There was no statistically significant increase in the micronucleus (MN) frequency in cells exposed to 60 GHz millimeter-wavelength radiation at 1 mW/cm² compared with sham-exposed controls and incubator controls. The MN frequency of cells treated with bleomycin for 1 h provided positive controls. The comet assay, used to detect DNA strand breaks, and heat shock protein (Hsp) expression also showed no statistically significant effects of exposure. These results indicate that exposure to millimeter-wavelength radiation has no effect on genotoxicity in human eye cells.

https://www.ncbi.nlm.nih.gov/pubmed/27509516

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RF EMF exposure in everyday microenvironments in Europe: A systematic literature review

Sagar S, Dongus S, Schoeni A, Roser K, Eeftens M, Struchen B, Foerster M, Meier N, Adem S, Röösli M. Radiofrequency electromagnetic field exposure in everyday microenvironments in Europe: A systematic literature review. J Expo Sci Environ Epidemiol. 2017 Aug 2. doi: 10.1038/jes.2017.13.

Abstract

The impact of the introduction and advancement in communication technology in recent years on exposure level of the population is largely unknown. The main aim of this study is to systematically review literature on the distribution of radiofrequency electromagnetic field (RF-EMF) exposure in the everyday environment in Europe and summarize key characteristics of various types of RF-EMF studies conducted in the European countries.

We systematically searched the ISI Web of Science for relevant literature published between 1 January 2000 and 30 April 2015, which assessed RF-EMF exposure levels by any of the methods: spot measurements, personal measurement with trained researchers and personal measurement with volunteers.

Twenty-one published studies met our eligibility criteria of which 10 were spot measurements studies, 5 were personal measurement studies with trained researchers (microenvironmental), 5 were personal measurement studies with volunteers and 1 was a mixed methods study combining data collected by volunteers and trained researchers. RF-EMF data included in the studies were collected between 2005 and 2013. The mean total RF-EMF exposure for spot measurements in European "Homes" and "Outdoor" microenvironments was 0.29 and 0.54 V/m, respectively. In the personal measurements studies with trained researchers, the mean total RF-EMF exposure was 0.24 V/m in "Home" and 0.76 V/m in "Outdoor". In the personal measurement studies with volunteers, the population weighted mean total RF-EMF exposure was 0.16 V/m in "Homes" and 0.20 V/m in "Outdoor". Among all European microenvironments in "Transportation", the highest mean total RF-EMF 1.96 V/m was found in trains of Belgium during 2007 where more than 95% of exposure was contributed by uplink.

Typical RF-EMF exposure levels are substantially below regulatory limits. We found considerable differences between studies according to the type of measurements procedures, which precludes cross-country comparison or evaluating temporal trends. A comparable RF-EMF monitoring concept is needed to accurately identify typical RF-EMF exposure levels in the everyday environment.

https://www.ncbi.nlm.nih.gov/pubmed/28766560

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Measurement of the environmental broadband electromagnetic waves in a mid-size European city

Fernández-García R, Gil I. Measurement of the environmental broadband electromagnetic waves in a mid-size European city. Environ Res. 2017 Jul 26;158:768-772. doi: 10.1016/j.envres.2017.07.040.

Abstract

In this paper, the level of exposure to broadband radiofrequency electromagnetic field in a mid-size European city was evaluated in accordance with the International Commission on Non-ionizing Radiation Protection guidelines from 1998. With the aim to analyse all the potential electromagnetic waves present in the city up to 18GHz, a total of 271 locations distributed along Terrassa (Spain) have been measured. To show the results in an easy-to-interpret way by the citizen, the results have been represented in a set of raster maps. The measurement results obtained showed that the electromagnetic wave measured in all broadband frequency range along the city is much lower than the safety level according to the international regulations for both public and occupational sectors.

https://www.ncbi.nlm.nih.gov/pubmed/28755561

Excerpts

... according to the World Health Organization, due to the ubiquitous source of RF radiation the percentage of all people being exposed to RF electromagnetic radiation is rapidly approaching the percentage exposed to polluted air (Lin, 2016) and therefore, more research must be devoted to this crucial issue. In addition, it is

necessary to extend the RF-EMF exposure assessment to broadband frequency measurements including fields beyond 6 GHz. This fact will be mandatory in the future because of the deployment of new wireless standards such as the fifth-generation mobile communication systems (5G) (Colombi et al., 2015; Zhao et al., 2015).

The electric field measurements have been carried out by means of the electromagnetic field meter *Wavecontrol SMP2* and a *WPF18* broadband isotropic probe to assess the radioelectric environment and all the potential hand-made radiofrequency sources. The probe has a broadband frequency range from 300 kHz to 18 GHz with a measurement range from 0.5 V/m to 250 V/m. The electromagnetic sensor is based on a diode technology and it presents a sensitivity of 0.5 V/m with a resolution lower than 5%, a dynamic range of 54 dB and a linearity of ± 0.5 dB. The measurement equipment has been calibrated according to the ISO 17025 standard. The equipment is able to cover all the potential non-ionizing electromagnetic emissions in the environment from 300 kHz to 18 GHz....

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Are electromagnetic fields in incubators a risk factor for autism?

Bellieni CV, Buonocore G. Acta Paediatr. Are electromagnetic fields in incubators a risk factor for autism? 2017 Jul 22. doi: 10.1111/apa.14001.

Abstract

Hugo Lagercrantz recently argued (1) that a possible cause of infantile autism was the unnatural isolation that babies experienced in neonatal incubators. Atypical brain connectivity has been detected in children with autism and it is possible that this may be also due to environmental factors, including the lack of physiological stimuli that is typically found in the incubator environment. We suggest that also another factor may expose babies in incubators to the risk of developing autistic traits and that is the high electromagnetic fields (EMF) produced by the incubator's electric engine.

https://www.ncbi.nlm.nih.gov/pubmed/28734102

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Report from the BioEM2017: Annual meeting of BEMS & EBEA

Dariusz Leszczynski. Report from the BioEM2017: Annual meeting of BEMS & EBEA, Hangzhou, China, June 5-9, 2017.

https://betweenrockandhardplace.files.wordpress.com/2017/07/report-from-bioem2017.pdf

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Effects of short and long term EMF exposure on the human hippocampus

Omur Gulsum Deniz, Suleyman Kaplan, Mustafa Bekir Selçuk, Murat Terzi, Gamze Altun, Kıymet Kübra Yurt, Kerim Aslan, Devra Davis. Effects of short and long term electromagnetic fields exposure on the human hippocampus. Journal of Microscopy and Ultrastructure, In Press, Corrected Proof, Available online 13 July 2017.

Highlights

• This pilot investigation of female medical students finds that electromagnetic fields exposure does not alter the volume of the human hippocampus.

• Widespread use of mobile phones among medical students results in a low level of concentration in the present study.
• Prolonged use of mobile phones can lead to a decline in the ability to suppress stimuli.

Abstract

The increasing use of mobile phones may have a number of physiological and psychological effects on human health. Many animal and human studies have reported various effects on the central nervous system and cognitive performance from of exposure to electromagnetic fields (EMF) emitted by mobile phones. The aim of the present study was to evaluate the effects of mobile phones on the morphology of the human brain and on cognitive performance using stereological and spectroscopic methods and neurocognitive tests.

Sixty healthy female medical school students aged 18–25 years were divided into a low exposure group (30 subjects, <30 min daily use by the head) and high exposure group (30 subjects, >90 min daily use by the head). Magnetic resonance images (MRI) of the brain analysed on OsiriX 3.2.1 workstation. Neuropsychological tests were performed for each subject. In addition, three dominant specific metabolites were analysed, choline at 3.21 ppm, creatine at 3.04 ppm and N-acetyl aspartate at 2.02 ppm. Analysis of the spectroscopic results revealed no significant difference in specific metabolites between the groups ($p > 0.05$). There was also no significant difference in terms of hippocampal volume between the groups ($p > 0.05$). In contrast, the results of the stroop and digit span (backward) neurocognitive tests of high exposure group for evaluating attention were significantly poorer from low exposure group ($p < 0.05$). Based on these results, we conclude that a lack of attention and concentration may occur in subjects who talk on mobile phones for longer times, compared to those who use phones relatively less.

http://www.sciencedirect.com/science/article/pii/S2213879X17300524

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Monte Carlo simulations of skin exposure to electromagnetic field from 10 GHz to 1 THz

Sasaki K, Mizuno M, Wake K, Watanabe S. Monte Carlo simulations of skin exposure to electromagnetic field from 10 GHz to 1 THz.
Phys Med Biol. 2017 Jul 25. doi: 10.1088/1361-6560/aa81fc.

Abstract

In this study, we present an assessment of human-body exposure to an electromagnetic eld at frequencies ranging from 10 GHz to 1 THz. The energy absorption and temperature elevation were assessed by solving boundary value problems of the one-dimensional Maxwell equations and a bioheat equation for a multilayer plane model. Dielectric properties were measured in vitro at frequencies of up to 1 THz at body temperature. A Monte Carlo simulation was conducted to assess variations of the transmittance into a skin surface and temperature elevation inside a body by considering the variation of the tissue thickness due to individual differences among human bodies. Furthermore, the impact of the dielectric properties of adipose tissue on temperature elevation, for which large discrepancies between our present measurement results and those in past works were observed, was also examined. We found that the dielectric properties of adipose tissue do not impact on temperature elevation at frequencies over 30 GHz. The potential risk of skin burn was discussed on the basis of the temperature elevation in millimeter-wave and terahertz-wave exposure. Furthermore, the consistency of the basic restrictions in the international guidelines set by ICNIRP was discussed.

https://www.ncbi.nlm.nih.gov/pubmed/28742056

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Electromagnetic fields may act via calcineurin inhibition to suppress immunity, thereby increasing risk

for opportunistic infection: Conceivable mechanisms of action

Doyon, PR, Johansson O. Electromagnetic fields may act via calcineurin inhibition to suppress immunity, thereby increasing risk for opportunistic infection: Conceivable mechanisms of action. Med Hypotheses. 106:71-87. Sep 2017. https://doi.org/10.1016/j.mehy.2017.06.028Get rights and content

Abstract

While a good number of studies have demonstrated that modern, man-made ambient electromagnetic fields can have both stimulatory and inhibitory effect on immune system function, the precise mechanisms have yet to be completely elucidated. It is hypothesized here that, depending on the parameters, one of the means by which long-term electromagnetic field exposure has the potential to eventually lead to immunosuppression is via downstream inhibition of the enzyme calcineurin — a protein phosphatase, which activates the T-cells of the immune system and can be blocked by pharmaceutical agents.

Calcineurin is the target of a class of pharmaceuticals called calcineurin inhibitors (e.g., cyclosporine, pimecrolimus and tacrolimus). When organ transplant recipients take such pharmaceuticals to prevent or suppress organ transplant rejection, one of the major side effects is immunosuppression leading to increased risk of opportunistic infection: e.g., fungal, viral (Epstein-Barr virus, cytomegalovirus), atypical bacterial (Nocardia, Listeria, mycobacterial, mycoplasma), and parasitic (e.g., toxoplasmosis) infections.

Frequent anecdotal reports, as well as a number of scientific studies, have shown that electromagnetic field exposures may indeed produce the same effect: a weakened immune system leading to an increase in the same or similar opportunistic infections: i.e., fungal, viral, atypical bacterial, and parasitic infections.

Furthermore, numerous research studies have shown that man-made electromagnetic fields have the potential to open voltage-gated calcium channels, which can in turn produce a pathological increase of intracellular calcium, leading downstream to the pathological production of a series of reactive oxygen species. Finally, there are a number of research studies demonstrating the inhibition of calcineurin by a pathological production of reactive oxygen species.

Hence, it is hypothesized here that exposures to electromagnetic fields have the potential to inhibit immune system response by means of an eventual pathological increase in the influx of calcium into the cytoplasm of the cell, which induces a pathological production of reactive oxygen species, which in turn can have an inhibitory effect on calcineurin. Calcineurin inhibition leads to immunosuppression, which in turn leads to a weakened immune system and an increase in opportunistic infection.

http://www.sciencedirect.com/science/article/pii/S0306987717301718

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Biochemical & pathological changes in male rat kidney & bladder following exposure to continuous 900-MHz EMF on postnatal days 22-59

Türedi S, Kerimoğlu G, Mercantepe T, Odacı E. Biochemical and pathological changes in the male rat kidney and bladder following exposure to continuous 900-MHz electromagnetic field on postnatal days 22-59. Int J Radiat Biol. 2017 Jul 27:1-10. doi: 10.1080/09553002.2017.1350768.

Abstract

PURPOSE: To investigate the effect on male rat kidney and bladder tissues of exposure to 900-megahertz (MHz) electromagnetic field (EMF) applied on postnatal days 22-59, inclusive.

MATERIALS AND METHODS: Twenty-four male Sprague Dawley rats, aged 21 days, were used. These were

divided equally into one of three groups, control (CG), sham (SG) or EMF (EMFG). CG was not exposed to any procedure. SG rats were kept inside a cage, without being exposed to the effect of EMF, for 1 h a day on postnatal days 22-59, inclusive. EMFG rats were exposed to continuous 900-MHz EMF for 1 h a day under the same conditions as those for the SG rats. Rats were sacrificed on postnatal day 60, and the kidney and bladder tissues were removed. Tissues were stained with hematoxylin and eosin (H&E) and Masson trichrome for histomorphological evaluation. The TUNEL method was used to assess apoptosis. Transmission electron microscopy (TEM) was also used for the kidney tissue. Oxidant/antioxidant parameters were studied in terms of biochemical values.

RESULTS: The findings showed that tissue malondialdehyde increased in EMFG compared to CG and SG in both kidney ($p = 0.004$ and $p = 0.004$, respectively) and bladder tissue ($p = 0.004$, $p = 0.006$, respectively), while catalase and glutathione levels decreased compared to CG ($p = 0.004$; $p = 0.004$, respectively) and SG ($p = 0.004$; $p = 0.004$, respectively). In the EMF group, pathologies such as dilatation and vacuolization in the distal and proximal tubules, degeneration in glomeruli and an increase in cells tending to apoptosis were observed in kidney tissue. In bladder tissue, degeneration in the transitional epithelium and stromal irregularity and an increase in cells tending to apoptosis were observed in EMFG. Additionally, EMFG samples exhibited glomerular capillary degeneration with capillary basement membranes under TEM.

CONCLUSIONS: We conclude that continuous exposure to the effect of 900-MHz EMF for 1 h a day on postnatal days 22-59, inclusive, causes an increase in oxidative stress and various pathological changes in male rat kidney and bladder tissues.

https://www.ncbi.nlm.nih.gov/pubmed/28747141

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Anxiety-like behavioural effects of ELF EMF in rats

Djordjevic NZ, Paunović MG, Peulić AS.Anxiety-like behavioural effects of extremely low-frequency electromagnetic field in rats. Environ Sci Pollut Res Int. 2017 Jul 29. doi: 10.1007/s11356-017-9710-1.

Abstract

In recent years, extremely low-frequency electromagnetic field (ELF-EMF) has received considerable attention for its potential biological effects. Numerous studies have shown the role of ELF-EMF in behaviour modulation. The aim of this study was to investigate the effect of short-term ELF-EMF (50 Hz) in the development of anxiety-like behaviour in rats through change hypothalamic oxidative stress and NO. Ten adult male rats (Wistar albino) were divided in two groups: control group-without exposure to ELF-EMF and experimental group-exposed to ELF-EMF during 7 days. After the exposure, time open field test and elevated plus maze were used to evaluate the anxiety-like behaviour of rats. Upon completion of the behavioural tests, concentrations of superoxide anion ($O2\cdot-$), nitrite ($NO2-$, as an indicator of NO) and peroxynitrite ($ONOO-$) were determined in the hypothalamus of the animals. Obtained results show that ELF-EMF both induces anxiety-like behaviour and increases concentrations of $O2\cdot-$ and NO, whereas it did not effect on $ONOO-$ concentration in hypothalamus of rats. In conclusion, the development of anxiety-like behaviour is mediated by oxidative stress and increased NO concentration in hypothalamus of rats exposed to ELF-EMF during 7 days.

https://www.ncbi.nlm.nih.gov/pubmed/28756602

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Influence of electromagnetic pulse on the offspring sex ratio of male BALB/c mice

Li JH, Jiang DP, Wang YF, Yan JJ, Guo QY, Miao X, Lang HY, Xu SL, Liu JY, Guo GZ.Influence of electromagnetic pulse on the offspring sex ratio of male BALB/c mice. Environ Toxicol Pharmacol. 2017 Jun

21;54:155-161. doi: 10.1016/j.etap.2017.06.015. [Epub ahead of print]

Abstract

Public concern is growing about the exposure to electromagnetic fields (EMF) and its effect on male reproductive health. Detrimental effect of EMF exposure on sex hormones, reproductive performance and sex-ratio was reported. The present study was designed to clarify whether paternal exposure to electromagnetic pulse (EMP) affects offspring sex ratio in mice. 50 male BALB/c mice aged 5-6 weeks were exposed to EMP daily for 2 weeks before mated with non-exposed females at 0d, 7d, 14d, 21d and 28d after exposure. Sex hormones including total testosterone, LH, FSH, and GnRH were detected using radioimmunoassay. The sex ratio was examined by PCR and agarose gel electrophoresis. The results of D0, D21 and D28 showed significant increases compared with sham-exposed groups. The serum testosterone increased significantly in D0, D14, D21, and D28 compared with sham-exposed groups ($p<0.05$). Overall, this study suggested that EMP exposure may lead to the disturbance of reproductive hormone levels and affect the offspring sex ratio.

https://www.ncbi.nlm.nih.gov/pubmed/28735146

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Hore PJ, Mouritsen H. The Radical-Pair Mechanism of Magnetoreception.Annu Rev Biophys. 2016 Jul 5;45:299-344. doi: 10.1146/annurev-biophys-032116-094545.

Abstract

Although it has been known for almost half a century that migratory birds can detect the direction of the Earth's magnetic field, the primary sensory mechanism behind this remarkable feat is still unclear. The leading hypothesis centers on radical pairs-magnetically sensitive chemical intermediates formed by photoexcitation of cryptochrome proteins in the retina. Our primary aim here is to explain the chemical and physical aspects of the radical-pair mechanism to biologists and the biological and chemical aspects to physicists. In doing so, we review the current state of knowledge on magnetoreception mechanisms. We dare to hope that this tutorial will stimulate new interdisciplinary experimental and theoretical work that will shed much-needed additional light on this fascinating problem in sensory biology.

https://www.ncbi.nlm.nih.gov/pubmed/27216936

Bolte P et al. Localisation of the Putative Magnetoreceptive Protein Cryptochrome 1b in the Retinae of Migratory Birds and Homing Pigeons. PLoS One. 2016 Mar 8;11(3):e0147819. doi: 10.1371/journal.pone.0147819.

Abstract

Cryptochromes are ubiquitously expressed in various animal tissues including the retina. Some cryptochromes are involved in regulating circadian activity. Cryptochrome proteins have also been suggested to mediate the primary mechanism in light-dependent magnetic compass orientation in birds. Cryptochrome 1b (Cry1b) exhibits a unique carboxy terminus exclusively found in birds so far, which might be indicative for a specialised function. Cryptochrome 1a (Cry1a) is so far the only cryptochrome protein that has been localised to specific cell types within the retina of migratory birds. Here we show that Cry1b, an alternative splice variant of Cry1a, is also expressed in the retina of migratory birds, but it is primarily located in other cell types than Cry1a. This could suggest different functions for the two splice products. Using diagnostic bird-specific antibodies (that allow for a precise discrimination between both proteins), we show that Cry1b protein is found in the retinae of migratory European robins (Erithacus rubecula), migratory Northern Wheatears (Oenanthe oenanthe) and pigeons (Columba livia). In all three species, retinal Cry1b is localised in cell types which have been discussed as potentially well suited locations for magnetoreception: Cry1b is observed in the cytosol of ganglion cells,

displaced ganglion cells, and in photoreceptor inner segments. The cytosolic rather than nucleic location of Cry1b in the retina reported here speaks against a circadian clock regulatory function of Cry1b and it allows for the possible involvement of Cry1b in a radical-pair-based magnetoreception mechanism.

https://www.ncbi.nlm.nih.gov/pubmed/26953791

Bazalova O et al. Cryptochrome 2 mediates directional magnetoreception in cockroaches.Proc Natl Acad Sci U S A. 2016 Feb 9;113(6):1660-5. doi: 10.1073/pnas.1518622113.

Abstract

The ability to perceive geomagnetic fields (GMFs) represents a fascinating biological phenomenon. Studies on transgenic flies have provided evidence that photosensitive Cryptochromes (Cry) are involved in the response to magnetic fields (MFs). However, none of the studies tackled the problem of whether the Cry-dependent magnetosensitivity is coupled to the sole MF presence or to the direction of MF vector. In this study, we used gene silencing and a directional MF to show that mammalian-like Cry2 is necessary for a genuine directional response to periodic rotations of the GMF vector in two insect species. Longer wavelengths of light required higher photon fluxes for a detectable behavioral response, and a sharp detection border was present in the cyan/green spectral region. Both observations are consistent with involvement of the FADox, FAD(•-) and FADH(-) redox forms of flavin. The response was lost upon covering the eyes, demonstrating that the signal is perceived in the eye region. Immunohistochemical staining detected Cry2 in the hemispherical layer of laminal glia cells underneath the retina. Together, these findings identified the eye-localized Cry2 as an indispensable component and a likely photoreceptor of the directional GMF response. Our study is thus a clear step forward in deciphering the in vivo effects of GMF and supports the interaction of underlying mechanism with the visual system.

https://www.ncbi.nlm.nih.gov/pubmed/26811445

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World Health Organization, radiofrequency radiation and health - a hard nut to crack (Review)

Hardell L. World Health Organization, radiofrequency radiation and health - a hard nut to crack (Review). International Journal of Oncology. Published online on: June 21, 2017. https://doi.org/10.3892/ijo.2017.4046

Abstract

In May 2011 the International Agency for Research on Cancer (IARC) evaluated cancer risks from radiofrequency (RF) radiation. Human epidemiological studies gave evidence of increased risk for glioma and acoustic neuroma. RF radiation was classified as Group 2B, a possible human carcinogen. Further epidemiological, animal and mechanistic studies have strengthened the association. In spite of this, in most countries little or nothing has been done to reduce exposure and educate people on health hazards from RF radiation. On the contrary ambient levels have increased. In 2014 the WHO launched a draft of a Monograph on RF fields and health for public comments. It turned out that five of the six members of the Core Group in charge of the draft are affiliated with International Commission on Non-Ionizing Radiation Protection (ICNIRP), an industry loyal NGO, and thus have a serious conflict of interest. Just as by ICNIRP, evaluation of non-thermal biological effects from RF radiation are dismissed as scientific evidence of adverse health effects in the Monograph. This has provoked many comments sent to the WHO. However, at a meeting on March 3, 2017 at the WHO Geneva office it was stated that the WHO has no intention to change the Core Group.

Open Access Paper: https://www.spandidos-publications.com/10.3892/ijo.2017.4046

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Use of cell phones and brain tumors: a true association?

Mortazavi, S.A.R., Mortazavi, G. & Mortazavi, S.M.J. Letter to the Editor: Use of cell phones and brain tumors: a true association? Neurol Sci (2017). doi:10.1007/s10072-017-3055-x.

Dear Editor:

With great interest, we have read the editorial by Beghi entitled “Use of cell phones and brain tumors: a true association?” that is published in the journal of Neurol Sci 2017 doi: 10.1007/s10072-017-2992-8 [1]. In this article, the author confirms the lack of robust evidence of association between use of cell phones and brain tumors. However, Beghi mentions that absence of evidence does not necessarily mean that there is no any association. The editorial authored by Beghi addresses a very challenging issue. However, this editorial cannot be considered as a good contribution in the field of radiofrequency exposure and cancer. Over the past several years, our team has conducted several studies on the possible association of exposure to radiofrequency electromagnetic fields (RF-EMFs) and adverse health effects. Beghi claims that the findings of case–control studies have not been confirmed by cohort studies “First of all, the positive results of some case–control studies have not been confirmed by cohort studies. Case–control studies, even when methodologically robust, cannot replace cohort studies in confirming or disproving an association between a given exposure and a disease. ….In this context, none of the cohort studies found an increased risk of brain tumors in people exposed to cell phones.” Although what he claims about the advantages of cohort studies seems to be right, his conclusion is problematic. Beghi does not mention that the number of cohort studies conducted on this topic so far is drastically low and all of these studies had some basic limitations. Therefore, the absence of cohort-proven findings does not necessarily mean that there is no detrimental effect. In this light, as free radical formation after exposure to RF-EMF is confirmed in many studies, even without firm conclusions from cohort studies, these exposures should be limited.

Furthermore, Beghi claims that “Second, the increased risk of brain tumors in case–control studies, if proven, is at best modest and, as brain tumors are rare diseases, the total number of tumors appears only slightly increased.” It is worth mentioning that a systematic review and meta-analysis recently published by Yang et al. could not find a link between mobile phone use of any duration and the odds of high-grade glioma. However, there was a 2.22 times greater odds of the occurrence of low-grade glioma for long-term mobile phone use (OR = 2.22, 95% CI = 1.69–2.92) [2]. Beghi also claims that a clear dose–response effect has never been confirmed. Over the past several years, our team has conducted several studies on the possible association of RF-EMFs and adverse health effects. Mortazavi et al. have also recently addressed the shortcoming of some of the papers claiming lack of association between exposure to RF-EMF and cancer. They have provided evidence showing that exposure to RF-EMFs, at least at high levels and long durations, can increase the risk of cancer [3]. Substantial evidence now indicates that the current controversy regarding the carcinogenesis of RF-EMFs might be caused by the lack of accurate information regarding the magnitude of exposure to RF-EMFs which possibly plays a basic role in RF-induced carcinogenesis [4]. We have also provided evidence which shows that, in a similar pattern with ionizing radiation, the carcinogenesis of non-ionizing RF-EMF may have a nonlinear J-shaped dose–response relationship [4].

https://www.ncbi.nlm.nih.gov/pubmed/28689225

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Use of mobile and cordless phones and change in cognitive function: a prospective cohort analysis of Australian primary school children

Bhatt CR, Benke G, Smith CL, Redmayne M, Dimitriadis C, Dalecki A, Macleod S, Sim MR, Croft RJ, Wolfe R,

Kaufman J, Abramson MJ Use of mobile and cordless phones and change in cognitive function: a prospective cohort analysis of Australian primary school children. Environ Health. 2017 Jun 19;16(1):62. doi: 10.1186/s12940-017-0250-4.

Abstract

BACKGROUND: Some previous studies have suggested an association between children's use of mobile phones (MPs)/cordless phones (CPs) and development of cognitive function. We evaluated possible longitudinal associations between the use of MPs and CPs in a cohort of primary school children and effects on their cognitive function.

METHODS: Data on children's socio-demographics, use of MPs and CPs, and cognitive function were collected at baseline (2010-2012) and follow-up (2012-2013). Cognitive outcomes were evaluated with the CogHealth™ test battery and Stroop Color-Word test. The change in the number of MP/CP voice calls weekly from baseline to follow-up was dichotomized: "an increase in calls" or a "decrease/no change in calls". Multiple linear regression analyses, adjusting for confounders and clustering by school, were performed to evaluate the associations between the change in cognitive outcomes and change in MP and CP exposures.

RESULTS: Of 412 children, a larger proportion of them used a CP (76% at baseline and follow-up), compared to a MP (31% at baseline and 43% at follow-up). Of 26 comparisons of changes in cognitive outcomes, four demonstrated significant associations. The increase in MP usage was associated with larger reduction in response time for response inhibition, smaller reduction in the number of total errors for spatial problem solving and larger increase in response time for a Stroop interference task. Except for the smaller reduction in detection task accuracy, the increase in CP usage had no effect on the changes in cognitive outcomes.

CONCLUSION: Our study shows that a larger proportion of children used CPs compared to MPs. We found limited evidence that change in the use of MPs or CPs in primary school children was associated with change in cognitive function.

https://www.ncbi.nlm.nih.gov/pubmed/28629417

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Patterns of cellular phone use among young people in 12 countries: Implications for RF exposure

Langer CE, de Llobet P, Dalmau A, Wiart J, Goedhart G, Hours M, et al. (32 authors). Patterns of cellular phone use among young people in 12 countries: Implications for RF exposure. Environ Int. 2017 Jun 29;107:65-74. doi: 10.1016/j.envint.2017.06.002.

Highlights

• Number and duration of calls varied by sex, age range, and socioeconomic status
• Laterality and hands-free use were less influenced by user characteristics
• Country of origin explained most of the variance in number and duration of calls, as well as SMS and data/Wi-Fi

Abstract

Characterizing exposure to radiofrequency (RF) fields from wireless telecommunications technologies during childhood and adolescence is a research priority in investigating the health effects of RF. The Mobi-Expo study aimed to describe characteristics and determinants of cellular phone use in 534 young people (10-24years) in 12 countries. The study used a specifically designed software application installed on smartphones to collect data on the use of wireless telecommunications devices within this age group. The role of gender, age, maternal education, calendar period, and country was evaluated through multivariate models mutually

adjusting for all variables. Call number and duration were higher among females compared to males (geometric mean (GM) ratio 1.17 and 1.42, respectively), among 20-24year olds compared to 10-14year olds (GM ratio 2.09 and 4.40, respectively), and among lowest compared to highest social classes (GM ratio 1.52 and 1.58, respectively). The number of SMS was higher in females (GM ratio 1.46) and the middle age group (15-19year olds: GM ratio 2.21 compared to 10-14year olds) and decreased over time. Data use was highest in the oldest age group, whereas Wi-Fi use was highest in the middle age group. Both data and Wi-Fi use increased over time. Large differences in the number and duration of calls, SMS, and data/Wi-Fi use were seen by country, with country and age accounting for up to 50% of the variance. Hands-free and laterality of use did not show significant differences by sex, age, education, study period, or country. Although limited by a convenience sample, these results provide valuable insights to the design, analysis, and interpretation of future epidemiological studies concerning the health effects of exposure resulting from cellular phone use in young people. In addition, the information provided by this research may be used to design strategies to minimize RF exposure.

https://www.ncbi.nlm.nih.gov/pubmed/28668725

Excerpts

Participants made on average 30.6 calls per week (median 20.9) and spent 60.8 min per week making or receiving calls (median 34.3; Table 2).

A total of 248 (46.4%) subjects had usable data for laterality. For these participants, 18.8% of total call time was “hands-free” on average (median 10.6%), i.e. using the speaker phone, a hands-free kit, or holding the phone away from the head (Table 2). Out of the total call time near the head (not “hands-free”), participants used the phone on the right side of the head in 63.8% of the time on average (median 70.8% - Table 2). With respect to gender, there was no statistically significant difference between males and females for hands-free usage, although females tended to speak somewhat less on their right-hand side (68% in males versus 61% in females, adj OR 0.75; 95% CI 0.54, 1.03).

Overall, UMTS (3G) was the most commonly used communication protocol with 37% of voice calls occurring using UMTS. HSDPA (3G transitional) was the next most common, with 32% of voice calls. UMTS was the most common communication protocol in Canada, France, Greece, Italy, and The Netherlands (80%, 30%, 36%, 41%, and 55%, respectively) (Fig. 2). In contrast, HSDPA was the most common network in Australia, Germany, Israel, Japan, New Zealand, and Spain (69%, 36%, 68%, 51%, 46%, and 33%, respectively). The most common network in Korea was “other” (43%). GPRS and EDGE (both 2G transitional) were not commonly used in any of the countries during our study period; use ranged from 0% (Japan and Korea) to 32% (The Netherlands) GPRS and 22% (France and Germany) EDGE, respectively.

In comparison with our findings, CEFALO, a study among 7–19 year old children and adolescents investigating possible associations between cellular phone use and brain tumors, had a much lower level of phone use among controls during a period from early 2004 through mid-2008 (Aydin et al., 2011). The top quartile of controls had a cumulative lifetime use of 2638 calls and 144 h spent on voice calls. Using the mean number and duration of calls, it would take the participants in our study less than three years to reach the lifetime use of the highest quartile of CEFALO controls.

First, the handset is not near the head for the full call duration, but rather for about 83% of the time. In addition to intentional hands-free device or speaker phone usage, this is explained by other hands-free use such as answering and ending a call. Furthermore, the time spent with the phone on one side of the head was not as high as the 90% assigned to the self-reported predominant side within the RF dose algorithm used in the INTERPHONE study (Cardis et al., 2011a), but that was a study of older adults.

A major limitation of this study is that it is a convenience sample, limiting the generalizability of the results. Given that most of the volunteers were found through friends and/or colleagues of the research team, the education level and in turn socioeconomic status is likely higher than that of the general population.

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Functional brain MRI in patients complaining of EHS after long term exposure to EMF

Heuser G, Heuser SA. Functional brain MRI in patients complaining of electrohypersensitivity after long term exposure to electromagnetic fields. Rev Environ Health. 2017 Jul 5.

Abstract

INTRODUCTION: Ten adult patients with electromagnetic hypersensitivity underwent functional magnetic resonance imaging (fMRI) brain scans. All scans were abnormal with abnormalities which were consistent and similar. It is proposed that fMRI brain scans be used as a diagnostic aid for determining whether or not a patient has electromagnetic hypersensitivity. Over the years we have seen an increasing number of patients who had developed multi system complaints after long term repeated exposure to electromagnetic fields (EMFs). These complaints included headaches, intermittent cognitive and memory problems, intermittent disorientation, and also sensitivity to EMF exposure. Regular laboratory tests were within normal limits in these patients. The patients refused to be exposed to radioactivity. This of course ruled out positron emission tomography (PET) and single-photon emission computed tomography (SPECT) brain scanning. This is why we ordered fMRI brain scans on these patients. We hoped that we could document objective abnormalities in these patients who had often been labeled as psychiatric cases.

MATERIALS AND METHODS: Ten patients first underwent a regular magnetic resonance imaging (MRI) brain scan, using a 3 Tesla Siemens Verio MRI open system. A functional MRI study was then performed in the resting state using the following sequences: A three-dimensional, T1-weighted, gradient-echo (MPRAGE) Resting state network. The echo-planar imaging (EPI) sequences for this resting state blood oxygenation level dependent (BOLD) scan were then post processed on a 3D workstation and the independent component analysis was performed separating out the various networks. Arterial spin labeling. Tractography and fractional anisotropy.

RESULTS: All ten patients had abnormal functional MRI brain scans. The abnormality was often described as hyper connectivity of the anterior component of the default mode in the medial orbitofrontal area. Other abnormalities were usually found. Regular MRI studies of the brain were mostly unremarkable in these patients.

CONCLUSION: We propose that functional MRI studies should become a diagnostic aid when evaluating a patient who claims electrohypersensitivity (EHS) and has otherwise normal studies. Interestingly, the differential diagnosis for the abnormalities seen on the fMRI includes head injury. It turns out that many of our patients indeed had a history of head injury which was then followed sometime later by the development of EHS. Many of our patients also had a history of exposure to potentially neurotoxic chemicals, especially mold. Head injury and neurotoxic chemical exposure may make a patient more vulnerable to develop EHS.

https://www.ncbi.nlm.nih.gov/pubmed/28678737

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An off-the-shelf meter for measuring body amperage: A new gold standard for epidemiologic studies?

Milham S. An off-the-shelf meter for measuring body amperage: A new gold standard for epidemiologic studies? Electromagn Biol Med. 2017 Jun 26:1. doi: 10.1080/15368378.2017.1336101.

No Abstract (letter)

https://www.ncbi.nlm.nih.gov/pubmed/28650676

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Effects of folic acid on rat kidney exposed to 900 MHz EMR

Ömür Gülsüm Deniz, Elfide Gizem Kıvrak, Arife Ahsen Kaplan, Berrin Zuhal Altunkaynak. Effects of folic acid on rat kidney exposed to 900 MHz electromagnetic radiation. Journal of Microscopy and Ultrastructure. Available online 17 June 2017.

Highlights

• The kidneys of adult male rats were investigated after exposure to 900-MHz electromagnetic radiation.
• Folic acid exhibited protective effects in the kidney against the side-effects of electromagnetic radiation exposure.
• Changes in volume and numbers of glomeruli in the kidney were analyzed using unbiased stereological methods.

Abstract

Because of increased use of cell phones, the purpose of this study was to investigation of the oxidative damage caused by electromagnetic radiation (EMR) emitted by cell phones and histological and morphometrical determination of the possible protective role of folic acid (FA) in preventing the detrimental effects of EMR on the kidney. Twenty-four adult male Wistar albino rats were divided into control (Cont), EMR, EMR + FA and FA groups, each containing six rats. The EMR and EMR + FA groups were exposed to EMR for 60 min a day over a period of 21 days, while no EMR exposure was applied to the Cont and FA groups. The source of the EMR was an EMR device which emits a digital signal producing 900-MHz frequency radiation. The generator connected to a one-monopole antenna was used in this study and the rats were placed in the plexiglass restrainer at an equal distance from the monopole antenna. Following the experimental period, and after tissue processing, a physical disector-Cavalieri method combination was applied to the sections. The mean volume of the cortex, medulla, proximal and distal tubules increased significantly in the EMR groups compared to the Cont group ($p < 0.01$). Contrarily, the total number of glomeruli in the EMR group decreased compared to the Cont group ($p < 0.01$). The protective effects of FA was observed in the kidney ($p < 0.05$).

In conclusion, the 900-MHz EMR leads to kidney damage. FA may exhibit a protective effect against the adverse effects of EMR exposure in terms of the total number of glomeruli.

http://www.sciencedirect.com/science/article/pii/S2213879X17300500

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Changes in locomotor activity in mice due to low-intensity microwaves amplitude modulated in the EEG spectral domain

Eeghem VV, Arfani AE, Anthoula A, Walrave L, Pourkazemi A, Bentea E, Demuyser T, Smolders I, Stiens J. Selective changes in locomotor activity in mice due to low-intensity microwaves amplitude modulated in the EEG spectral domain. Neuroscience. 2017 Jul 4. pii: S0306-4522(17)30461-X. doi: 10.1016/j.neuroscience.2017.06.056.

Abstract

Despite the numerous benefits of microwave applications in our daily life, microwaves were associated with diverse neurological complaints such as headaches and impaired sleep patterns, and changes in the electroencephalogram (EEG). To which extent microwaves influence the brain function remains unclear. This

exploratory study assessed the behavior and neurochemistry in mice immediately or 4 weeks after a 6-day exposure to low-intensity 10 GHz microwaves with an amplitude modulation (AM) of 2 or 8 Hz. These modulation frequencies of 2 and 8 Hz are situated within the delta and theta-alpha frequency bands in the EEG spectrum and are associated with sleep and active behavior, respectively. During these experiments, the specific absorbance rate was 0.3 W/kg increasing the brain temperature with 0.23°C. For the first time, exposing mice to 8 Hz AM significantly reduced locomotor activity in an open field immediately after exposure which normalized after 4 weeks. This in contrast to 2 Hz AM which didn't induce significant changes in locomotor activity immediately and 4 weeks after exposure. Despite this difference in motor behavior, no significant changes in striatal dopamine and DOPAC levels and DOPAC/dopamine turnover nor in cortical glutamate concentrations were detected. In all cases, no effects on motor coordination on a rotarod, spatial working memory, anxiety nor depressive-like behavior were observed. The outcome of this study indicates that exposing mice to low-intensity 8 Hz AM microwaves can alter the locomotor activity in contrast to 2 Hz AM which did not affect the tested behaviors.

https://www.ncbi.nlm.nih.gov/pubmed/28687311

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Influence of RF EMF from 3rd-generation cellular phones on fertilization and embryo development in mice (W-CDMA study)

Suzuki S, Okutsu M, Suganuma R, Komiya H, Nakatani-Enomoto S, Kobayashi S, Ugawa Y, Tateno H, Fujimori K.Influence of radiofrequency-electromagnetic waves from 3rd-generation cellular phones on fertilization and embryo development in mice. Bioelectromagnetics. 2017 Jun 19. doi: 10.1002/bem.22063.

Abstract

The purpose of this study was to evaluate the effects of 3rd-generation (3G) cellular phone radiofrequency-electromagnetic wave (RF-EMW) exposure on fertilization and embryogenesis in mice. Oocytes and spermatozoa were exposed to 3G cellular phone RF-EMWs, 1.95 GHz wideband code division multiple access, at a specific absorption rate of 2 mW/g for 60 min, or to sham exposure. After RF-EMW exposure, in vitro fertilization and intracytoplasmic sperm injection were performed. Rates of fertilization, embryogenesis (8-cell embryo, blastocyst), and chromosome aberration were compared between the combined spermatozoa and oocyte groups: both exposed, both non-exposed, one exposed, and the other non-exposed. Rates of fertilization, embryogenesis, and blastocyst formation did not change significantly across the four groups. Considering that the degree of exposure in the present study was ≥100 times greater than daily exposure of human spermatozoa and even greater than daily exposure of oocytes, the present results indicate safety of RF-EMW exposure in humans.

https://www.ncbi.nlm.nih.gov/pubmed/28628221

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The Effects of Exposure to Low Frequency EMF on Male Fertility

Darbandi M, Darbandi S, Agarwal A, Henkle R, Sadeghi MR. The Effects of Exposure to Low Frequency Electromagnetic Fields on Male Fertility. Altern Ther Health Med. 2017 Jun 23. pii: AT5423.

Abstract

Context • People are increasingly exposed to low frequency (LF) electromagnetic fields (EMFs), mainly from electricity distribution networks and electronic devices. Critics of this widespread exposure believe that it can have detrimental effects on the human body. On the other hand, many in vivo and in vitro studies have claimed that low frequency electromagnetic therapy can function as a form of alternative medicine and that therapists

can treat disease by applying electromagnetic radiation or pulsed EMFs to the body or cells. It is not yet entirely clear, however, whether LF-EMF is beneficial or harmful.
Objectives • This study aimed to examine the effects of LF-EMFs on men's reproductive functions, according to the types of waveform and the frequency and duration of exposure.
Design • The study reviewed all available research, both human and animal, on the effects of LF-EMFs on male reproductive functions, covering the literature from January 1978 to June 2016. The documents were obtained from PubMed, Science Direct, and Google Scholar, and any article that was irrelevant or a duplicate was excluded. A total of 61 articles were found, and 27 articles were reviewed.
Setting • This project was performed at the Avicenna Research Center (Tehran, Iran).
Participants • Literature included human and animal studies conducted on rabbits, mice, rats, and boars.
Intervention • Among these studies, any article that was irrelevant, a duplicate, or published with duplicate data was excluded. At the end, 27 articles were checked.
Outcome Measures • Outcome measures included testing related to reproductive organ weights, reproductive endocrinal hormones, fetal development, and spermatogenesis as well as sperm motility, morphology, and vitality.
Results • The reviewed studies provided contradictory results that were highly dependent on the exposure parameters, such as the shape and frequency of wave, intensity, duration, and timing of the exposure.
Conclusions • LF-EMF at 15 Hz with a peak intensity of 8 Gauss, with a square waveform of 50 Hz frequency and a duration of a few hours or less can have a positive effect on sperm quality, motility, and fertility. Exposures at other frequencies either had no effects on the sperm's performance and quality or held biological hazard for cells. It appears that there is still little understanding of how EMF affects cellular functions. Therefore, more standardized and controlled studies should be carried out to understand the effects of EMF on the body.

https://www.ncbi.nlm.nih.gov/pubmed/28646801

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Proteomic Analysis of the Effect of ELF-EMF With Different Intensities in SH-SY5Y Neuroblastoma Cell Line

Rezaie-Tavirani M, Hasanzadeh H, Seyyedi S, Zali H.Proteomic Analysis of the Effect of Extremely Low-Frequency Electromagnetic Fields (ELF-EMF) With Different Intensities in SH-SY5Y Neuroblastoma Cell Line.J Lasers Med Sci. 2017 Spring;8(2):79-83. doi: 10.15171/jlms.2017.14.

Abstract

Introduction: During the last 3 decades, human is exposed to extremely low frequency electromagnetic fields (ELF-EMF) emitted by power lines and electronic devices. It is now well accepted that ELF-EMF are able to produce a variety of biological effects, although the molecular mechanism is unclear and controversial. Investigation of different intensities effects of 50 Hz ELF-EMF on cell morphology and protein expression is the aim of this study.
Methods: SH-SY5Y human neuroblastoma cell line was exposed to 0.5 and 1 mT 50 Hz (ELF-EMF) for 3 hours. Proteomics techniques were used to determine the effects of these fields on protein expression. Bioinformatic and statistical analysis of proteomes were performed using Progensis SameSpots software.
Results: Our results showed that exposure to ELF-EMF changes cell morphology and induces a dose-dependent decrease in the proliferation rate of the cells. The proteomic studies and bioinformatic analysis indicate that exposure to 50 Hz ELF-EMF leads to alteration of cell protein expression in both dose-dependent and intensity dependent manner, but the later is more pronounced.
Conclusion: Our data suggests that increased intensity of ELF-EMF may be associated with more alteration in cell protein expression, as well as effect on cell morphology and proliferation

https://www.ncbi.nlm.nih.gov/pubmed/28652900

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The bee, the flower, and the electric field: electric ecology and aerial electroreception

Clarke D, Morley E, Robert D. The bee, the flower, and the electric field: electric ecology and aerial electroreception. J Comp Physiol A Neuroethol Sens Neural Behav Physiol. 2017 Jun 24. doi: 10.1007/s00359-017-1176-6.

Abstract

Bees and flowering plants have a long-standing and remarkable co-evolutionary history. Flowers and bees evolved traits that enable pollination, a process that is as important to plants as it is for pollinating insects. From the sensory ecological viewpoint, bee-flower interactions rely on senses such as vision, olfaction, humidity sensing, and touch. Recently, another sensory modality has been unveiled; the detection of the weak electrostatic field that arises between a flower and a bee. Here, we present our latest understanding of how these electric interactions arise and how they contribute to pollination and electroreception. Finite-element modelling and experimental evidence offer new insights into how these interactions are organised and how they can be further studied. Focusing on pollen transfer, we deconstruct some of the salient features of the three ingredients that enable electrostatic interactions, namely the atmospheric electric field, the capacity of bees to accumulate positive charge, and the propensity of plants to be relatively negatively charged. This article also aims at highlighting areas in need of further investigation, where more research is required to better understand the mechanisms of electrostatic interactions and aerial electroreception.

https://www.ncbi.nlm.nih.gov/pubmed/28647753

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Biological effects related to geomagnetic activity and possible mechanisms

Krylov VV. Biological effects related to geomagnetic activity and possible mechanisms. Bioelectromagnetics. 2017 Jun 21. doi: 10.1002/bem.22062. [Epub ahead of print]

Abstract

This review presents contemporary data on the biological effects of geomagnetic activity. Correlations between geomagnetic indices and biological parameters and experimental studies that used simulated geomagnetic storms to detect possible responses of organisms to these events in nature are discussed. Possible mechanisms by which geomagnetic activity influences organisms are also considered. Special attention is paid to the idea that geomagnetic activity is perceived by organisms as a disruption of diurnal geomagnetic variation. This variation, in turn, is viewed by way of a secondary zeitgeber for biological circadian rhythms. Additionally, we discuss the utility of cryptochrome as a biological detector of geomagnetic storms. The possible involvement of melatonin and protein coding by the CG8198 gene in the biological effects of geomagnetic activity are discussed. Perspectives for studying mechanisms by which geomagnetic storms affect organisms are suggested.

https://www.ncbi.nlm.nih.gov/pubmed/28636777

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Mobile phone use and risk for intracranial tumors and salivary gland tumors - A meta-analysis

Bortkiewicz A, Gadzicka E, Szymczak W. Mobile phone use and risk for intracranial tumors and salivary gland tumors - A meta-analysis. Int J Occup Med Environ Health. 2017 Feb 21;30(1):27-43. doi:

10.13075/ijomeh.1896.00802. Epub 2017 Feb 13.

Abstract

Results of epidemiological studies on the association between use of mobile phone and brain cancer are ambiguous, as well as the results of 5 meta-analysis studies published to date. Since the last meta-analysis (2009), new case-control studies have been published, which theoretically could affect the conclusions on this relationship. Therefore, we decided to perform a new meta-analysis. We conducted a systematic review of multiple electronic data bases for relevant publications. The inclusion criteria were: original papers, case-control studies, published till the end of March 2014, measures of association (point estimates as odds ratio and confidence interval of the effect measured), data on individual exposure. Twenty four studies (26 846 cases, 50 013 controls) were included into the meta-analysis. A significantly higher risk of an intracranial tumor (all types) was noted for the period of mobile phone use over 10 years (odds ratio (OR) = 1.324, 95% confidence interval (CI): 1.028-1.704), and for the ipsilateral location (OR = 1.249, 95% CI: 1.022-1.526). The results support the hypothesis that long-term use of mobile phone increases risk of intracranial tumors, especially in the case of ipsilateral exposure. Further studies are needed to confirm this relationship.

Excerpts

The results obtained in the random effects model indicated that there was a significant relationship between mobile phone use for longer than 10 years and the risk of intracranial tumors (OR = 1.46, 95% CI: 1.07–1.98).

Because OR is significantly greater than 1 (OR = 1.25, 95% CI: 1.04–1.52), we can conclude that there is a significant relationship between the time from the first regular use of mobile phone of 10 years or more and the risk of intracranial tumors.

Since OR is greater than 1 (OR = 1.29, 95% CI: 1.06–1.57), there is a significant relationship between ipsilateral use of mobile phone and the risk of intracranial tumor.

We found a significant relationship between:
— all intracranial tumors and all phone types; ipsilateral exposure;
— all intracranial tumors and all phone types, when the time of mobile phone use was not shorter than 10 years;
— all intracranial tumors and all phone types when the time from the first regular use of mobile phone was 10 years or more.

We are not able to compare our results with reference to different kinds of intracranial tumors (glioma, meningioma, acoustic neuroma) in relation to time of using mobile phones. A reliable analysis was not feasible because, in our opinion, the number of original works is too small.

Conclusions
Our results support the hypothesis that long-term (over 10 years) use of mobile phones increases the risk of intracranial tumors, especially in the case of ipsilateral exposure. The same conclusions are valid for the work by Davis et al. (2013) [45], who reviewed papers on the association between the use of wireless (mobile and cordless) phones and intracranial tumors. Those authors stress that the risk of tumors in people who have used the phone for periods longer than 10 years is significantly elevated. In people who had started using the phone on a regular basis before they were 20 years old, the risk of ipsilateral glioma was found to be fourfold higher. Hardell et al. (2013) [46] stress the significance of the “lifetime exposure dose.” For an exposure of ≥ 1640 h, the risk of ipsilateral acoustic neuroma is 2.55 (95% CI: 1.5–4.4).

These results are in concordance with the conclusion of the expert panel for the International Agency for Research on Cancer (IARC), that cell phones are possibly carcinogenic (Group 2B) [47]. More research is needed to confirm that electromagnetic fields emitted by mobile phones are carcinogenic to humans.

Open Access Paper: http://bit.ly/2m8Amwt

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Mobile phone use and risk of brain tumours: a systematic review of association between study quality, source of funding, and research outcomes

Prasad M, Kathuria P, Nair P, Kumar A, Prasad K. Mobile phone use and risk of brain tumours: a systematic review of association between study quality, source of funding, and research outcomes. Neurol Sci. 2017 Feb 17. doi: 10.1007/s10072-017-2850-8. [Epub ahead of print]

Abstract

Mobile phones emit electromagnetic radiations that are classified as possibly carcinogenic to humans. Evidence for increased risk for brain tumours accumulated in parallel by epidemiologic investigations remains controversial. This paper aims to investigate whether methodological quality of studies and source of funding can explain the variation in results. PubMed and Cochrane CENTRAL searches were conducted from 1966 to December 2016, which was supplemented with relevant articles identified in the references. Twenty-two case control studies were included for systematic review. Meta-analysis of 14 case-control studies showed practically no increase in risk of brain tumour [OR 1.03 (95% CI 0.92-1.14)]. However, for mobile phone use of 10 years or longer (or >1640 h), the overall result of the meta-analysis showed a significant 1.33 times increase in risk. The summary estimate of government funded as well as phone industry funded studies showed 1.07 times increase in odds which was not significant, while mixed funded studies did not show any increase in risk of brain tumour. Metaregression analysis indicated that the association was significantly associated with methodological study quality ($p < 0.019$, 95% CI 0.009-0.09). Relationship between source of funding and log OR for each study was not statistically significant ($p < 0.32$, 95% CI 0.036-0.010). We found evidence linking mobile phone use and risk of brain tumours especially in long-term users (≥10 years). Studies with higher quality showed a trend towards high risk of brain tumour, while lower quality showed a trend towards lower risk/protection.

https://www.ncbi.nlm.nih.gov/pubmed/28213724

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Non-ionizing radiation (NIR): Evaluating safety

Martin Blank. Non-ionizing radiation (NIR): Evaluating safety. Environmental Pollution. 222:153. March 2017. http://dx.doi.org/10.1016/j.envpol.2016.12.063.

No Abstract.

Excerpt

... the divisions of the EM spectrum were created by engineers and physicists who set frequency boundaries that did not take biological factors into account. It is clear that stress protein synthesis is stimulated across the ranges of the spectrum. If the public is to be protected, safety standards should be based on measurable properties that relate to protective biological mechanisms, rather than the less sensitive thermal criterion.

http://www.sciencedirect.com/science/article/pii/S0269749116328159

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Mobile phone types and SAR characteristics of the human brain

Lee AK, Hong SE, Kwon JH, Choi HD, Cardis E. Mobile phone types and SAR characteristics of the human brain.Phys Med Biol. 2017 Mar 7;62(7):2741-2761. doi: 10.1088/1361-6560/aa5c2d. [Epub ahead of print]

Abstract

Mobile phones differ in terms of their operating frequency, outer shape, and form and location of the antennae, all of which affect the spatial distributions of their electromagnetic field and the level of electromagnetic absorption in the human head or brain. For this paper, the specific absorption rate (SAR) was calculated for four anatomical head models at different ages using 11 numerical phone models of different shapes and antenna configurations. The 11 models represent phone types accounting for around 86% of the approximately 1400 commercial phone models released into the Korean market since 2002. Seven of the phone models selected have an internal dual-band antenna, and the remaining four possess an external antenna. Each model was intended to generate an average absorption level equivalent to that of the same type of commercial phone model operating at the maximum available output power. The 1 g peak spatial SAR and ipsilateral and contralateral brain-averaged SARs were reported for all 11 phone models. The effects of the phone type, phone position, operating frequency, and age of head models on the brain SAR were comprehensively determined.

https://www.ncbi.nlm.nih.gov/pubmed/28267685

Excerpts

Both the psSAR in the brain and the brain hemisphere-averaged SAR were analyzed for the four anatomical head models and 11 representative phone models. The head models used are Eartha and Billie (8 and 11 year-old females), and Louis and Duke (14 and 34 year-old males) from IT'IS. The 11 phone models include bar, slider, and flip types operating at 835 and 1850
MHz (1765 MHz for some of the flip-type models) ....

• Phone positions and SAR. The gap in the psSAR between the cheek and tilt positions is small in the brain compared to that in the SAM phantom. Flip-type phone models with an external antenna (M8h, M8w, M9h, and M9w) generated higher SAR levels at the left position than at the right position for both frequencies.
• Frequency and SAR. Both the psSAR and the brain hemisphere-averaged SAR are higher at low frequency (835 MHz) than at high frequency (1850 or 1765 MHz). This seems to be because the electromagnetic energy penetrates deeper and is deposited in a larger 'hot spot' area at lower frequency.
• Phone types and SAR. ...The closer the antenna is located to the receiver of the phone, the higher the SAR that seems to appear in the brain. The variability in the psSAR in the brain is much higher between the different phone types than between the different head models. It suggests that it is crucial for study subjects to report exact information on the phone models used for proper exposure assessments in epidemiological studies.
• Laterality of brain hemisphere-averaged SAR. The contralateral brain-averaged SAR level of some models such as M7 and M8 at low frequency is comparable to their ipsilateral brain-averaged SAR at high frequency.
• Age-related changes in SAR. Both the psSAR (tables 2 and 3) and the brain hemisphere-averaged SAR (figures 11 and 12) seem to be strongly influenced by the distance between the head (or auricle) surface and the surface of the temporal lobe of the brain; the temporal lobe of Eartha is the farthest away from the phone body out of all of head models, and Eartha showed the lowest 1 g psSAR and lowest ipsilateral brain-averaged SAR for most of the cases considered. Overall, the variability in the brain SAR of the four head models in this study did not form a consistent pattern with age.

It is impossible to obtain the proper amount of global information regarding the outer shape, antenna location, operating frequency, and detailed SAR values because the SAR-compliance process for mobile phones varies by country. The phone models used in this paper cover the phone types of around 86% of all commercial models released onto the Korean market
since 2002. The closer the antenna is located to the receiver of the phone, the higher the SAR is generally produced in the human brain. The maximum difference in psSAR in the brain between the numerical phone

models amounted to around 12 dB. The results suggest that it is very important for all subjects to report exact information on the phone models they use if
accurate exposure levels are to be obtained in epidemiological studies ....

The issue of whether children are more sensitive to EMF emitted from mobile phones has been a hot topic among many researchers over the past two decades. In this study, a maximum psSAR variability of 5.6 dB was shown between the four head models, but was not dependent on age. To generate representative head models, the anatomical morphology of the human head at different ages and for both genders is being statistically investigated using MR images of hundreds of Koreans from early childhood to adult. The resultant statistical figures will become the foundation for detecting age-related influences on the SAR.
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On the averaging area for incident power density for human exposure limits at frequencies over 6 GHz

Hashimoto Y, Hirata A, Morimoto R, Aonuma S, Laakso I, Jokela K, Foster K. On the averaging area for incident power density for human exposure limits at frequencies over 6 GHz. Phys Med Biol. 2017 Feb 8. doi: 10.1088/1361-6560/aa5f21.

Abstract

Incident power density is used as the dosimetric quantity to specify the restrictions on human exposure to electromagnetic fields at frequencies above 3 or 10 GHz in order to prevent excessive temperature elevation at the body surface. However, international standards and guidelines have different definitions for the size of the area over which the power density should be averaged. This study reports computational evaluation of the relationship between the size of the area over which incident power density is averaged and the local peak temperature elevation in a multi-layer model simulating a human body. Three wave sources are considered in the frequency range from 3 to 300 GHz: an ideal beam, a half-wave dipole antenna, and an antenna array. One-dimensional analysis shows that averaging area of 20 mm × 20 mm is a good measure to correlate with the local peak temperature elevation when the field distribution is nearly uniform in that area. The averaging area is different from recommendations in the current international standards/guidelines, and not dependent on the frequency. For a non-uniform field distribution, such as a beam with small diameter, the incident power density should be compensated by multiplying a factor that can be derived from the ratio of the effective beam area to the averaging area. The findings in the present study suggest that the relationship obtained using the one-dimensional approximation is applicable for deriving the relationship between the incident power density and the local temperature elevation.

https://www.ncbi.nlm.nih.gov/pubmed/28176675

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A Technical Approach to the Evaluation of Radiofrequency Radiation Emissions from Mobile Telephony Base Stations

Buckus R, Strukčinskienė B, Raistenskis J, Stukas R, Šidlauskienė A, Čerkauskienė R, Isopescu DN, Stabryla J, Cretescu I. A Technical Approach to the Evaluation of Radiofrequency Radiation Emissions from Mobile Telephony Base Stations. Int J Environ Res Public Health. 2017 Mar 1;14(3). pii: E244. doi: 10.3390/ijerph14030244.

Abstract

During the last two decades, the number of macrocell mobile telephony base station antennas emitting radiofrequency (RF) electromagnetic radiation (EMR) in residential areas has increased significantly, and therefore much more attention is being paid to RF EMR and its effects on human health. Scientific field measurements of public exposure to RF EMR (specifically to radio frequency radiation) from macrocell mobile

telephony base station antennas and RF electromagnetic field (EMF) intensity parameters in the environment are discussed in this article. The research methodology is applied according to the requirements of safety norms and Lithuanian Standards in English (LST EN). The article presents and analyses RF EMFs generated by mobile telephony base station antennas in areas accessible to the general public. Measurements of the RF electric field strength and RF EMF power density were conducted in the near- and far-fields of the mobile telephony base station antenna. Broadband and frequency-selective measurements were performed outside (on the roof and on the ground) and in a residential area. The tests performed on the roof in front of the mobile telephony base station antennas in the near-field revealed the presence of a dynamic energy interaction within the antenna electric field, which changes rapidly with distance. The RF EMF power density values on the ground at distances of 50, 100, 200, 300, 400, and 500 m from the base station are very low and are scattered within intervals of 0.002 to 0.05 μW/cm². The results were compared with international exposure guidelines (ICNIRP).

https://www.ncbi.nlm.nih.gov/pubmed/28257069

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Effect of Base Transceiver Station waves on some immunological and hematological factors in exposed persons

Taheri M, Roshanaei G, Ghaffari J, Rahimnejad S, Khosroshahi BN, Aliabadi M, Eftekharian MM. The effect of Base Transceiver Station waves on some immunological and hematological factors in exposed persons. Hum Antibodies. 2017;25(1-2):31-37. doi: 10.3233/HAB-160303.

Abstract

BACKGROUND: Since the number of mobile subscribers has significantly increased in recent years, the installation and deployment of Base Transceiver Station (BTS) antennas sending and receiving signals has become common and inevitable in different regions.

OBJECTIVE: In this study, we have tried to evaluate the effect of the waves on some immunological and hematological parameters in exposed individuals. In this study, the exposed and non-exposed individuals were used as the test and control groups, respectively.

METHODS: The test group was healthy people who resided in the vicinity of the Base Transceiver Station (BTS) antenna and received the maximum of radiation. The control group was selected from the healthy individuals that were matched with the exposed group by age. They resided in a distance of Base Transceiver Station (BTS) antenna and received the minimum of radiation. After stating complete explanations and obtaining the consent, the venous blood samples were taken from them. Then, CBC and the level of cytokines including IL-4, IL-10 and interferon γ were performed on the samples and the results were analyzed by SPSS software.

RESULTS: In the test group, the whole number of white blood cells, the level of hematocrit, percent of monocytes, eosinophils and basophils were significantly lower than the control group. The number of red blood cells, their average volume and the mean concentration of hemoglobin were notably higher than the controls. There was not observed a significant difference between the two groups in hemoglobin, its mean concentration, platelet count, percent of lymphocytes and neutrophils as well as serum levels of cytokines IL-4, IL-10 and interferon γ .

CONCLUSIONS: It seems that radiation of mobile phone antennas influenced the blood and immune systems, but further study should be done to exactly determine the targets.

https://www.ncbi.nlm.nih.gov/pubmed/27911288

Also see: http://bit.ly/1cXH1B4

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A study on the effect of prolonged mobile phone use on pure tone audiometry thresholds of medical students of Sikkim

Das S, Chakraborty S, Mahanta B. A study on the effect of prolonged mobile phone use on pure tone audiometry thresholds of medical students of Sikkim. J Postgrad Med. 2017 Mar 3. doi: 10.4103/0022-3859.201419. [Epub ahead of print]

Abstract

INTRODUCTION: Mobile phones have become indispensable for daily activities, and people are exposed to them from an early age. There is, however, concern about the harmful effect of the electromagnetic radiation emitted from the mobile phones.

OBJECTIVE: The objective of the study was to study the effect of mobile phone on average pure tone audiometry (PTA) threshold of the person and to study the changes in the pure tone threshold at high frequencies such as 2 kHz, 4 kHz, and 8 kHz among the students with prolonged exposure to mobile phones.

METHODOLOGY: A cross-sectional study was conducted among the medical students who have been using mobile phones for the past 5 years. The effect of mobile phones on the PTA threshold in the exposed ear and the nonexposed ear was assessed.

RESULTS: The study shows that there is a significant difference in average air conduction (AC) and bone conduction (BC) hearing threshold among the exposed and the nonexposed ears ($P < 0.05$). A significant rise of both AC and BC threshold at individual frequencies between the exposed and the nonexposed ear is also noted in this study.

CONCLUSION: The study conducted shows changes in the hearing threshold of the exposed ear when compared with the nonexposed ear. There are however lot of unanswered questions which provide an interesting avenue for further research. Till concrete evidence is available the only feasible way to control its exposure is to limit the duration of usage of mobile phones.

https://www.ncbi.nlm.nih.gov/pubmed/28272071

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RF EMR from cell phone causes defective testicular function in male Wistar rats

Oyewopo AO, Olaniyi SK, Oyewopo CI, Jimoh AT. Radiofrequency electromagnetic radiation from cell phone causes defective testicular function in male Wistar rats. Andrologia. 2017 Mar 6. doi: 10.1111/and.12772. [Epub ahead of print]

Abstract

Cell phones have become an integral part of everyday life. As cell phone usage has become more widespread, concerns have increased regarding the harmful effects of radiofrequency electromagnetic radiation from these devices. The current study was undertaken to investigate the effects of the emitted radiation by cell phones on testicular histomorphometry and biochemical analyses. Adult male Wistar rats weighing 180-200 g were randomly allotted to control, group A (switched off mode exposure), group B (1-hr exposure), group C (2-hr exposure) and group D (3-hr exposure). The animals were exposed to radiofrequency electromagnetic radiation of cell phone for a period of 28 days. Histomorphometry, biochemical and histological investigations

were carried out. The histomorphometric parameters showed no significant change ($p < .05$) in the levels of germinal epithelial diameter in all the experimental groups compared with the control group. There was no significant change ($p < .05$) in cross-sectional diameter of all the experimental groups compared with the control group. Group D rats showed a significant decrease ($p < .05$) in lumen diameter compared with group B rats. There was an uneven distribution of germinal epithelial cells in groups B, C and D. However, there was degeneration of the epithelia cells in group D when compared to the control and group B rats. Sera levels of malondialdehyde (MDA) and superoxide dismutase (SOD), which are markers of reactive oxygen species, significantly increased (MDA) and decreased (SOD), respectively, in all the experimental groups compared with the control group. Also sera levels of gonadotropic hormones (FSH, LH and testosterone) significantly decreased ($p < .05$) in groups C and D compared with the control group. The study demonstrates that chronic exposure to radiofrequency electromagnetic radiation of cell phone leads to defective testicular function that is associated with increased oxidative stress and decreased gonadotropic hormonal profile.

https://www.ncbi.nlm.nih.gov/pubmed/28261838

Also see: http://www.saferemr.com/2015/09/effect-of-mobile-phones-on-sperm.html

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Activation of autophagy at cerebral cortex and apoptosis at brainstem are differential responses to 835 MHz RF-EMF exposure

Kim JH, Yu DH, Kim HR. Activation of autophagy at cerebral cortex and apoptosis at brainstem are differential responses to 835 MHz RF-EMF exposure. Korean J Physiol Pharmacol. 2017 Mar;21(2):179-188. doi: 10.4196/kjpp.2017.21.2.179. Epub 2017 Feb 21.

Abstract

With the explosive increase in exposure to radiofrequency electromagnetic fields (RF-EMF) emitted by mobile phones, public concerns have grown over the last few decades with regard to the potential effects of EMF exposure on the nervous system in the brain. Many researchers have suggested that RF-EMFs can effect diverse neuronal alterations in the brain, thereby affecting neuronal functions as well as behavior. Previously, we showed that long-term exposure to 835 MHz RF-EMF induces autophagy in the mice brain. In this study, we explore whether short-term exposure to RF-EMF leads to the autophagy pathway in the cerebral cortex and brainstem at 835 MHz with a specific absorption rate (SAR) of 4.0 W/kg for 4 weeks. Increased levels of autophagy genes and proteins such as LC3B-II and Beclin1 were demonstrated and the accumulation of autophagosomes and autolysosomes was observed in cortical neurons whereas apoptosis pathways were up-regulated in the brainstem but not in the cortex following 4 weeks of RF exposure. Taken together, the present study indicates that monthly exposure to RF-EMF induces autophagy in the cerebral cortex and suggests that autophagic degradation in cortical neurons against a stress of 835 MHz RF during 4 weeks could correspond to adaptation to the RF stress environment. However, activation of apoptosis rather than autophagy in the brainstem is suggesting the differential responses to the RF-EMF stresses in the brain system.

https://www.ncbi.nlm.nih.gov/pubmed/28280411

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RF radiation induced genotoxic and carcinogenic effects on chickpea root tip cells

Sadaf Tabasum Qureshi, Sajjad Ahmed Memon, Abdul Rasool Abassi, Mahboob Ali Sial, Farooque Ali Bughio. Radiofrequency radiations induced genotoxic and carcinogenic effects on chickpea (Cicer arietinum L.) root tip cells. Saudi Journal of Biological Sciences. Published online Feb 11, 2017.
http://dx.doi.org/10.1016/j.sjbs.2016.02.011

Abstract

Present study was under taken to predict the possible DNA damages (genotoxicity) and carcinogenicity caused by radiofrequency radiations (RF) to living tissue. Dry seeds of chickpea were treated with GSM cell phone (900 MHz) and laptop (3.31 GHz) as RF source for 24 and 48 h. Untreated seeds were used as (0 h) negative control and Gamma rays (250 Gray) as positive control. Plant chromosomal aberration assay was used as genotoxicity marker. All the treatment of RF inhibits seed germination percentage. 48 h laptop treatment has the most negative effect as compared to untreated control. A decrease was observed in mitotic index (M.I) and increase in abnormality index (A.I) with the increase in exposure duration and frequency in (Hz). Cell membrane damages were also observed only in 48 h exposure of cell phone and laptop (RF). Maximum nuclear membrane damages and ghost cells were again recorded in 48 h exposure of cell phone and laptop. The radiofrequency radiations (900 MHz and 3.31 GHz) are only genotoxic as they induce micronuclei, bi-nuclei, multi-nuclei and scattered nuclei but could be carcinogenic as 48 h incubation of RF induced fragmentation and ghost cells. Therefore cell phones and laptop should not be used unnecessarily to avoid possible genotoxic and carcinogenic effects.

Conclusion

It is concluded that radiofrequency radiations are genotoxic as they induced chromosomal aberrations in chickpea mitotic cells and the presence of ghost cells is clear indication of their carcinogenic potential. To avoid reported DNA damages in this work cell phones should always be used either for short duration or with hands-free for long duration and they should not be kept in pockets or near body. Laptops should not be used unnecessarily for enjoyment purpose. It must be placed on desk top rather lap to minimize their exposure to human body. Further assay of carcinogenity are recommended on mouse and human cell lines.

http://www.sciencedirect.com/science/article/pii/S1319562X16000589

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ELF-MF exposure affects the robustness of epigenetic programming during granulopoiesis

Manser M, Sater MR, Schmid CD, Noreen F, Murbach M, Kuster N, Schuermann D, Schär P. ELF-MF exposure affects the robustness of epigenetic programming during granulopoiesis. Sci Rep. 2017 Mar 7;7:43345. doi: 10.1038/srep43345.

Abstract

Extremely-low-frequency magnetic fields (ELF-MF) have been classified as "possibly carcinogenic" to humans on the grounds of an epidemiological association of ELF-MF exposure with an increased risk of childhood leukaemia. Yet, underlying mechanisms have remained obscure. Genome instability seems an unlikely reason as the energy transmitted by ELF-MF is too low to damage DNA and induce cancer-promoting mutations. ELF-MF, however, may perturb the epigenetic code of genomes, which is well-known to be sensitive to environmental conditions and generally deranged in cancers, including leukaemia. We examined the potential of ELF-MF to influence key epigenetic modifications in leukaemic Jurkat cells and in human CD34+ haematopoietic stem cells undergoing in vitro differentiation into the neutrophilic lineage. During granulopoiesis, sensitive genome-wide profiling of multiple replicate experiments did not reveal any statistically significant, ELF-MF-dependent alterations in the patterns of active (H3K4me2) and repressive (H3K27me3) histone marks nor in DNA methylation. However, ELF-MF exposure showed consistent effects on the reproducibility of these histone and DNA modification profiles (replicate variability), which appear to be of a stochastic nature but show preferences for the genomic context. The data indicate that ELF-MF exposure stabilizes active chromatin, particularly during the transition from a repressive to an active state during cell differentiation.

https://www.ncbi.nlm.nih.gov/pubmed/28266526

In conclusion, we report that ELF-MF exposure has no significant effect in a deterministic manner on the epigenetic landscapes of leukaemic and differentiating haematopoietic cells. However, our data indicate that ELF-MF exposure may influence the robustness of histone modification and DNA methylation patterning in the course of the global chromatin reorganization associated with neutrophilic differentiation. This, however, did not affect notably the overall dynamics and efficiency of granulopoiesis.

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Spontaneous magnetic alignment behaviour in free-living lizards

Diego-Rasilla FJ, Pérez-Mellado V, Pérez-Cembranos A. Spontaneous magnetic alignment behaviour in free-living lizards. Naturwissenschaften. 2017 Apr;104(3-4):13. doi: 10.1007/s00114-017-1439-7. Epub 2017 Mar 1.

Abstract

Several species of vertebrates exhibit spontaneous longitudinal body axis alignment relative to the Earth's magnetic field (i.e., magnetic alignment) while they are performing different behavioural tasks. Since magnetoreception is still not fully understood, studying magnetic alignment provides evidence for magnetoreception and broadens current knowledge of magnetic sense in animals. Furthermore, magnetic alignment widens the roles of magnetic sensitivity in animals and may contribute to shed new light on magnetoreception. In this context, spontaneous alignment in two species of lacertid lizards (Podarcis muralis and Podarcis lilfordi) during basking periods was monitored. Alignments in 255 P. muralis and 456 P. lilfordi were measured over a 5-year period. The possible influence of the sun's position (i.e., altitude and azimuth) and geomagnetic field values corresponding to the moment in which a particular lizard was observed on lizards' body axis orientation was evaluated. Both species exhibited a highly significant bimodal orientation along the north-northeast and south-southwest magnetic axis. The evidence from this study suggests that free-living lacertid lizards exhibit magnetic alignment behaviour, since their body alignments cannot be explained by an effect of the sun's position. On the contrary, lizard orientations were significantly correlated with geomagnetic field values at the time of each observation. We suggest that this behaviour might provide lizards with a constant directional reference while they are sun basking. This directional reference might improve their mental map of space to accomplish efficient escape behaviour. This study is the first to provide spontaneous magnetic alignment behaviour in free-living reptiles.

https://www.ncbi.nlm.nih.gov/pubmed/28251303

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Corporate Ties That Bind: An Examination of Corporate Manipulation and Vested Interest in Public Health. Martin J. Walker (Ed.). New York: Skyhorse Publishing. Mar 28, 2017. 24 chapters; 592 pp.

In the 21st century, corporations have worked their way into government and, as they become increasingly more powerful, arguments about their involvement with public health have become increasingly black and white. With corporations at the center of public health and environmental issues, everything chemical or technological is good, everything natural is bad; scientists who are funded by corporations are right and those who are independent are invariably wrong. There is diminishing common ground between the two opposed sides in these arguments.

Corporate Ties that Bind is a collection of essays written by influential academic scholars, activists, and epidemiologists from around the world that scrutinize the corporate reasoning, false science and trickery involving those, like in-house epidemiologists, who mediate the scientific message of organizations who attack and censure independent voices. This book addresses how the growth of corporatism is destroying liberal democracy and personal choice.

Whether addressing asbestos, radiation, PCBs, or vaccine regulation, the essays here address the dangers of trusting corporations and uncover the lengths to which corporations put profits before health.

Foreward: David O. Carpenter

Chapter 3: Lennart Hardell. A Battleground--From Phenoxyacetic Acids, Chlorphenyls and Dioxins to Mobile Phones--Cancer Risks, Greenwashing and Vested Interests

Chapter 10: Christian Blom. Escaping Electrosensitivity.

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Brief Report on the Gaps in the Knowledge about the Health Effects of the RF-EMF Exposures

Leszczynski D. Brief Report on the Gaps in the Knowledge about the Health Effects of the RF-EMF Exposures. unpublished paper. Mar 15, 2017.

https://betweenrockandhardplace.files.wordpress.com/2017/03/brief-report-on-gaps-in-the-knowledge.pdf

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Analysis of mobile phone use among young patients with brain tumors in Japan

Sato Y, Kojimahara N, Yamaguchi N. Analysis of mobile phone use among young patients with brain tumors in Japan. Bioelectromagnetics. 2017 Mar 24. doi: 10.1002/bem.22047.

Abstract

The purpose of this study was to clarify ownership and usage of mobile phones among young patients with brain tumors in Japan. The subjects of this study were patients with brain tumors diagnosed between 2006 and 2010 who were between the ages of 6 and 18 years. The target population for the analysis was 82 patients. Patients were divided into two groups: 16 patients who were mobile phone owners 1 year before diagnosis, and 66 patients who did not own mobile phones (non-owners). Using data on the mobile phone ownership rate obtained from three general-population surveys, we calculated the expected number of mobile phone owners. The three age-adjusted standardized ownership ratios were 0.83 (95% confidence interval [CI]: 0.56-1.22), 0.51 (95% CI: 0.24-1.04), and 0.75 (95% CI: 0.42-1.32). The mobile phone ownership prevalence among the young Japanese patients with brain tumors in the current study does not differ from available estimates for the general population of corresponding age. However, since the use of mobile phones among children is increasing annually, investigations into the health effects of mobile phone use among children should continue.

https://www.ncbi.nlm.nih.gov/pubmed/28342194

Note: This study has some major methodologic limitations including a small sample size. The study did not examine other sources of exposure to RF radiation (e.g., cordless phone use).

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Electronic control of gene expression and cell behaviour in Escherichia coli through redox signalling

Tschirhart T, Kim E, McKay R, Ueda H, Wu HC, Pottash AE, Zargar A, Negrete A, Shiloach J, Payne GF, Bentley WE. Electronic control of gene expression and cell behaviour in Escherichia coli through redox signalling. Nat Commun. 2017 Jan 17;8:14030. doi: 10.1038/ncomms14030.

Abstract

The ability to interconvert information between electronic and ionic modalities has transformed our ability to record and actuate biological function. Synthetic biology offers the potential to expand communication 'bandwidth' by using biomolecules and providing electrochemical access to redox-based cell signals and behaviours. While engineered cells have transmitted molecular information to electronic devices, the potential for bidirectional communication stands largely untapped. Here we present a simple electrogenetic device that uses redox biomolecules to carry electronic information to engineered bacterial cells in order to control transcription from a simple synthetic gene circuit. Electronic actuation of the native transcriptional regulator SoxR and transcription from the PsoxS promoter allows cell response that is quick, reversible and dependent on the amplitude and frequency of the imposed electronic signals. Further, induction of bacterial motility and population based cell-to-cell communication demonstrates the versatility of our approach and potential to drive intricate biological behaviours.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5247576/

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Exposure to radiofrequency radiation emitted from mobile phone jammers adversely affects the quality of human sperm

M.E. Parsanezhad, S.M.J. Mortazavi, T. Doohandeh, B. Namavar Jahromi1, H. Mozdarani, A. Zarei, M. Davari, S. Amjadi,
A. Soleimani, M. Haghani. Exposure to radiofrequency radiation emitted from mobile phone jammers adversely affects the quality of human sperm. International Journal of Radiation Research. 15(1). Jan 2017.

Abstract

Background: The health effect of rapidly increasing everyday exposure of humans to radiofrequency radiation is a major global concern. Mobile phone jammers prevent the mobile phones from receiving signals from base stations by interfering with authorized mobile carriers' services. In spite of the fact that mobile jammer use is illegal, they are occasionally used in offices,
shrines, conference rooms and cinemas. The purpose of this study was to investigate the biological effects of short term exposure of human sperm to radiofrequency radiation emitted from a commercial mobile phone jammer.

Materials and Methods: Fresh semen samples were obtained by masturbation from 50 healthy donors who had referred with their wives to Infertility Treatment Center at the Mother and Child Hospital, Shiraz University of Medical Sciences. Female problem was diagnosed as the reason for infertility in these couples. The semen sample of each participant was divided into 4 aliquots. The first aliquot was subjected to swim-up and exposed to jammer radiation. The second aliquot was not subjected to swimup but was exposed to jammer radiation. The third and fourth aliquots were not exposed to jammer radiation but only the 3rd aliquot was subjected to swim-up.

Results: Semen samples exposed to radiofrequency radiation showed a significant decrease in sperm motility and increase in DNA fragmentation.

Conclusion: Electromagnetic radiation in radiofrequency range emitted from mobile phone jammers may lead to decreased motility and increased DNA fragmentation in human semen. It can be concluded that mobile phone jamming might exert adverse reproductive health effects.

http://bit.ly/2nyVhck

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Pulsed or continuous EMF induce apoptotic signaling pathway in mouse spermatogenic cells in vitro and may affect male fertility

Solek P, Majchrowicz L, Bloniarz D, Krotoszynska E, Koziorowski M. Pulsed or continuous electromagnetic field induce p53/p21-mediated apoptotic signaling pathway in mouse spermatogenic cells in vitro and thus may affect male fertility. Toxicology. 2017 Mar 16. pii: S0300-483X(17)30092-6. doi: 10.1016/j.tox.2017.03.015. [Epub ahead of print]

Abstract

The impact of electromagnetic field (EMF) on the human health and surrounding environment is a common topic investigated over the years. A significant increase in the electromagnetic field concentration arouses public concern about the long-term effects of EMF on living organisms associated with many aspects. In the present study, we investigated the effects of pulsed and continuous electromagnetic field (PEMF/CEMF) on mouse spermatogenic cell lines (GC-1 spg and GC-2 spd) in terms of cellular and biochemical features in vitro. We evaluated the effect of EMF on mitochondrial metabolism, morphology, proliferation rate, viability, cell cycle progression, oxidative stress balance and regulatory proteins. Our results strongly suggest that EMF induces oxidative and nitrosative stress-mediated DNA damage, resulting in p53/p21-dependent cell cycle arrest and apoptosis. Therefore, spermatogenic cells due to the lack of antioxidant enzymes undergo oxidative and nitrosative stress-mediated cytotoxic and genotoxic events, which contribute to infertility by reduction in healthy sperm cells pool. In conclusion, electromagnetic field present in surrounding environment impairs male fertility by inducing p53/p21-mediated cell cycle arrest and apoptosis.

https://www.ncbi.nlm.nih.gov/pubmed/28323003

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Exposing the G-quadruplex to electric fields: the role played by telomeres in the propagation of DNA errors

Cerón-Carrasco JP, Jacquemin D. Exposing the G-quadruplex to electric fields: the role played by telomeres in the propagation of DNA errors. Phys Chem Chem Phys. 2017 Mar 20. doi: 10.1039/c7cp01034f. [Epub ahead of print]

Abstract

To protect their core machinery from the attack of exogenous agents, cells locate DNA in their nucleus. Nevertheless, some reactive chemical species and physical agents might reach DNA and alter its natural double helix structure. For instance, pulsed electric fields can be used to selectively rewrite the stored genetic information. However, for such modification to be effective, one needs, as a prerequisite, that the replication mechanism is not stopped by the field, so that the changes propagate over the following generations. Here, we use theoretical calculations to demonstrate that while such fields lead to permanent noncanonical Watson-Crick guanine-cytosine (GC) base pairs, the G-quadruplex motifs present in telomeres can more effectively preserve their native forms. Indeed, G-quadruplexes "resist" the perturbations induced by field strengths going up to 60 × 10-4 a.u., a figure constituting the upper limit before the complete destruction of the double helix architecture. Since the induced errors in the DNA base pairs are not transcribed into the telomeres, electric fields can indeed be used as a source of selective mutations in the genetic code.

https://www.ncbi.nlm.nih.gov/pubmed/28317975

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Effect of 1.8 GHz RF EMR on novel object associative recognition memory in mice

Wang K, Lu JM, Xing ZH, Zhao QR, Hu LQ, Xue L, Zhang J, Mei YA. Effect of 1.8 GHz radiofrequency electromagnetic radiation on novel object associative recognition memory in mice. Sci Rep. 2017 Mar 17;7:44521. doi: 10.1038/srep44521.

Abstract

Mounting evidence suggests that exposure to radiofrequency electromagnetic radiation (RF-EMR) can influence learning and memory in rodents. In this study, we examined the effects of single exposure to 1.8 GHz RF-EMR for 30 min on subsequent recognition memory in mice, using the novel object recognition task (NORT). RF-EMR exposure at an intensity of >2.2 W/kg specific absorption rate (SAR) power density induced a significant density-dependent increase in NORT index with no corresponding changes in spontaneous locomotor activity. RF-EMR exposure increased dendritic-spine density and length in hippocampal and prefrontal cortical neurons, as shown by Golgi staining. Whole-cell recordings in acute hippocampal and medial prefrontal cortical slices showed that RF-EMR exposure significantly altered the resting membrane potential and action potential frequency, and reduced the action potential half-width, threshold, and onset delay in pyramidal neurons. These results demonstrate that exposure to 1.8 GHz RF-EMR for 30 min can significantly increase recognition memory in mice, and can change dendritic-spine morphology and neuronal excitability in the hippocampus and prefrontal cortex. The SAR in this study (3.3 W/kg) was outside the range encountered in normal daily life, and its relevance as a potential therapeutic approach for disorders associated with recognition memory deficits remains to be clarified.

https://www.ncbi.nlm.nih.gov/pubmed/28303965

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Mitochondrial DNA damage and oxidative damage in HL-60 cells exposed to 900MHz RF

Sun Y, Zong L, Gao Z, Zhu S, Tong J, Cao Y. Mitochondrial DNA damage and oxidative damage in HL-60 cells exposed to 900MHz radiofrequency fields. Mutat Res. 2017 Mar 7;797-799:7-14. doi: 10.1016/j.mrfmmm.2017.03.001.

Abstract

HL-60 cells, derived from human promyelocytic leukemia, were exposed to continuous wave 900MHz radiofrequency fields (RF) at 120μW/cm2 power intensity for 4h/day for 5 consecutive days to examine whether such exposure is capable damaging the mitochondrial DNA (mtDNA) mediated through the production of reactive oxygen species (ROS). In addition, the effect of RF exposure was examined on 8-hydroxy-2'-dexoyguanosine (8-OHdG) which is a biomarker for oxidative damage and on the mitochondrial synthesis of adenosine triphosphate (ATP) which is the energy required for cellular functions. The results indicated a significant increase in ROS and significant decreases in mitochondrial transcription factor A, mtDNA polymerase gamma, mtDNA transcripts and mtDNA copy number in RF-exposed cells compared with those in sham-exposed control cells. In addition, there was a significant increase in 8-OHdG and a significant decrease in ATP in RF-exposed cells. The response in positive control cells exposed to gamma radiation (GR, which is also known to induce ROS) was similar to those in RF-exposed cells. Thus, the overall data indicated that RF exposure was capable of inducing mtDNA damage mediated through ROS pathway which also induced oxidative damage. Prior-treatment of RF- and GR-exposed the cells with melatonin, a well-known free radical scavenger, reversed the effects observed in RF-exposed cells.

https://www.ncbi.nlm.nih.gov/pubmed/28340409

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Personal medical electronic devices and walk-through metal detector security systems: assessing EMI effects

Guag J, Addissie B, Witters D. Personal medical electronic devices and walk-through metal detector security systems: assessing electromagnetic interference effects. Biomed Eng Online. 2017 Mar 20;16(1):33. doi: 10.1186/s12938-017-0328-9.

Abstract

BACKGROUND: There have been concerns that Electromagnetic security systems such as walk-through metal detectors (WTMDs) can potentially cause electromagnetic interference (EMI) in certain active medical devices including implantable cardiac pacemakers and implantable neurostimulators. Incidents of EMI between WTMDs and active medical devices also known as personal medical electronic devices (PMED) continue to be reported. This paper reports on emission measurements of sample WTMDs and testing of 20 PMEDs in a WTMD simulation system.

METHODS: Magnetic fields from sample WTMD systems were characterized for emissions and exposure of certain PMEDs. A WTMD simulator system designed and evaluated by FDA in previous studies was used to mimic the PMED exposures to the waveform from sample WTMDs. The simulation system allows for controlled PMED exposure enabling careful study with adjustable magnetic field strengths and exposure duration, and provides flexibility for PMED exposure at elevated levels in order to study EMI effects on the PMED. The PMED samples consisted of six implantable cardiac pacemakers, six implantable cardioverter defibrillators (ICD), five implantable neurostimulators, and three insulin pumps. Each PMED was exposed in the simulator to the sample WTMD waveforms using methods based on appropriate consensus test standards for each of the device type.

RESULTS: Testing the sample PMEDs using the WTMD simulator revealed EMI effects on two implantable pacemakers and one implantable neurostimulator for exposure field strength comparable to actual WTMD field strength. The observed effects were transient and the PMEDs returned to pre-exposure operation within a few seconds after removal from the simulated WTMD exposure fields. No EMI was observed for the sample ICDs or insulin pumps.

CONCLUSION: The findings are consistent with earlier studies where certain sample PMEDs exhibited EMI effects. Clinical implications were not addressed in this study. Additional studies are needed to evaluate potential PMED EMI susceptibilities over a broader range of security systems.

https://www.ncbi.nlm.nih.gov/pubmed/28320451

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Exposure to EMF from smart utility meters in Great Britain; part I) laboratory measurements

Peyman A, Addison D, Mee T, Goiceanu C, Maslanyj M, Mann S. Exposure to electromagnetic fields from smart utility meters in GB; part I) laboratory measurements. Bioelectromagnetics. 2017 Mar 21. doi: 10.1002/bem.22044. [Epub ahead of print]

Abstract

Laboratory measurements of electric fields have been carried out around examples of smart meter devices used in Great Britain. The aim was to quantify exposure of people to radiofrequency signals emitted from smart meter devices operating at 2.4 GHz, and then to compare this with international (ICNIRP) health-related guidelines and with exposures from other telecommunication sources such as mobile phones and Wi-Fi devices. The angular distribution of the electric fields from a sample of 39 smart meter devices was measured in a controlled laboratory environment. The angular direction where the power density was greatest was

identified and the equivalent isotropically radiated power was determined in the same direction. Finally, measurements were carried out as a function of distance at the angles where maximum field strengths were recorded around each device. The maximum equivalent power density measured during transmission around smart meter devices at 0.5 m and beyond was 15 mWm^{-2} , with an estimation of maximum duty factor of only 1%. One outlier device had a maximum power density of 91 mWm^{-2} . All power density measurements reported in this study were well below the 10 W m^{-2}

https://www.ncbi.nlm.nih.gov/pubmed/28324620

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The effect of Wi-Fi EMF on object recognition tasks in male rats

Hassanshahi A, Shafeie SA, Fatemi I, Hassanshahi E, Allahtavakoli M, Shabani M, Roohbakhsh A, Shamsizadeh A. The effect of Wi-Fi electromagnetic waves in unimodal and multimodal object recognition tasks in male rats.Neurol Sci. 2017 Mar 22. doi: 10.1007/s10072-017-2920-y. [Epub ahead of print]

Abstract

Wireless internet (Wi-Fi) electromagnetic waves (2.45 GHz) have widespread usage almost everywhere, especially in our homes. Considering the recent reports about some hazardous effects of Wi-Fi signals on the nervous system, this study aimed to investigate the effect of 2.4 GHz Wi-Fi radiation on multisensory integration in rats. This experimental study was done on 80 male Wistar rats that were allocated into exposure and sham groups. Wi-Fi exposure to 2.4 GHz microwaves [in Service Set Identifier mode (23.6 dBm and 3% for power and duty cycle, respectively)] was done for 30 days (12 h/day). Cross-modal visual-tactile object recognition (CMOR) task was performed by four variations of spontaneous object recognition (SOR) test including standard SOR, tactile SOR, visual SOR, and CMOR tests. A discrimination ratio was calculated to assess the preference of animal to the novel object. The expression levels of M1 and GAT1 mRNA in the hippocampus were assessed by quantitative real-time RT-PCR. Results demonstrated that rats in Wi-Fi exposure groups could not discriminate significantly between the novel and familiar objects in any of the standard SOR, tactile SOR, visual SOR, and CMOR tests. The expression of M1 receptors increased following Wi-Fi exposure. In conclusion, results of this study showed that chronic exposure to Wi-Fi electromagnetic waves might impair both unimodal and cross-modal encoding of information.

https://www.ncbi.nlm.nih.gov/pubmed/28332042

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Assessment of Public Exposure From WLANs in the West Bank-Palestine

Lahham A, Sharabati A, ALMasri H. Assessment of Public Exposure From WLANs in the West Bank-Palestine. Radiat Prot Dosimetry. 2017 Mar 3:1-5. doi: 10.1093/rpd/ncx028.

Abstract

A total of 271 measurements were conducted at 69 different sites including homes, hospitals, educational institutions and other public places to assess the exposure to radiofrequency emission from wireless local area networks (WLANs). Measurements were conducted at different distances from 40 to 10 m from the access points (APs) in real life conditions using Narda SRM-3000 selective radiation meter. Three measurements modes were considered at 1 m distance from the AP which are transmit mode, idle mode, and from the client card (laptop computer). All measurements were conducted indoor in the West Bank environment. Power density levels from WLAN systems were found to vary from 0.001 to ~1.9 μW cm-2 with an average of 0.12 μW cm-2. Maximum value found was in university environment, while the minimum was found in schools. For one measurement case where the AP was 20 cm far while transmitting large files, the measured power density

reached a value of ~4.5 μW cm-2. This value is however 221 times below the general public exposure limit recommended by the International Commission on Non-Ionizing Radiation Protection, which was not exceeded in any case. Measurements of power density at 1 m around the laptop resulted in less exposure than the AP in both transmit and idle modes as well. Specific absorption rate for the head of the laptop user was estimated and found to vary from 0.1 to 2 mW/kg. The frequency distribution of measured power densities follows a log-normal distribution which is generally typical in the assessment of exposure resulting from sources of radiofrequency emissions.

https://www.ncbi.nlm.nih.gov/pubmed/28338865

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Effect of acute millimeter wave exposure on dopamine metabolism of NGF-treated PC12 cells

Haas AJ, Le Page Y, Zhadobov M, Sauleau R, Dréan YL, Saligaut C. Effect of acute millimeter wave exposure on dopamine metabolism of NGF-treated PC12 cells. J Radiat Res. 2017 Feb 24:1-7. doi: 10.1093/jrr/rrx004.

Abstract

Several forthcoming wireless telecommunication systems will use electromagnetic frequencies at millimeter waves (MMWs), and technologies developed around the 60-GHz band will soon know a widespread distribution. Free nerve endings within the skin have been suggested to be the targets of MMW therapy which has been used in the former Soviet Union. So far, no studies have assessed the impact of MMW exposure on neuronal metabolism. Here, we investigated the effects of a 24-h MMW exposure at 60.4 GHz, with an incident power density (IPD) of 5 mW/cm², on the dopaminergic turnover of NGF-treated PC12 cells. After MMW exposure, both intracellular and extracellular contents of dopamine (DA) and 3,4-dihydroxyphenylacetic acid (DOPAC) were studied using high performance liquid chromatography. Impact of exposure on the dopamine transporter (DAT) expression was also assessed by immunocytochemistry. We analyzed the dopamine turnover by assessing the ratio of DOPAC to DA, and measuring DOPAC accumulation in the medium. Neither dopamine turnover nor DAT protein expression level were impacted by MMW exposure. However, extracellular accumulation of DOPAC was found to be slightly increased, but not significantly. This result was related to the thermal effect, and overall, no evidence of non-thermal effects of MMW exposure were observed on dopamine metabolism.

https://www.ncbi.nlm.nih.gov/pubmed/28339776

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SAR Simulations & Safety

Fiedler TM, Ladd ME, Bitz AK. SAR Simulations & Safety. Neuroimage. 2017 Mar 20. pii: S1053-8119(17)30243-4. doi: 10.1016/j.neuroimage.2017.03.035.

Abstract

At ultra-high fields, the assessment of radiofrequency (RF) safety presents several new challenges compared to low-field systems. Multi-channel RF transmit coils in combination with parallel transmit techniques produce time-dependent and spatially varying power loss densities in the tissue. Further, in ultra-high-field systems, localized field effects can be more pronounced due to a transition from the quasistationary to the electromagnetic field regime. Consequently, local information on the RF field is required for reliable RF safety assessment as well as for monitoring of RF exposure during MR examinations. Numerical RF and thermal simulations for realistic exposure scenarios with anatomical body models are currently the only practical way to obtain the requisite local information on magnetic and electric field distributions as well as tissue temperature. In this article, safety regulations and the fundamental characteristics of RF field distributions in ultra-high-field

systems are reviewed. Numerical methods for computation of RF fields as well as typical requirements for the analysis of realistic multi-channel RF exposure scenarios including anatomical body models are highlighted. In recent years, computation of the local tissue temperature has become of increasing interest, since a more accurate safety assessment is expected because temperature is directly related to tissue damage. Regarding thermal simulation, bio-heat transfer models and approaches for taking into account the physiological response of the human body to RF exposure are discussed. In addition, suitable methods are presented to validate calculated RF and thermal results with measurements. Finally, the concept of generalized simulation-based specific absorption rate (SAR) matrix models is discussed. These models can be incorporated into local SAR monitoring in multi-channel MR systems and allow the design of RF pulses under constraints for local SAR.

https://www.ncbi.nlm.nih.gov/pubmed/28336426

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Effect of adverse environmental conditions & protective clothing on temperature rise in a human exposed to RF EMF

Moore SM, McIntosh RL, Iskra S, Lajevardipour A, Wood AW. Effect of adverse environmental conditions and protective clothing on temperature rise in a human body exposed to radiofrequency electromagnetic fields. Bioelectromagnetics. 2017 Mar 24. doi: 10.1002/bem.22048.

Abstract

This study considers the computationally determined thermal profile of a finely discretized, heterogeneous human body model, simulating a radiofrequency electromagnetic field (RF-EMF) worker wearing protective clothing subject to RF-EMF exposure, and subject to various environmental conditions including high ambient temperature and high humidity, with full thermoregulatory mechanisms in place. How the human body responds in various scenarios was investigated, and the information was used to consider safety limits in current international RF-EMF safety guidelines and standards. It was found that different environmental conditions had minimal impact on the magnitude of the thermal response due to RF-EMF exposure, and that the current safety factor of 10 applied in international RF-EMF safety guidelines and standards for RF-EMF workers is generally conservative, though it is only narrowly so when workers are subjected to the most adverse environmental conditions.

https://www.ncbi.nlm.nih.gov/pubmed/28342187

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"These Power Lines Make Me Ill": A Typology of Residents' Health Responses to a New High-Voltage Power Line

Porsius JT, Claassen L, Woudenberg F, Smid T, Timmermans DR."These Power Lines Make Me Ill": A Typology of Residents' Health Responses to a New High-Voltage Power Line. Risk Anal. 2017 Mar 17. doi: 10.1111/risa.12786. [Epub ahead of print]

Abstract

Little attention has been devoted to the potential diversity in residents' health responses when exposed to an uncertain environmental health risk. The present study explores whether subgroups of residents respond differently to a new high-voltage power line (HVPL) being put into operation. We used a quasi-experimental prospective field study design with two pretests during the construction of a new HVPL, and two posttests after it was put into operation. Residents living nearby (0-300 m, n = 229) filled out questionnaires about their health and their perception of the environment. We applied latent class growth models to investigate heterogeneity in the belief that health complaints were caused by a power line. Classes were compared on a wide range of

variables relating to negative-oriented personality traits, perceived physical and mental health, and perceptions of the environment. We identified five distinct classes of residents, of which the largest (49%) could be described as emotionally stable and healthy with weak responses to the introduction of a new power line. A considerable minority (9%) responded more strongly to the new line being activated. Residents in this class had heard more about the health effects of power lines beforehand, were more aware of the activation of the new line, and reported a decrease in perceived health afterwards. Based on our findings we can conclude that there is a considerable heterogeneity in health responses to a new HVPL. Health risk perceptions appear to play an important role in this typology, which has implications for risk management.

https://www.ncbi.nlm.nih.gov/pubmed/28314060

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Measuring Occupational Exposure to Extremely Low-Frequency Electric Fields at 220 kV Substations

Pirkkalainen H, Heiskanen T, Tonteri J, Elovaara J, Mika P, Korpinen L.Measuring Occupational Exposure to Extremely Low-Frequency Electric Fields at 220 kV Substations. Radiat Prot Dosimetry. 2017 Mar 3:1-4. doi: 10.1093/rpd/ncx023.

Abstract

Earlier studies conducted at 400 and 110 kV substations in Finland have shown that the occupational exposure to electric fields can exceed the action levels (ALs) set by Directive 2013/35/EU. This is a case study investigating the level of occupational exposure experienced by workers at 220 kV substations in order to determine if the actions levels are being exceeded. The measurements were conducted at two old 220 kV substations in Finland. The higher AL of 20 kV m-1 was exceeded at both substations.

https://www.ncbi.nlm.nih.gov/pubmed/28338889

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Effects of power-frequency MF on cardiomyocytes differentiated from human induced pluripotent stem cells

Takahashi M1, Saito A, Jimbo Y, Nakasono S. Evaluation of the effects of power-frequency magnetic fields on the electrical activity of cardiomyocytes differentiated from human induced pluripotent stem cells. J Toxicol Sci. 2017;42(2):223-231. doi: 10.2131/jts.42.223.

Abstract

Although cardiac activity is known to differ between species in many respects, most evaluations of the cardiac effects of low-frequency electric and magnetic fields, which have a stimulant effect on electrically activated cells, have been performed in non-human experimental animals and cells, and the effects in humans have been assessed using theoretical models. In recent years, it has been verified that human cardiomyocytes differentiated from human induced pluripotent stem cells (hiPS-CM) are useful for evaluating human responses to various cardioactive compounds. In this study, we applied hiPSCMs for the first time to evaluate the human cardiac effects of power-frequency magnetic fields (MFs). After preparation of hiPS-CMs, we subjected a hiPS-CM monolayer formed on a multi-electrode array to short-term exposure to a 50 Hz MF at 400 mT with recording of the extracellular field potentials. The field potential duration of the hiPS-CMs did not differ significantly pre- and post-exposure, indicating that under these conditions, exposure to a 50 Hz MF at 400 mT does not affect the electrical activity of hiPSCMs.

https://www.ncbi.nlm.nih.gov/pubmed/28321048

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EMF Seems to Not Influence Transcription via CTCT Motif in Three Plant Promoters

Sztafrowski D, Aksamit-Stachurska A, Kostyn K, Mackiewicz P, Łukaszewicz M. Electromagnetic Field Seems to Not Influence Transcription via CTCT Motif in Three Plant Promoters. Front Plant Sci. 2017 Mar 7;8:178. doi: 10.3389/fpls.2017.00178.

Abstract

It was proposed that magnetic fields (MFs) can influence gene transcription via CTCT motif located in human HSP70 promoter. To check the universality of this mechanism, we estimated the potential role of this motif on plant gene transcription in response to MFs using both bioinformatics and experimental studies. We searched potential promoter sequences (1000 bp upstream) in the potato Solanum tuberosum and thale cress Arabidopsis thaliana genomes for the CTCT sequence. The motif was found, on average, 3.6 and 4.3 times per promoter (148,487 and 134,361 motifs in total) in these two species, respectively; however, the CTCT sequences were not randomly distributed in the promoter regions but were preferentially located near the transcription initiation site and were closely packed. The closer these CTCT sequences to the transcription initiation site, the smaller distance between them in both plants. One can assume that genes with many CTCT motifs in their promoter regions can be potentially regulated by MFs. To check this assumption, we tested the influence of MFs on gene expression in a transgenic potato with three promoters (16R, 20R, and 5UGT) containing from 3 to 12 CTCT sequences and starting expression of β-glucuronidase as a reported gene. The potatoes were exposed to a 50 Hz 60-70 A/m MF for 30 min and the reporter gene activity was measured for up to 24 h. Although other factors induced the reporter gene activity, the MF did not. It implies the CTCT motif does not mediate in response to MF in the tested plant promoters.

Open Access Paper: https://www.ncbi.nlm.nih.gov/pubmed/28326086

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ELF exposure from mobile and cordless phones for the epidemiological MOBI-Kids study

Calderón C, Ichikawa H, Taki M, Wake K, Addison D, Mee T, Maslanyj M, Kromhout H, Lee AK, Sim MR, Wiart J, Cardis E.
ELF exposure from mobile and cordless phones for the epidemiological MOBI-Kids study. Environ Int. 2017 Jan 23. pii: S0160-4120(17)30047-8. doi: 10.1016/j.envint.2017.01.005. [Epub ahead of print]

Abstract

This paper describes measurements and computational modelling carried out in the MOBI-Kids case-control study to assess the extremely low frequency (ELF) exposure of the brain from use of mobile and cordless phones. Four different communication systems were investigated: Global System for Mobile (GSM), Universal Mobile Telecommunications System (UMTS), Digital Enhanced Cordless Telecommunications (DECT) and Wi-Fi Voice over Internet Protocol (VoIP). The magnetic fields produced by the phones during transmission were measured under controlled laboratory conditions, and an equivalent loop was fitted to the data to produce three-dimensional extrapolations of the field. Computational modelling was then used to calculate the induced current density and electric field strength in the brain resulting from exposure to these magnetic fields. Human voxel phantoms of four different ages were used: 8, 11, 14 and adult. The results indicate that the current densities induced in the brain during DECT calls are likely to be an order of magnitude lower than those generated during GSM calls but over twice that during UMTS calls. The average current density during Wi-Fi VoIP calls was found to be lower than for UMTS by 30%, but the variability across the samples investigated was high. Spectral contributions were important to consider in relation to current density, particularly for DECT phones. This study suggests that the spatial distribution of the ELF induced current densities in brain tissues is determined by the physical characteristics of the phone (in particular battery position) while the amplitude is

mainly dependent on communication system, thus providing a feasible basis for assessing ELF exposure in the epidemiological study. The number of phantoms was not large enough to provide definitive evidence of an increase of induced current density with age, but the data that are available suggest that, if present, the effect is likely to be very small.

https://www.ncbi.nlm.nih.gov/pubmed/28126406

Also see: http://www.saferemr.com/2013/05/mobi-kids-childhood-brain-tumor-risk.html

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Corrigendum to "Inferring the 1985-2014 impact of mobile phone use on selected brain cancer subtypes using Bayesian structural time series and synthetic controls"

de Vocht F. Corrigendum to "Inferring the 1985-2014 impact of mobile phone use on selected brain cancer subtypes using Bayesian structural time series and synthetic controls" [Environ. Int. (2016), 97, 100-107]. Environ Int. 2017 Jan 25. pii: S0160-4120(17)30124-1. doi: 10.1016/j.envint.2017.01.015. [Epub ahead of print]

https://www.ncbi.nlm.nih.gov/pubmed/28131518

Also see: Changing Mix of Brain Tumors in U.K. http://microwavenews.com/short-takes-archive/changing-mix-uk-bts

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Effects of RF-EMF Exposure from GSM Mobile Phones on Proliferation Rate of Human Adipose-derived Stem Cells: An In-vitro Study

Shahbazi-Gahrouei D, Hashemi-Beni B, Ahmadi Z. Effects of RF-EMF Exposure from GSM Mobile Phones on Proliferation Rate of Human Adipose-derived Stem Cells: An In-vitro Study. J Biomed Phys Eng. 2016 Dec 1;6(4):243-252. eCollection 2016.

Abstract

BACKGROUND: As the use of mobile phones is increasing, public concern about the harmful effects of radiation emitted by these devices is also growing. In addition, protection questions and biological effects are among growing concerns which have remained largely unanswered. Stem cells are useful models to assess the effects of radiofrequency electromagnetic fields (RF-EMF) on other cell lines. Stem cells are undifferentiated biological cells that can differentiate into specialized cells. Adipose tissue represents an abundant and accessible source of adult stem cells. The aim of this study is to investigate the effects of GSM 900 MHz on growth and proliferation of mesenchymal stem cells derived from adipose tissue within the specific distance and intensity.

MATERIALS AND METHODS: ADSCs were exposed to GSM mobile phones 900 MHz with intensity of 354.6 μW/cm2 square waves (217 Hz pulse frequency, 50% duty cycle), during different exposure times ranging from 6 to 21 min/day for 5 days at 20 cm distance from the antenna. MTT assay was used to determine the growth and metabolism of cells and trypan blue test was also done for cell viability. Statistical analyses were carried out using analysis of one way ANOVA. $P<0.05$ was considered to be statistically significant.

RESULTS: The proliferation rates of human ADSCs in all exposure groups were significantly lower than control groups ($P<0.05$) except in the group of 6 minutes/day which did not show any significant difference with control groups.

CONCLUSION: The results show that 900 MHz RF signal radiation from antenna can reduce cell viability and

proliferation rates of human ADSCs regarding the duration of exposure.

https://www.ncbi.nlm.nih.gov/pubmed/28144594

Excerpts

Electromagnetic radiation sources such as cordless phones, telecommunications stations, high-voltage lines, Wi-Fi, wireless, radio and television antenna could be one of the main reasons for human abnormalities if protection protocol recommendations for safety are not used [4]. Since mobile phone cannot be removed from human lives, to protect from the probable effects of radiations, all mobile operators according to CRA (Community Reinvestment Act) agreements with radio communication, must obtain a license to work with radio-waves and microwaves from the radiation protection for installation and the operation of mobile phone equipment. The most of literature and findings of researchers [3-7, 25- 27] agree on the protection methods against irradiation of EMFs. They believe that using some protection methods are recommended like reducing the length of calls, talking to phone in case of emergency, keeping the phone away from vital organs, using special anti-radiation coatings for mobile phones and banning the use of cell phones during pregnancy and childhood, the least presence in environments with high levels of microwave in main stations, consumption of antioxidants such as vitamins A, C, E and green tea in daily diet. Of course, more studies are needed to cover all biological effects of EMFs on living systems.

Conclusion Based on the findings of the present study, it is believed that GSM mobile phone 900 MHz with intensity of 354.6 μW/cm2 five times exposure at 20cm distance may inhibit the proliferation rates of human ADSCs, but no mechanism has been proposed to explain the effects of this radiation. However, further studies for assessing RF-EMF with other intensities, frequencies and different exposure times on stem cells are suggested.

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The Fundamental Reasons Why Laptop Computers should not be Used on Your Lap

S A R Mortazavi, S Taeb, S M J Mortazavi, S Zarei, M Haghani, P Habibzadeh, M B Shojaei-fard. The Fundamental Reasons Why Laptop Computers should not be Used on Your Lap. J Biomed Phys Eng. 2016 Dec 1;6(4):279-284. eCollection 2016.

Abstract

As a tendency to use new technologies, gadgets such as laptop computers are becoming more popular among students, teachers, businessmen and office workers. Today laptops are a great tool for education and learning, work and personal multimedia. Millions of men, especially those in the reproductive age, are frequently using their laptop computers on the lap (thigh). Over the past several years, our lab has focused on the health effects of exposure to different sources of electromagnetic fields such as cellular phones, mobile base stations, mobile phone jammers, laptop computers, radars, dentistry cavitrons and Magnetic Resonance Imaging (MRI). Our own studies as well as the studies performed by other researchers indicate that using laptop computers on the lap adversely affects the male reproductive health. When it is placed on the lap, not only the heat from a laptop computer can warm men's scrotums, the electromagnetic fields generated by laptop's internal electronic circuits as well as the Wi-Fi Radiofrequency radiation hazards (in a Wi-Fi connected laptop) may decrease sperm quality. Furthermore, due to poor working posture, laptops should not be used on the lap for long hours.

https://www.ncbi.nlm.nih.gov/pubmed/28144597

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Characterizing and Mapping of Exposure to Radiofrequency Electromagnetic Fields (20-3,000 Mhz) in Chengdu, China

Zhu G, Gong X, Luo R. Characterizing and Mapping of Exposure to Radiofrequency Electromagnetic Fields (20-3,000 Mhz) in Chengdu, China. Health Phys. 2017 Mar;112(3):266-275. doi: 10.1097/HP.0000000000000599.

Abstract

With radiofrequency exposure caused by electronic applications increasing, some members of the public are worrying about potential health risks. In this paper, methods of performing large-scale radiofrequency exposure evaluation are described. All studied sites were divided into three categories: commercial-area, residential-urban, and residential-rural. Then a series of site investigations were conducted on a car-mounted system in the years 2014 and 2015, aiming to characterize electric field exposure from 12 different radiofrequency sources. The results indicate that the studied environment is safe as indicated by exposure below guidelines and standards. The highest exposure measured in the 2 y of monitoring was from an FM source, 316.23 mV m. Telecommunication sources dominate exposure, contributing the most power density (65-90%). Meanwhile, intergroup differences are discussed and summarized. The spatial distributions of FM and GSM1800 exposure are demonstrated on a map. This study describes an approach for the assessment of the spatiotemporal pattern of radiofrequency exposures in Chengdu and facilitates the identification of any sources causing exposure above relevant guidelines and standards.

https://www.ncbi.nlm.nih.gov/pubmed/28121727

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The effects of human height and mass on the calculated induced electric fields at 50 Hz for comparison with the EMF Directive 2013/35/EU

Findlay RP. The effects of human height and mass on the calculated induced electric fields at 50 Hz for comparison with the EMF Directive 2013/35/EU.J Radiol Prot. 2017 Jan 24;37(1):201-213. doi: 10.1088/1361-6498/37/1/201. [Epub ahead of print]

Abstract

A worker's height and mass can significantly affect the way in which incident low frequency electric and magnetic fields are absorbed in the body. To investigate this, several anatomically realistic human models were produced for heights between 1.56 and 1.96 m and masses between 33 and 113 kg. The human models were derived from the MAXWEL surface-based phantom, the model previously used in the EMF Directive 2013/35/EU Practical Guide to demonstrate how induced electric fields in the body are calculated. Computer simulations were carried out to calculate the low frequency EMF directive exposure limit value (ELV) quantities, i.e. the induced electric fields, in these human model variations from exposure to external 50 Hz magnetic and electric fields. The computational work showed that simple relationships relating the human model's height/weight with the induced electric fields in tissue types such as bone, fat, muscle, brain, spinal cord and retina could be developed. Calculations of parameters that affected absorption and fields required to produce the EMF Directive ELVs were carried out and compared with the action levels (ALs). It was found that the ALs generally provided a conservative estimate of the ELVs for the various human models and exposure situations studied.

https://www.ncbi.nlm.nih.gov/pubmed/28118155

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Risk agents related to work and amyotrophic lateral sclerosis: An occupational medicine focus

Garzillo EM, Miraglia N, Pedata P, Feola D, Lamberti M. Risk agents related to work and amyotrophic lateral sclerosis: An occupational medicine focus. Int J Occup Med Environ Health. 2016;29(3):355-67. doi: 10.13075/ijomeh.1896.00368.

Abstract

Amyotrophic lateral sclerosis (ALS) is a neurodegenerative disease characterized by progressive muscular paralysis reflecting degeneration of motor neurons. In recent years, in addition to several studies about genetic mechanisms leading to motor neurons damage, various epigenetic theories have been developed, involving the study of the patients' work and lifestyle. The work aims at focusing the role of occupational exposure related to ALS by literature data analysis. Articles, selected on the basis of keywords, year of publication and topics, are related to occupational exposure, suggesting an impact on ALS onset. The literature review shows that there are still a lot of biases in the studies design, which actually do not allow to draw unequivocal conclusions.

https://www.ncbi.nlm.nih.gov/pubmed/26988875

Excerpt

Exposure to electromagnetic fields has been studied in epidemiological [62–66], observational [67] and laboratory works [68]. A recent meta-analysis suggests a slightly but significantly increased risk of ALS among workers exposed to an extremely low frequency electromagnetic field (ELF-EMF), but does not deny the possibility of bias in the data analysis [69]. However, in the case of electromagnetic fields, there are many problems: at present, no apparent correlation between the exposure assessment and the observed associations is possible. In order to better assess exogenous risk factors of ALS, a job exposure matrix (JEM) may have to be used, with a detailed exposure index to electric fields and magnetic fields [70].

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Rapid and Delayed Effects of Pulsed Radiofrequency on Neuropathic Pain: Electrophysiological, Molecular, and Behavioral Evidence Supporting Long-Term Depression

Huang RY, Liao CC, Tsai SY, Yen CT, Lin CW, Chen TC, Lin WT, Chang CH, Wen YR.Rapid and Delayed Effects of Pulsed Radiofrequency on Neuropathic Pain: Electrophysiological, Molecular, and Behavioral Evidence Supporting Long-Term Depression. Pain Physician. 2017 Feb;20(2):E269-E283.

Abstract

BACKGROUND: Pulsed radiofrequency (PRF) has been widely employed for ameliorating clinical neuropathic pain. How PRF alters electrophysiological transmission and modulates biomolecular functions in neural tissues has yet to be clarified. We previously demonstrated that an early application of low-voltage bipolar PRF adjacent to the dorsal root ganglion (DRG) reduced acute neuropathic pain in animals. By contrast, the present study investigated how PRF alters postsynaptic sensitization to produce early and delayed effects on neuropathic pain.

OBJECTIVES: Our objective was to test the hypothesis that a 5-minute session of PRF could rapidly produce selective long-term depression (LTD) on C-fiber-mediated spinal sensitization and sustain the effect through the long-lasting inhibition of injury-induced ERK-MAPK activation. This may explain the prolonged analgesic effect of PRF on chronic neuropathic pain.

STUDY DESIGN: Experiments were conducted on both normal rats and neuropathic pain rats that received spinal nerve ligation (SNL) 8 days prior.

SETTING: An animal laboratory in a medical center of a university in Taiwan.

METHODS: We first compared changes in field potentials in the L5 superficial spinal dorsal horn (SDH) that were evoked by conditioning electrical stimuli in the sciatic nerve in male adult rats before (as the baseline) and after PRF stimulation for at least 2 hours. Bipolar PRF was applied adjacent to the L5 DRG at an intensity of 5 V for 5 minutes, whereas the control rats were treated with sham applications. The electrophysiological findings were tested for any correlation with induction of spinal phospho-ERK (p-ERK) in normal and neuropathic pain rats. We then investigated the delayed effect of PRF on SNL-maintained pain behaviors for 2 weeks as well as p-ERK in SDH among the control, SNL, and PRF groups. Finally, potential injury in the DRGs after PRF stimulation was evaluated through behavioral observations and ATF-3, a neuronal stress marker.

RESULTS: In the evoked field-potential study, the recordings mediated through A- and C-afferent fibers were identified as A-component and C-component, respectively. PRF significantly reduced the C-components over 2 hours in both the normal and SNL rats, but it did not affect the A-components. In the SNL rats, the C-component was significantly depressed in the PRF group compared with the sham group. PRF also inhibited acute p-ERK induced by mechanical nociception in both the control and SNL rats. For a longer period, PRF ameliorated SNL-maintained mechanical allodynia for 10 days and thermal analgesia for 14 days, and it significantly reduced late ERK activation within spinal neurons and astrocytes 14 days afterward. Moreover, PRF in the normal rats did not alter basal withdrawal thresholds or increase the expression and distribution of ATF-3 in the DRGs.

LIMITATIONS: Several issues should be considered before translating the animal results to clinical applications.

CONCLUSIONS: Low-voltage bipolar PRF produces LTD through selective suppression on the C-component, but not on the A-component. It also inhibits ERK activation within neurons and astrocytes in SDHs. The findings suggest that PRF alleviates long-lasting neuropathic pain by selectively and persistently modulating C-fiber-mediated spinal nociceptive hypersensitivity.Key words: Pulsed radiofrequency (PRF), dorsal root ganglion (DRG), neuropathic pain, ERK activation, evoked field potential, ATF-3, long-term depression (LTD), spinal nerve ligation (SNL).
https://www.ncbi.nlm.nih.gov/pubmed/28158164

Excerpt
The specially designed bipolar system has been described previously (27,29). The stimulation electrode was inserted into the left L5 foraminal canal, whereas the reference electrode was placed in contact with the surrounding non-neural tissues. The electrodes were connected to a PXI-5402 Function Generator (National Instruments, Austin, TX) to generate RF pulses with the following parameter settings based on clinical settings: 2-Hz biphasic trains with 500-kHz RF waves, 25-ms train width, and oscillating amplitudes at an intensity of ± 2.5 V. The PRF duration was 300 seconds. The control group received an electrode placement without electricity as a sham stimulation.

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Evaluation of the potential of mobile phone specific electromagnetic fields (UMTS) to produce micronuclei in human glioblastoma cell lines

Halh Al-Serori, Michael Kundi, Franziska Ferk, Miroslav Mišík,Armen Nersesyan, Manuel Murbach, Tamara T. Lah, Siegfried Knasmüller. Evaluation of the potential of mobile phone specific electromagnetic fields (UMTS) to produce micronuclei in human glioblastoma cell lines. Toxicology in Vitro. 40:264-271. April 2017.
http://dx.doi.org/10.1016/j.tiv.2017.01.012

Highlights

• Aim was to find out if mobile phone specific radiation causes chromosomal damage.
• The effect of the UMTS signal was tested in two human glioblastoma cell lines.
• No induction of micronuclei and several other nuclear anomalies were found.
• Induction of programmed cell death was observed in a p53 mutated cell line (U251).
• In p53 proficient cells (U87) the apoptosis rate was not increased.

Abstract

Some epidemiological studies indicate that mobile phones cause glioblastomas in humans. Since it is known that genomic instability plays a key role in the etiology of cancer, we investigated the effects of the universal mobile telecommunications system radiofrequency (UMTS-RF) signal, which is used in “smart” phones, on micronucleus (MN) formation and other anomalies such as nuclear buds (NBUDs) and nucleoplasmatic bridges (NPBs). MN are formed by structural and numerical aberrations, NBs reflect gene amplification and NPBs are formed from dicentric chromosomes. The experiments were conducted with human glioblastoma cell lines, which differ in regard to their p53 status, namely U87 (wild-type) and U251 (mutated). The cells were cultivated for 16 h in presence and absence of fetal calf serum and exposed to different SAR doses (0.25, 0.50 and 1.00 W/kg), which reflect the exposure of humans, in presence and absence of mitomycin C as former studies indicate that RF may cause synergistic effects in combination with this drug. We found no evidence for induction of MN and other anomalies. However, with the highest dose, induction of apoptosis was observed in U251 cells on the basis of the morphological features of the cells. Our findings indicate that the UMTS-RF signal does not cause chromosomal damage in glioblastoma cells; the mechanisms which lead to induction of programmed cell death will be investigated in further studies.

Excerpts

1950 MHz UMTS

In conclusion, the results of the present study indicate that exposure of cultured human glioblastoma cells to mobile phone specific RF does not cause MN formation. These findings can be taken as an indication that mechanisms other than chromosomal damage lead to induction of glioblastomas, which was observed in a number of epidemiological studies (for review see IARC (2013) Volume 102). However, as described above we found clear evidence for induction of apoptosis in one of the cell lines with defective *p53*. The observation of induction of programmed cell death in a glioma derived cell line indicates that the UMTS signal causes physiological effects (such as primary DNA damage or other processes), which finally leads to the elimination of the cells. Future investigations will be conducted to understand the biological consequences and the molecular mechanisms which cause this phenomenon.

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Numerical Exposure Assessment Method for Low Frequency Range and Application to Wireless Power Transfer

Park S, Kim M. Numerical Exposure Assessment Method for Low Frequency Range and Application to Wireless Power Transfer. PLoS One. 2016 Nov 29;11(11):e0166720. doi: 10.1371/journal.pone.0166720. eCollection 2016.

Abstract

In this paper, a numerical exposure assessment method is presented for a quasi-static analysis by the use of finite-difference time-domain (FDTD) algorithm. The proposed method is composed of scattered field FDTD method and quasi-static approximation for analyzing of the low frequency band electromagnetic problems. The

proposed method provides an effective tool to compute induced electric fields in an anatomically realistic human voxel model exposed to an arbitrary non-uniform field source in the low frequency ranges. The method is verified, and excellent agreement with theoretical solutions is found for a dielectric sphere model exposed to a magnetic dipole source. The assessment method serves a practical example of the electric fields, current densities, and specific absorption rates induced in a human head and body in close proximity to a 150-kHz wireless power transfer system for cell phone charging. The results are compared to the limits recommended by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the IEEE standard guidelines.

Open access: http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0166720

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Quantitative changes in testicular structure and function in rat exposed to mobile phone radiation

Çetkin M, Kızılkan N, Demirel C, Bozdağ Z, Erkılıç S, Erbağcı H. Quantitative changes in testicular structure and function in rat exposed to mobile phone radiation. Andrologia. 2017 Jan 26. doi: 10.1111/and.12761. [Epub ahead of print]

Abstract

The possible effects of the electromagnetic fields (EMF) generated by mobile phones on reproductive functions have been discussed in recent years. The aim of this study was to evaluate the effects of EMF emitted from mobile phones on the rat testis morphology and histopathology using stereological techniques. We also investigated cortisol, testosterone, FSH and LH levels. A total of thirty-two (n = 32) male Wistar albino rats were used in this study. Animals were randomly divided into four groups as control (C, n = 8), sham (Sh, n = 8), mobile phone speech (Sp, n = 8) and mobile phone standby (ST by). Morphometric measurements were made with the help of a computer-assisted stereological analysis system. The testis weight and volume were significantly lower in the EMF exposed groups. The mean volume fraction of interstitial tissue was higher, but the volume fraction of tubular tissue was lower in the EMF-exposed groups. The mean tubular and germinal tissue volume, seminiferous tubule diameter and germinal epithelium height were also lower in EMF exposed groups. The cortisol levels in the EMF-exposed groups were significantly higher. In conclusion, the EMF created by mobile phones caused morphologic and histological changes by the affecting germinal epithelium tissue negatively.

https://www.ncbi.nlm.nih.gov/pubmed/28124386

Excerpts

In order to generate EMF, mobile phones using GSM mobile phone systems were employed. The highest SAR (specific absorption rate) of the mobile phones was 0.96 W/kg and each of these phones had a 890-915 MHz carrier frequency band, 217 Hz modulation frequency, 250 mW maximum average power and 2 W maximum peak power (Dasdag et al., 1999).

Speech mode was obtained by keeping the mobile phone in the experiment box on speech mode for 2 hr/day. For the standby mode, the mobile phone was put on standby for 12 hr/day.

It was seen at the end of the study that exposure to mobile phones caused degeneration in germinal epithelium tissue and as a result, such parameters as testis volume, tubular tissue volume fraction and volume, germinal epithelium volume, STD, GEH and Johnsen biopsy score were affected adversely. Moreover, exposure to mobile phones was found to increase cortisol levels as well.

Inconclusion, it has been found in our study that EMF generated by mobile phones causes degeneration in the germinal epithelium. As a result of this degeneration, significant decreases were observed in the testis

volumes, tubular tissue volumes, STD and GEH of the experimental groups. While EMF increased serum cortisol levels in the experimental group, it caused no change in gonadal hormones. All these findings are considered to be useful for studies examining the effects of EMF on reproductive functions.

Also see: http://www.saferemr.com/2015/09/effect-of-mobile-phones-on-sperm.html

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GSM-like radiofrequency exposure induces apoptosis via caspase-dependent pathway in infant rabbits

Meral O, Ozgur E, Kismali G, Guler G, Alpay M, Sel T, Seyhan N. GSM-like radiofrequency exposure induces apoptosis via caspase-dependent pathway in infant rabbits. Bratisl Lek Listy. 2016;117(11):672-676. doi: 10.4149/BLL_2016_129.

Abstract

BACKGROUND: There have been several Radio Frequency (RF) field researches on various populations and groups of different ages in recent years. However, the most important group for research has been declared as the pregnant women and their babies.

OBJECTIVE: The aim of the study was to analyse the effect on apoptotic factors of RF fields on newborn rabbit liver tissues.

MATERIALS AND METHODS: Cytochrome c and AIF (Apoptosis Inducing Factor) levels were measured by western blot and caspase 1, 3 and 9 activities were measured by colorimetric method.

RESULTS: Cytochrome c and AIF levels were not altered, but all caspase activities were increased in female infant rabbits that exposed to 1800 MHz GSM-like RF signals when they reached 1 month of age and caspase 1 and caspase 3 levels were decreased in male infant rabbits that exposed to 1800 MHz GSM-like RF signals between 15th and 22nd days of the gestational period. Results showed that 1800 MHz GSM-like RF exposure might lead to apoptosis in infant rabbit's liver tissues.

CONCLUSION: According to the results, we suggest that postnatal RF exposure causes caspase dependent apoptosis in female infant rabbits liver tissues (Tab. 1, Fig. 2, Ref. 27).

https://www.ncbi.nlm.nih.gov/pubmed/28125894

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GSM 900 MHz Microwave Radiation-Induced Alterations of Insulin Level and Histopathological Changes of Liver and Pancreas in Rat

Mortazavi SMJ, Owji SM, Shojaie-fard MB, Ghader-Panah M, Mortazavi SAR, Tavakoli-Golpayegani A, Haghani M, Taeb S, Shokrpour N, Koohi O. GSM 900 MHz Microwave Radiation-Induced Alterations of Insulin Level and Histopathological Changes of Liver and Pancreas in Rat. J Biomed Phys Eng. 2016 Dec 1;6(4):235-242. eCollection 2016.

Abstract

Background: The rapidly increasing use of mobile phones has led to public concerns about possible health effects of these popular communication devices. This study is an attempt to investigate the effects of radiofrequency (RF) radiation produced by GSM mobile phones on the insulin release in rats.

Methods: Forty two female adult Sprague Dawley rats were randomly divided into 4 groups. Group1 were

exposed to RF radiation 6 hours per day for 7 days. Group 2 received sham exposure (6 hours per day for 7 days). Groups 3 and 4 received RF radiation 3 hours per day for 7 days and sham exposure (3 hours per day), respectively. The specific absorption rate (SAR) of RF was 2.0 W/kg.

Results: Our results showed that RF radiations emitted from mobile phone could not alter insulin release in rats. However, mild to severe inflammatory changes in the portal spaces of the liver of rats as well as damage in the cells of islet of Langerhans were observed. These changes were linked with the duration of the exposures.

Conclusion: RF exposure can induce inflammatory changes in the liver as well causing damage in the cells of islet of Langerhans.

http://www.jbpe.org/Journal_OJS/JBPE/index.php/jbpe/article/view/447/224

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The effect of the non ionizing radiation on exposed, laboratory cultivated upland cotton plants

Aikaterina L. Stefi, Lukas H. Margaritis, Nikolaos S. Christodoulakis.The effect of the non ionizing radiation on exposed, laboratory cultivated upland cotton (Gossypium hirsutum L.) plants. Flora - Morphology, Distribution, Functional Ecology of Plants. Volume 226:55-64. January 2017. http://dx.doi.org/10.1016/j.flora.2016.11.009.

Highlights

• Upland cotton plants grow under long term microwave radiation.
• They suffer significant biomass reduction of exposed plants.
• Chloroplast structure is severely affected.
• Photosynthetic pigment content reduces.
• Roots do respond to radiation stress.

Abstract

A series of experiments was carried out to investigate possible structural or biochemical alterations in Gossypium hirsutum plants after a long term (21 days) exposure to non ionizing radiation (1882 MHz) emitted from the base unit of a cordless DECT system. Exposed plants, compared to the negative (matched) controls, seem to be seriously affected. Notably lower biomass production for the above ground part and the root was recorded. Reduction of the photosynthetic pigments and severe damage of the chloroplast structure were also observed. It seems that non ionizing radiation can be noxious for plant life functions.

Excerpts

In the middle of one of the two cages, the base unit of a DECT telephone apparatus (General, Model 123) was appropriately positioned. The DECT base was in a 24 h a day, 7 days a week, pulsed transmission mode, at 1882 MHz, as described elsewhere (Margaritis et al., 2014)....

Supplementary, low precision measurements were made in the control cage; with a broadband field meter (TES-92, 50 MHz–3.5 GHz, Electromagnetic radiation detector – TES Electrical Electronic Corp. Taipei, Taiwan, R.O.C.) at the value of 490.1 mV/m. In the nearby cage (exposed), radiation reached the value of 27.46 V/m (27.460 mV/m, at 1882 MHz) (55 fold higher).

Conclusion

The effect of the non-ionizing radiation at the microwave band, on the *Gossypium hirsutum* young plants, after a long term exposure, can be considered as significant. The disastrous effect on chloroplast structure, the

reduction of the photosynthetic pigments and the suppression of the photosynthetic potential, are the main causes for the significant reduction of the primary productivity. Moreover, a serious effect on the underground part of the plant was recorded but this cannot be evaluated yet.

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Sustainable perspectives on energy consumption, EMR, environment, health & accident risks associated with mobile phone use

Manivannan Senthil Velmurugan. Sustainable perspectives on energy consumption, EMRF, environment, health and accident risks associated with the use of mobile phones. Renewable and Sustainable Energy Reviews. 67:192-206. January 2017. http://dx.doi.org/10.1016/j.rser.2016.09.011

Abstract

Mobile phones have grown rapidly using today's wireless technology thereby providing a new dimension to simplify daily routine jobs by users. Mobile phone's applications have a great impact on the way of faster and more effective to convey information. In contrast, mobile phones could harm its users. This paper explored detrimental effects of mobile phones on energy consumption, electromagnetic radiofrequency radiation, environment, health and accidents. The effect of mobile phone's energy consumption can be considered during energy spend for its production and use. The electromagnetic radiofrequency radiation (EMRF) may cause adverse health effects on human. The raw materials which are used to manufacture for mobile phones may cause the severe environmental impacts due to their levels of toxicity. The health hazards are correlated with high-toxic substances released from the mobile phones and its addiction through a prolonged use. Mobile phone usage while driving can cause road traffic collisions and motor vehicle crashes. Furthermore, sustainable perspectives have been suggested as a way to overcoming these detrimental effects of mobile phones.

http://www.sciencedirect.com/science/article/pii/S1364032116305056

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Major influences in households and business spaces — Wi-Fi, telecommunication masts outputs and electrical pollution

Francis Markho, Ioan Tuleasca. Major influences in households and business spaces — Wi-Fi, telecommunication masts outputs and electrical pollution. Electrical and Power Engineering (EPE), 2016 International Conference and Exposition on Electrical and Power Engineering. Oct 20-22, 2016. Iasi, Romania.

Abstract

The paper offers a non-exhaustive perspective, as well as a spectrum of performed measurements, in the field of non-ionizing electromagnetic radiation. Shielding Wi-Fi is shown to be an effective means of counteracting its health risks. The effects of cell phone towers positioning next to living and working spaces is presented and analyzed. Electrical pollution mitigation is described, as well as the problem of earth bound stray electrical currents. Effective actions and measures to be taken for the benefit of future generations are suggested and justified.

Conclusions

The adverse health effects due to Wi-Fi and cell phone towers are well known (Carpenter's testimony [29] and Dode's findings [19]) should be more than enough to put the matter to rest in this respect). However, it seems

to be no willingness to change the status quo, even if Lloyd's took
steps [30] to distance themselves from the possible EMF claims related issues. The careless use of this type of technology might cost us dearly in the future in both health sector national budgets blowouts and genetic degeneration.

Dirty electricity (electrical pollution) just completes the picture and adds to the effects of the above mentioned stressors. The seriousness of the problem is compounded by the availability and cheapness of various electrical devices and systems that are responsible for the creation of high
frequency voltage transients in the electrical networks. Mitigating these transients can, fortunately, be performed using shielding and adequate design for electrical circuitry in addition to other appropriate means [31].

The way forward, however, may be linked to broad, thorough and mandatory institutional measures at national and international levels. The first step in this direction was taken by France [32], where the French National Assembly passed a Law that regulates the exposure to electromagnetic field EMF (Law on Sobriety, Transparency, Information and Consultation for Exposure to Electromagnetic Waves, 29
January 2015). The Law addresses a range of EMF-related aspects, from Wi-Fi usage in nurseries (banned) and schools (limited), to mobile phones Specific Absorption Rate SAR labelling and cell phone towers emissions compliance verification. The Electrohypersensitivity EHS issue was also addressed as part of this Law, where a Report on EHS must be presented to the French Parliament within one year.

At international level it may be that not only the Precautionary Principle has to have a role in organising adequate EMF exposure limits, but also specific internationally recognized legal instruments, like the Nuremberg Code of Ethics. According to this Code, one cannot submit human beings to actions causing them harm, where the said human beings are not able to "bring the experiment to an end" [33]. Since the human race is unwittingly submitted to a world-wide encompassing, society-directed, experiment, in the form of biologically adverse, profit driven, imposed EMF exposure, the Code is duly applicable.

Considering the way other crucial health-related issues (asbestos, tobacco, ionizing radiation) were dealt with over the years, it seems that there is a long way ahead in tackling EMF exposure risks. However, this time is different, since our own long term wellbeing as a species is at risk [34], due to the genotoxic effect of the presented stressors.

http://ieeexplore.ieee.org/document/7781450/

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Inaccurate official assessment of RF safety by the Advisory Group on Non-ionising Radiation (AGNIR)

Starkey SJ. Inaccurate official assessment of radiofrequency safety by the Advisory Group on Non-ionising Radiation. Rev Environ Health. 2016 Dec 1;31(4):493-503. doi: 10.1515/reveh-2016-0060.

Abstract

The Advisory Group on Non-ionising Radiation (AGNIR) 2012 report forms the basis of official advice on the safety of radiofrequency (RF) electromagnetic fields in the United Kingdom and has been relied upon by health protection agencies around the world. This review describes incorrect and misleading statements from within the report, omissions and conflict of interest, which make it unsuitable for health risk assessment. The executive summary and overall conclusions did not accurately reflect the scientific evidence available. Independence is needed from the International Commission on Non-Ionizing Radiation Protection (ICNIRP), the group that set the exposure guidelines being assessed. This conflict of interest critically needs to be addressed for the forthcoming World Health Organisation (WHO) Environmental Health Criteria Monograph on Radiofrequency Fields. Decision makers, organisations and individuals require accurate information about the safety of RF electromagnetic signals if they are to be able to fulfil their safeguarding responsibilities and protect

those for whom they have legal responsibility.

https://www.ncbi.nlm.nih.gov/pubmed/27902455

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Does cell phone use increase the chances of parotid gland tumor development? A systematic review and meta-analysis

de Siqueira EC, de Souza FT, Gomez RS, Gomes CC, de Souza RP. Does cell phone use increase the chances of parotid gland tumor development? A systematic review and meta-analysis. J Oral Pathol Med. 2016 Dec 9. doi: 10.1111/jop.12531. [Epub ahead of print]

Abstract

BACKGROUND: Prior epidemiological studies had examined the association between cell phone use and the development of tumors in the parotid glands. However there is no consensus about the question of whether cell phone use is associated with increased risk of tumors in the parotid glands. We performed a meta-analysis to evaluate the existing literature about the mean question and to determine their statistical significance.

METHODS: Primary association studies. Papers that associated cell phone use and parotid gland tumors development were included, with no restrictions regarding publication date, language and place of publication. Systematic literature search using PubMed, Scielo and Embase followed by meta-analysis.

RESULTS AND CONCLUSION: Initial screening included 37 articles and three were included in meta-analysis. Using three independent samples including 5087 subjects from retrospective case-control studies, cell phone use seems to be associated with greater odds (1.28, 95%- confidence interval 1.09 - 1.51) to develop salivary gland tumor. Results should be read with caution due to the limited number of studies available and their retrospective design.

http://bit.ly/2gFfUBh

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Cell phone use is associated with an inflammatory cytokine profile of parotid gland saliva

Siqueira EC, de Souza FT, Ferreira E, Souza RP, Macedo SC, Friedman E, Gomez MV, Gomes CC, Gomez RS. Cell phone use is associated with an inflammatory cytokine profile of parotid gland saliva.. J Oral. Pathol Med. 45(9):682-686. doi: 10.1111/jop.12434. 2016.

Abstract

BACKGROUND: There is controversy on the effects of the non-ionizing radiation emitted by cell phones on cellular processes and the impact of such radiation exposure on health. The purpose of this study was to investigate whether cell phone use alters cytokine expression in the saliva produced by the parotid glands.

METHODS: Cytokine expression profile was determined by enzyme linked immuno sorbent assay (ELISA) in the saliva produced by the parotid glands in healthy volunteers, and correlated with self-reported cell phone use and laterality.

RESULTS: The following parameters were determined, in 83 Brazilian individuals in saliva produced by the parotid glands comparing the saliva from the gland exposed to cell phone radiation (ipsilateral) to that from the contralateral parotid: salivary flow, total protein concentration, interleukin 1 β (IL-1 β), interleukin 6 (IL-6), interleukin 10 (IL-10), interferon γ (IFN-γ), and tumor necrosis factor α (TNF-α) salivary levels by ELISA. After

multiple testing correction, decreased IL-10 and increased IL-1β salivary levels in the ipsilateral side compared with the contralateral side (P < 0.05) were detected. Subjects who used cell phones for more than 10 years presented higher differences between IL-10 levels in ipsilateral versus contralateral parotids (P = 0.0012). No difference was observed in any of the tested parameters in correlation with cell phone monthly usage in minutes.

CONCLUSION: The exposure of parotid glands to cell phones can alter salivary IL-10 and IL-1β levels, consistent with a pro-inflammatory microenvironment that may be related to heat production.

http://1.usa.gov/24cKkun

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Electromagnetic hypersensitivity: Nation-wide survey among general practitioners, occupational physicians & hygienists in the Netherlands

Slottje P, van Moorselaar I, van Strien R, Vermeulen R, Kromhout H, Huss A. Electromagnetic hypersensitivity (EHS) in occupational and primary health care: A nation-wide survey among general practitioners, occupational physicians and hygienists in the Netherlands. Int J Hyg Environ Health. 2016 Dec 2. pii: S1438-4639(16)30385-6. doi: 10.1016/j.ijheh.2016.11.013. [Epub ahead of print]

Abstract

Subjects who attribute health complaints to every day levels of non-ionizing electromagnetic fields (EMF) have been referred to as electrohypersensitive (EHS). Previous surveys in Europe showed that 68-75% of general practitioners had ever been consulted on EHS. Given the lack of data on EHS in the Netherlands in the general population and on EHS in occupational settings, we performed a national survey among three professional groups that are likely in the first line of being consulted by EHS individuals. Results show that about one third of occupational hygienists, occupational physicians and general practitioners had ever been consulted by one or more EHS subjects. Many of these professionals considered a causal relationship between EMF and health complaints to some degree plausible, and their approach often included exposure reduction advice. Given the lack of scientific evidence for EHS and how low level EMF exposure could cause reported health complaints and given the finding that the majority of these professionals felt insufficiently informed about EMF and health, targeted information campaigns might assist them in their evidence based dealing with subjects who attribute symptoms to EMF.

Conclusions

About a third of occupational hygienist, occupational physicians and general practitioners in the Netherlands are consulted by patients attributing symptoms to EMF exposure. Many of these professionals consider a causal relationship between EMF and health complaints to some degree plausible, and their approach often also includes exposure reduction advice. Given the lack of a scientific evidence basis for EMF to cause symptoms and the finding that the majority of these professionals feels insufficiently informed about EMF and health, targeted information campaigns might assist them in their evidence based dealing with patients who attribute symptoms to EMF.

http://www.sciencedirect.com/science/article/pii/S1438463916303856

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Extrapolation techniques evaluating 24 hours of average EMF emitted by radio base station installations: spectrum analyzer measurements of LTE and UMTS signals

Mossetti S, de Bartolo D, Veronese I, Cantone MC, Cosenza C, Nava E. Extrapolation techniques evaluating

24 hours of average electromagnetic field emitted by radio base station installations: spectrum analyzer measurements of LTE and UMTS signals.
Radiat Prot Dosimetry. 2016 Dec 1. [Epub ahead of print]

Abstract

International and national organizations have formulated guidelines establishing limits for occupational and residential electromagnetic field (EMF) exposure at high-frequency fields. Italian legislation fixed 20 V/m as a limit for public protection from exposure to EMFs in the frequency range 0.1 MHz-3 GHz and 6 V/m as a reference level. Recently, the law was changed and the reference level must now be evaluated as the 24-hour average value, instead of the previous highest 6 minutes in a day. The law refers to a technical guide (CEI 211-7/E published in 2013) for the extrapolation techniques that public authorities have to use when assessing exposure for compliance with limits. In this work, we present measurements carried out with a vectorial spectrum analyzer to identify technical critical aspects in these extrapolation techniques, when applied to UMTS and LTE signals. We focused also on finding a good balance between statistically significant values and logistic managements in control activity, as the signal trend in situ is not known. Measurements were repeated several times over several months and for different mobile companies. The outcome presented in this article allowed us to evaluate the reliability of the extrapolation results obtained and to have a starting point for defining operating procedures.

https://www.ncbi.nlm.nih.gov/pubmed/27909155

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Randomised, placebo-controlled trial of transcranial pulsed EMF in patients with multiple chemical sensitivity

Tran MT, Skovbjerg S, Arendt-Nielsen L, Christensen KB, Elberling J. A randomised, placebo-controlled trial of transcranial pulsed electromagnetic fields in patients with multiple chemical sensitivity. Acta Neuropsychiatr. 2016 Dec 6:1-11. [Epub ahead of print]

Abstract

OBJECTIVE: To evaluate the efficacy of transcranially applied pulsed electromagnetic fields (PEMF) on functional impairments and symptom severity in multiple chemical sensitivity (MCS) patients.

METHODS: The study was conducted as a nationwide trial in Denmark using a randomised, parallel-group, double-blind and placebo-controlled design. Sample size was estimated at 40 participants. Eligibility criteria were age 18-75 years and fulfilment of the MCS case criteria. Participants received either PEMF or placebo PEMF (no stimulation) applied transcranially for 6 weeks. The primary outcome was the Life Impact Scale (LIS) of the Quick Environmental Exposure and Sensitivity Inventory (QEESI). Secondary outcomes were the Symptom Severity Scale (SSS) and the Chemical Intolerance Scale of QEESI.

RESULTS: A total of 39 participants were randomised to PEMF or placebo treatment. No significant difference was observed on QEESI LIS between groups with a mean change score of -5.9 in the PEMF group compared with -1.5 in the placebo group (p=0.35, effect size=-0.31). However, a significant decrease was detected on QEESI SSS within and between groups with a mean change score of -11.3 in the PEMF group compared with -3.2 in the placebo group (p=0.03, effect size=-0.60).

CONCLUSION: PEMF treatment of 6 weeks showed no effect on functional impairments in MCS. However, a significant decrease in symptom severity was observed.

https://www.ncbi.nlm.nih.gov/pubmed/27919300

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Mobile-phone Radiation-induced Perturbation of Gene-expression Profiling, Redox Equilibrium & Sporadic-apoptosis Control in the Ovary of Drosophila melanogaster

Manta AK, Papadopoulou D, Polyzos AP, Fragopoulou AF, Skouroliakou AS, Thanos D, Stravopodis DJ, Margaritis LH. Mobile-phone Radiation-induced Perturbation of Gene-expression Profiling, Redox Equilibrium and Sporadic-apoptosis Control in the Ovary of Drosophila melanogaster.
Fly (Austin). 2016 Dec 14:0. [Epub ahead of print]

Abstract

BACKGROUND: The daily use by people of wireless communication devices has increased exponentially in the last decade, begetting concerns regarding its potential health hazards.

METHODS: Drosophila melanogaster four days-old adult female flies were exposed for 30 min to radiation emitted by a commercial mobile phone at a SAR of 0.15 W/kg and a SAE of 270 J/kg. ROS levels and apoptotic follicles were assayed in parallel with a genome-wide microarrays analysis.

RESULTS: ROS cellular contents were found to increase by 1.6 fold (x), immediately after the end of exposure, in follicles of pre-choriogenic stages (germarium - stage 10), while sporadically generated apoptotic follicles (germarium 2b and stages 7-9) presented with an averaged 2x upregulation in their sub-population mass, 4 h after fly's irradiation with mobile device. Microarray analysis revealed 168 genes being differentially expressed, 2 h post-exposure, in response to radiofrequency (RF) electromagnetic field-radiation exposure (≥1.25x, $P<0.05$) and associated with multiple and critical biological processes, such as basic metabolism and cellular subroutines related to stress response and apoptotic death.

CONCLUSION: Exposure of adult flies to mobile-phone radiation for 30 min has an immediate impact on ROS production in animal's ovary, which seems to cause a global, systemic and non-targeted transcriptional reprogramming of gene expression, 2 h post-exposure, being finally followed by induction of apoptosis 4 h after the end of exposure. Conclusively, this unique type of pulsed radiation, mainly being derived from daily used mobile phones, seems capable of mobilizing critical cytopathic mechanisms, and altering fundamental genetic programs and networks in D. melanogaster.

https://www.ncbi.nlm.nih.gov/pubmed/27960592

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Effect of electromagnetic waves from mobile phone on immune status of male rats: possible protective role of vitamin D

El-Gohary O, Said MA. Effect of electromagnetic waves from mobile phone on immune status of male rats: possible protective role of vitamin D. Can J Physiol Pharmacol. 2016 Sep 5:1-6. [Epub ahead of print]

Abstract

There are considerable public concerns about the relationship between mobile phone radiation and human health. The present study assesses the effect of electromagnetic field (EMF) emitted from a mobile phone on the immune system in rats and the possible protective role of vitamin D. Rats were randomly divided into six groups: Group I: control group; Group II: received vitamin D (1000 IU/kg/day) orally; Group III: exposed to EMF 1 h/day; Group IV: exposed to EMF 2 h/day; Group V: exposed to EMF 1 h/day and received vitamin D (1000 IU/kg/day); Group VI: exposed to EMF 2 h/day and received vitamin D (1000 IU/kg/day). After 30 days of exposure time, 1 h/day EMF exposure resulted in significant decrease in immunoglobulin levels (IgA, IgE, IgM, and IgG); total leukocyte, lymphocyte, eosinophil and basophil counts; and a significant increase in neutrophil

and monocyte counts. These changes were more increased in the group exposed to 2 h/day EMF. Vitamin D supplementation in EMF-exposed rats reversed these results when compared with EMF-exposed groups. In contrast, 7, 14, and 21 days of EMF exposure produced nonsignificant differences in these parameters among all experimental groups. We concluded that exposure to mobile phone radiation compromises the immune system of rats, and vitamin D appears to have a protective effect.

https://www.ncbi.nlm.nih.gov/pubmed/27901344

Excerpts

In the EMF exposure room, there were no other metals, and the use of any other EMF-emitting device except the mobile phone used in the study was not allowed. There was no WiFi or cellular signal in the room. The rats were exposed to EMF (900 MHz at a specific absorption rate of approximately 0.9 W/kg) emitted by Nokia N70 mobile phone (Nokia Corporation, Finland) for 1 h daily (from 0800 to 0900) for groups III and V or 2 h daily (from 0800 to 1000) for groups IV and VI for 30 days. For the used mobile phone (Nokia N70), the highest SAR value under the International Commission on Non-Ionizing Radiation Protection guidelines for use of the device and the European Union SAR value stated by the manufacturer was 0.95 W/kg of body mass (Chan et al. 1997; Sierań-Stołtny et al. 2015). The mobile phone was placed directly under the cage in which the animals stayed during the exposure. It was kept in the silent mode during the time of exposure; this means that both sound of a bell and sound in the receiver were switched off, so the animals were exposed solely to EMF generated by the mobile phone (Al-Damegh 2012; Hammodi 2011).

Several mechanisms have been proposed to explain the effects of EMF on the immune system. Cell phone radiation results in activation of the hypothalamo-pituitary adrenal system, leading to elevated serum level of corticosteroid, indicating the existence of stress response in rats exposed to cell phone radiation. The elevated corticosteroid level may be the reason for the decreased lymphocytes (Ahmadi et al. 2014; Barnes and Greenebaum 2006). The percentage of lymphocytes and neutrophils are inversely related to each other both in basal and stressed conditions. Thus, the increase in the neutrophil count could be secondary to the decrease in the lymphocyte count (Keller et al. 1983).

Among the putative mechanisms by which EMF from mobile phones may affect biological systems is the interference of EMF with Ca2+ regulatory processes in lymphoid cells (Walleczek 1992) or increasing free radicals' life span and cellular concentration of reactive oxygen species (Balci et al. 2007). This leads to oxidative damage in major cell macromolecules such as lipids and nucleic acids (Lee et al. 2004). Lantow et al. (2006) reported a significant increase in reactive oxygen species production in human monocytes and lymphocytes after exposure to 1800 MHz RF–EMFs. Increased free radicals and interference with Ca2+ regulatory processes can both cause cell growth inhibition, protein misfolding, and DNA breaks (Gye and Park 2012).--

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Different responses of Drosophila to ELF magnetic field: fitness components & locomotor activity

Zmejkoski D, Petković B, Pavković-Lučić S, Prolić Z, Anđelković M, Savić T. Different responses of Drosophila subobscura isofemale lines to extremely low frequency magnetic field (50 Hz, 0.5 mT): fitness components and locomotor activity. Int J Radiat Biol. 2016 Dec 6:1-29. [Epub ahead of print]

Abstract

PURPOSE: Extremely low frequency (ELF) magnetic fields as essential ecological factor may induce specific responses in genetically different lines. The subject of this study was to investigate the impact of ELF magnetic field on fitness components and locomotor activity of five Drosophila subobscura isofemale (IF) lines.

MATERIALS AND METHODS: Each D. subobscura IF line, arbitrarily named: B16/1, B24/4, B39/1, B57/2 and

B69/5, was maintained in five full-sib inbreeding generations. Their genetic structures were defined based on the mitochondrial DNA variability. Egg-first instar larvae and one-day-old flies were exposed to ELF magnetic field (50 Hz, 0.5 mT, 48 h) and thereafter, fitness components and locomotor activity of males and females in an open field test were observed for each selected IF line, respectively.

RESULTS: Exposure of egg-first instar larvae to ELF magnetic field shortened developmental time, and did not affect viability and sex ratio of D. subobscura IF lines. Exposure of one-day-old males and females IF lines B16/1 and B24/4 to ELF magnetic field significantly decreased their locomotor activity and this effect lasted longer in females than males.

CONCLUSIONS: These results indicate various responses of D. subobscura IF lines to the applied ELF magnetic field depending on their genetic background.

http://www.tandfonline.com/doi/abs/10.1080/09553002.2017.1268281

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15 Hz square wave magnetic fields affects voltage-gated sodium & potassium channels in neurons

Zheng Y, Dou JR, Gao Y, Dong L, Li G. Effects of 15 Hz square wave magnetic fields on the voltage-gated sodium and potassium channels in prefrontal cortex pyramidal neurons. Int J Radiat Biol. 2016 Dec 7:1-7. [Epub ahead of print]

Abstract

PURPOSE: Although magnetic fields have significant effects on neurons, little is known about the mechanisms behind their effects. The present study aimed to measure the effects of magnetic fields on ion channels in cortical pyramidal neurons.

MATERIALS AND METHODS: Cortical pyramidal neurons of Kunming mice were isolated and then subjected to 15 Hz, 1 mT square wave (duty ratio 50%) magnetic fields stimulation. Sodium currents (INa), transient potassium currents (IA) and delayed rectifier potassium currents (IK) were recorded by whole-cell patch clamp method.

RESULTS: We found that magnetic field exposure depressed channel current densities, and altered the activation kinetics of sodium and potassium channels. The inactivation properties of INa and IA were also altered.

CONCLUSION: Magnetic field exposure alters ion channel function in neurons. It is likely that the structures of sodium and potassium channels were influenced by the applied field. Sialic acid, which is an important component of the channels, could be the molecule responsible for the reported results.

https://www.ncbi.nlm.nih.gov/pubmed/27924669

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A follow-up study of the association between mobile phone use and symptoms of ill health

Cho YM, Lim HJ, Jang H, Kim K, Choi JW, Shin C, Lee SK, Kwon JH, Kim N. A follow-up study of the association between mobile phone use and symptoms of ill health. Environ Health Toxicol. 2016 Dec 29. doi: 10.5620/eht.e2017001. [Epub ahead of print]

Abstract

Objectives: The duration and frequency of mobile phone calls, and their relationship with various health effects, have been investigated in our previous cross-sectional study. This two-year period follow-up study after aimed to assess the changes in these variables of same subjects.

Methods: The study population comprised 532 non-patient adult subjects sampled from the Korean Genome Epidemiology Study. The subjects underwent a medical examination at a hospital in 2012/2013 and revisited the same hospital in 2014/2015 to have the same examination for the characteristics of mobile phone use performed. In addition, to evaluate the effects on health, the Headache Impact Test-6 (HIT-6), Psychosocial Well-being Index-Short Form (PWI-SF), Beck Depression Inventory (BDI), Korean-Instrumental Activities of Daily Living (K-IADL), Perceived Stress Scale (PSS), Pittsburgh Sleep Quality Index (PSQI), and 12-Item Short Form Health Survey (SF-12) were analyzed. For all these tests, the higher the score, the greater the effect on health. Variances between scores in all the indices in the baseline and follow-up surveys were calculated, and correlations of each index were analyzed.

Results: The average duration per call and HIT-6 score of the subjects decreased significantly compared with those recorded two years ago. The results showed a slight but significant correlation between call duration changes and HIT-6 score changes for female subjects, but not for males. HIT-6 scores in the follow-up survey significantly decreased compared to those in the baseline survey, but long-time call users (subjects whose call duration was ≥5 min in both the baseline and follow-up surveys) had no statistically significant reduction in HIT-6 scores.

Conclusion: This study suggests that increased call duration is a greater risk factor for increases in headache than any other type of adverse health effect, and that this effect can be chronic.

https://www.ncbi.nlm.nih.gov/pubmed/28111420

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Symptoms and the use of wireless communication devices: A prospective cohort study in Swiss adolescents

Schoeni A, Roser K, Röösli M. Symptoms and the use of wireless communication devices: A prospective cohort study in Swiss adolescents.Environ Res. 2017 Jan 20;154:275-283. doi: 10.1016/j.envres.2017.01.004. [Epub ahead of print]

Abstract

BACKGROUND: We investigated whether radiofrequency electromagnetic fields (RF-EMF) from mobile phones and other wireless devices or by the wireless device use itself due to non-radiation related factors in that context are associated with an increase in health symptom reports of adolescents in Central Switzerland.

METHODS: In a prospective cohort study, 439 study participants (participation rate: 36.8%) aged 12-17 years, completed questionnaires about their mobile and cordless phone use, their self-reported symptoms and possible confounding factors at baseline (2012/2013) and one year later (2013/2014). Operator recorded mobile phone data was obtained for a subgroup of 234 adolescents. RF-EMF dose measures considering various factors affecting RF-EMF exposure were computed for the brain and the whole body. Data were analysed using a mixed-logistic cross-sectional model and a cohort approach, where we investigated whether cumulative dose over one year was related to a new onset of a symptom between baseline and follow-up. All analyses were adjusted for relevant confounders.

RESULTS: Participation rate in the follow-up was 97% (425 participants). In both analyses, cross-sectional and cohort, various symptoms tended to be mostly associated with usage measures that are only marginally related to RF-EMF exposure such as the number of text messages sent per day (e.g. tiredness: OR:1.81;

95%CI:1.20-2.74 for cross-sectional analyses and OR:1.87; 95%CI:1.04-3.38 for cohort analyses). Outcomes were generally less strongly or not associated with mobile phone call duration and RF-EMF dose measures.

CONCLUSIONS: Stronger associations between symptoms of ill health and wireless communication device use than for RF-EMF dose measures were observed. Such a result pattern does not support a causal association between RF-EMF exposure and health symptoms of adolescents but rather suggests that other aspects of extensive media use are related to symptoms.

https://www.ncbi.nlm.nih.gov/pubmed/28113068

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Exposure to Radiofrequency Electromagnetic Fields From Wi-Fi in Australian Schools

Karipidis K, Henderson S, Wijayasinghe D, Tjong L, Tinker R.Exposure to Radiofrequency Electromagnetic Fields From Wi-Fi in Australian Schools.Radiat Prot Dosimetry. 2017 Jan 10. doi: 10.1093/rpd/ncw370. [Epub ahead of print]

Note: Typical and peak RF levels were found to be lower than ICNIRP guidelines. However, many researchers believe that the guidelines are inadequate to ensure safety. Furthermore,peak RF levels were averaged over 1 minute which is much too long as very short-term intense pulses may have biologic effects.

Abstract

The increasing use of Wi-Fi in schools and other places has given rise to public concern that the radiofrequency (RF) electromagnetic fields from Wi-Fi have the potential to adversely affect children. The current study measured typical and peak RF levels from Wi-Fi and other sources in 23 schools in Australia. All of the RF measurements were much lower than the reference levels recommended by international guidelines for protection against established health effects. The typical and peak RF levels from Wi-Fi in locations occupied by children in the classroom were of the order of 10-4 and 10-2% of the exposure guidelines, respectively. Typical RF levels in the classroom were similar between Wi-Fi and radio but higher than other sources. In the schoolyard typical RF levels were higher for radio, TV and mobile phone base stations compared to Wi-Fi. The results of this study showed that the typical RF exposure of children from Wi-Fi at school is very low and comparable or lower to other sources in the environment.

Excerpts

Wi-Fi transmissions consist of sequences of RF burst signals or pulses ranging in duration depending on the amount of data being carried by a pulse(15). The proportion of time that Wi-Fi transmits RF signals is called the duty cycle. Joseph et al.(14) in measuring Wi-Fi in 176 different urban locations (outdoors, homes, offices) found a median duty cycle of 1.4% over all the measurements. Particularly in schools, Khalid et al.(10) in measuring Wi-Fi in six schools found a mean duty cycle from the access points of 4.8%. In our study duty cycle was measured separately for the 2.45 and 5 GHz transmissions when performing the stationary Wi-Fi measurements in the centre of the classroom. The median duty cycle for 23 schools that were measured in the current study was 6.3 and 2.4% for 2.45 and 5 GHz transmissions, respectively.

Members of the public often ask about the cumulative exposure that a child receives when using a Wi-Fi device in a classroom in which a number of children are simultaneously using Wi-Fi. When downloading files, most of the transmissions will be from the access point, not the students' device. When downloading and uploading only a portion of the maximum capacity of a network would be used even in a classroom filled with children using Wi-Fi. The Wi-Fi network divides RF transmissions among the access points and client devices therefore the individual RF exposure to a child in a classroom that is using a device consists of sequential exposures from all active devices, the majority of which are located at some distance away(15). For the majority of schools (20) the measurements in the current study were conducted in an empty classroom (to

avoid lesson disruption) with an access point and one laptop. In three schools, measurements were conducted with students or teachers present and using Wi-Fi devices. A comparison between measurements conducted in empty classrooms and classrooms with multiple students/teachers using Wi-Fi showed no significant difference in the RF levels ($p > 0.1$ for all); although this may have been due to low numbers (only three schools measured with multiple users in the classroom).

Open Access Paper: http://rpd.oxfordjournals.org/content/early/2017/01/10/rpd.ncw370.long

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Monitoring of RF/Microwave field strength at schools in a pilot district in Samsun/Turkey

Çetin Kurnaz, Begüm Korunur Engiz, Murat Cem Bozkurt. Monitoring of RF/Microwave field strength at schools in a pilot district in Samsun/Turkey. Microwave Symposium (MMS), 2016 16th Mediterranean. 14-16 Nov 2016.

Abstract

As a result of the growing usage of wireless devices and a large number of WLANs installations at schools; determining the exposure levels to students and staff from these systems has become more crucial than before. Since microwave radio links are used to provide connection between wireless devices, proper assessment of exposure to microwave emissions must be carried out. For this reason, in this study electromagnetic radiation (EMR) measurements were conducted at 92 different schools in Ilkadim district twice in 2016 using PMM 8053 EMR meter. The changes in and statistical properties of electric field strengths (E) are determined on the basis of these measurements. The maximum Es (Emax) are 5.39 V/m and 3.04 V/m for each measurement while the maximum average Es (Eavg) are 2.22 and 2.25 V/m. Even though the measured E levels are below the limits that are determined by the International Commission on Non-Ionizing Radiation Protection (ICNIRP); for providing a wide margin of protection and evaluating the health risks they may cause, regular control/measurement of exposed EMR levels is recommended.

Excerpt

The pie chart showing the distributions of all EMR sources is given in Fig.5. As seen from the figure, 99.16% of total EMR in the medium is emitted by base stations which use 800MHz (LTE800), 900MHz (GSM900), 1800MHz (GSM1800) and 2100MHz (UMTS2100) frequency bands. Among the four of them, GSM900 has the most contribution
with 36.49%.

[Note: The paper did not discuss the extent Wi-Fi was used in these schools. WLAN was found to emit 0.024 V/m on average.]

http://ieeexplore.ieee.org/document/7803786/

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RF exposure survey of children and adults: First results from Slovenia

Gajšek P, Struchen B, Valič B. RF exposure survey of children and adults: First results from Slovenia. IEEE Radio and Antenna Days of the Indian Ocean (RADIO). 10-13 Oct. 2016. 10.1109/RADIO.2016.7772027

Abstract

Although RF exposure surveys have been carried out in the general environment using recently developed personal measurement devices (exposure meters), comprehensive measurement of exposure with a true population based sampling frame and a common protocol across countries has never been conducted. Within the FP-7 funded project Geronimo a personal RF exposure measurements in 5 European countries are

conducted following a common measurement protocol. First measurements from 49 children and 49 parents in Slovenia yielded an average personal RF-EMF exposure of 0.26 V/m. Average personal RF-EMF exposure by technology was 0.11 V/m from uplink, 0.18 V/m from downlink, 0.15 V/m from broadcasting, 0.07 V/m from DECT and 0.08 V/m from WLAN.

http://ieeexplore.ieee.org/document/7772027/

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Can body-worn devices be used for measuring personal exposure to mm waves?

Thielens A, Martens L, Joseph W. Can body-worn devices be used for measuring personal exposure to mm waves? Bioelectromagnetics. 2017 Jan 20. doi: 10.1002/bem.22036. [Epub ahead of print]

Abstract

Fifth generation (5G) telecommunication networks will require more bandwidth and will use mm waves (30-300 GHz). Consequently, the aperture of antennas that are used for electromagnetic field measurements will be reduced in comparison to the ones currently used for lower frequencies (0.1-6 GHz). In combination with existing limits on incident power density prescribed by exposure guidelines, this provides an upper limit to received powers during exposure measurements. Simultaneously, an increase in the noise floor of transmitted signals will occur. These effects limit the dynamic range of measurements to 53 dB (2×10^5) at 300 GHz and 73 dB (2×10^7) at 30 GHz, which are determined using a simplified model. Additional propagation losses that exceed this dynamic range can occur during on-body measurements. Therefore, in future wireless networks, an on-body measurement of the incident power density cannot be guaranteed using a single antenna. This effect is problematic for both occupational measurements and epidemiological studies. We propose to use multiple, dynamic antennas on the body instead.

https://www.ncbi.nlm.nih.gov/pubmed/28106915

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Measurements of intermediate-frequency electric and magnetic fields in households

Aerts S, Calderon C, Valič B, Maslanyj M, Addison D, Mee T, Goiceanu C, Verloock L, Van den Bossche M, Gajšek P Vermeulen 5, Röösli M, Cardis E, Martens L, Joseph W.Measurements of intermediate-frequency electric and magnetic fields in households. Environ Res. 2017 Jan 10;154:160-170. doi: 10.1016/j.envres.2017.01.001. [Epub ahead of print]

Highlights

- Survey of residential electric and magnetic fields at intermediate frequencies (IF).
- IF-EF and -MF emitted by 280 household appliances were characterised.
- Strongest emitters were induction cookers, CFLs, LCD-TVs, and microwave ovens.
- No emissions exceeded ICNIRP limits (highest exposure quotient was 1.00).

Abstract

Historically, assessment of human exposure to electric and magnetic fields has focused on the extremely-low-frequency (ELF) and radiofrequency (RF) ranges. However, research on the typically emitted fields in the intermediate-frequency (IF) range (300Hz to 1MHz) as well as potential effects of IF fields on the human body remains limited, although the range of household appliances with electrical components working in the IF range has grown significantly (e.g., induction cookers and compact fluorescent lighting). In this study, an extensive measurement survey was performed on the levels of electric and magnetic fields in the IF range

typically present in residences as well as emitted by a wide range of household appliances under real-life circumstances. Using spot measurements, residential IF field levels were found to be generally low, while the use of certain appliances at close distance (20cm) may result in a relatively high exposure. Overall, appliance emissions contained either harmonic signals, with fundamental frequencies between 6kHz and 300kHz, which were sometimes accompanied by regions in the IF spectrum of rather noisy, elevated field strengths, or much more capricious spectra, dominated by 50Hz harmonics emanating far in the IF domain. The maximum peak field strengths recorded at 20cm were 41.5V/m and 2.7A/m, both from induction cookers. Finally, none of the appliance emissions in the IF range exceeded the exposure summation rules recommended by the International Commission on Non-Ionizing Radiation Protection guidelines and the International Electrotechnical Commission (IEC 62233) standard at 20cm and beyond (maximum exposure quotients EQE 1.0 and EQH 0.13).

https://www.ncbi.nlm.nih.gov/pubmed/28086101

Conclusions

Measurements of electric and magnetic fields at intermediate frequencies (IF) were performed in residences in three countries by way of a common protocol. Typical IF fields in the most frequented rooms were assessed as well as emissions from a wide range of household appliances. At distances of 1 m or more from the IF sources, field levels were found to be generally low. However, use of certain appliances at close distances (20–50cm), including induction cookers, LCD screens, microwave ovens and refrigerators with inverter technology, and (compact) fluorescent lighting, may result in exposures above 5% of public ICNIRP (2010) reference levels. In general, EF and MF emissions of household appliances in the IF range contained either harmonic signals, with fundamental frequencies between 6 and 293 kHz, which were sometimes accompanied by regions in the IF spectrum of rather noisy, elevated field strengths, or much more capricious spectra, seemingly dominated by 50 Hz harmonics emanating far in the IF domain. The maximum peak field strengths recorded in this study were 41.5 V/m and 2.7 A/m (both resulting from induction cookers) and at 20 cm and beyond none of the appliances exceeded the ICNIRP and IEC exposure summation rules (maximum observed electric- and magnetic-field exposure quotients were 1.00 and 0.13, respectively). The results reported here may provide a useful resource for epidemiological studies investigating the potential link between (adverse) health effects and exposure to IF fields.

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Effect of Low Level Subchronic Microwave Radiation on Rat Brain

Deshmukh PS, Megha K, Nasare N, Banerjee BD, Ahmed RS, Abegaonkar MP, Tripathi AK, Mediratta PK. Effect of Low Level Subchronic Microwave Radiation on Rat Brain. Biomed Environ Sci. 2016 Dec;29(12):858-867. doi: 10.3967/bes2016.115.

Abstract

OBJECTIVE: The present study was designed to investigate the effects of subchronic low level microwave radiation (MWR) on cognitive function, heat shock protein 70 (HSP70) level and DNA damage in brain of Fischer rats.

METHODS: Experiments were performed on male Fischer rats exposed to microwave radiation for 90 days at three different frequencies: 900, 1800, and 2450 MHz. Animals were divided into 4 groups: Group I: Sham exposed, Group II: animals exposed to microwave radiation at 900 MHz and specific absorption rate (SAR) 5.953 × 10-4 W/kg, Group III: animals exposed to 1800 MHz at SAR 5.835 × 10-4 W/kg and Group IV: animals exposed to 2450 MHz at SAR 6.672 × 10-4 W/kg. All the animals were tested for cognitive function using elevated plus maze and Morris water maze at the end of the exposure period and subsequently sacrificed to collect brain tissues. HSP70 levels were estimated by ELISA and DNA damage was assessed using alkaline comet assay.

RESULTS: Microwave exposure at 900-2450 MHz with SAR values as mentioned above lead to decline in cognitive function, increase in HSP70 level and DNA damage in brain.

CONCLUSION: The results of the present study suggest that low level microwave exposure at frequencies 900, 1800, and 2450 MHz may lead to hazardous effects on brain.

Open source paper: http://bit.ly/2jhXm84

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Long-term exposure to 835 MHz RF-EMF induces hyperactivity, autophagy and demyelination in the cortical neurons of mice

Kim JH, Yu DH, Huh YH, Lee EH, Kim HG, Kim HR.Long-term exposure to 835 MHz RF-EMF induces hyperactivity, autophagy and demyelination in the cortical neurons of mice. Sci Rep. 2017 Jan 20;7:41129. doi: 10.1038/srep41129.

Abstract

Radiofrequency electromagnetic field (RF-EMF) is used globally in conjunction with mobile communications. There are public concerns of the perceived deleterious biological consequences of RF-EMF exposure. This study assessed neuronal effects of RF-EMF on the cerebral cortex of the mouse brain as a proxy for cranial exposure during mobile phone use. C57BL/6 mice were exposed to 835 MHz RF-EMF at a specific absorption rate (SAR) of 4.0 W/kg for 5 hours/day during 12 weeks. The aim was to examine activation of autophagy pathway in the cerebral cortex, a brain region that is located relatively externally. Induction of autophagy genes and production of proteins including LC3B-II and Beclin1 were increased and accumulation of autolysosome was observed in neuronal cell bodies. However, proapoptotic factor Bax was down-regulted in the cerebral cortex. Importantly, we found that RF-EMF exposure led to myelin sheath damage and mice displayed hyperactivity-like behaviour. The data suggest that autophagy may act as a protective pathway for the neuronal cell bodies in the cerebral cortex during radiofrequency exposure. The observations that neuronal cell bodies remained structurally stable but demyelination was induced in cortical neurons following prolonged RF-EMF suggests a potential cause of neurological or neurobehavioural disorders.

https://www.ncbi.nlm.nih.gov/pubmed/28106136

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Extremely low-level microwaves attenuate immune imbalance induced by inhalation exposure to low-level toluene in mice

Novoselova EG, Glushkova OV, Khrenov MO, Novoselova TV, Lunin SM, Fesenko EE. Extremely low-level microwaves attenuate immune imbalance induced by inhalation exposure to low-level toluene in mice. Int J Radiat Biol. 2017 Jan 9:1-9. doi: 10.1080/09553002.2017.1270473. [Epub ahead of print]

Abstract

PURPOSE: To clarify whether extremely low-level microwaves (MW) alone or in combination with p38 inhibitor affect immune cell responses to inhalation exposure of mice to low-level toluene.

MATERIALS AND METHODS: The cytokine profile, heat shock proteins expression, and the activity of several signal cascades, namely, NF-κB, SAPK/JNK, IRF-3, p38 MAPK, and TLR4 were measured in spleen lymphocytes of mice treated to air-delivered toluene (0.6 mg/m3) or extremely low-level microwaves (8.15-18 GHz, 1μW/cm2, 1 Hz swinging frequency) or combined action of these two factors.

RESULTS: A single exposure to air-delivered low-level toluene induced activation of NF-κB, SAPK/JNK, IFR-3, p38 MAPK and TLR4 pathways. Furthermore, air toluene induced the expression of Hsp72 and enhanced IL-1, IL-6, and TNF-α in blood plasma, which is indicative of a pro-inflammatory response. Exposure to MW alone also resulted in the enhancement of the plasma cytokine values (e.g. IL-6, TNF-α, and IFN-γ) and activation of the NF-κB, MAPK p38, and especially the TLR4 pathways in splenic lymphocytes. Paradoxically, pre-exposure to MW partially recovered or normalized the lymphocyte parameters in the toluene-exposed mice, while the p38 inhibitor XI additionally increased protective activity of microwaves by down regulating MAPKs (JNK and p38), IKK, as well as expression of TLR4 and Hsp90-α.

CONCLUSIONS: The results suggest that exposure to low-intensity MW at specific conditions may recover immune parameters in mice undergoing inhalation exposure to low-level toluene via mechanisms involving cellular signaling.

EXCERPT: In the present study, we examined the effects of MW on the immunity of toluene-exposed mice. We hypothesized that MW exposure would protect mouse cells from the possible toxic effects of toluene. Indeed, we have previously demonstrated that the extremely low-level centimetre waves improved immunity of tumor-bearing mice, and this anti-tumor effect was mediated by TNF production (Novoselova et al. 2004Novoselova EG, Ogay VB, Sorokina OV, Glushkova OV, Sinotova OA, Fesenko EE.2004. The production of tumor necrosis factor in cells of tumor-bearing mice after total-body microwave irradiation and antioxidant diet. Elec Bio Med. 23:167–180.[Taylor & Francis Online], [Web of Science ®]). These results indicate the biologic activity of extremely low-level MW that might be used as a tolerable immunomodulatory factor. The present study demonstrated that the p38 Inhibitor XI increased the protective activity of MW via down-regulation of MAPKs (JNK and p38), IKK, as well as expression of TLR4 and Hsp90-α.

In conclusion, we focused on the changes of several signaling cascade activities, plasma cytokine values, TLR4 and heat shock protein expression in mice exposed to a low-level of toluene, with or without MW alone or in combination with p38 Inhibitor XI. Our data demonstrated that a single exposure to low-level air toluene induced a pro-inflammatory response, while MW alone or in combination with the inhibitor, partially recovered or normalized the studied parameters in the murine spleen.

Further studies using appropriate animal models are necessary to provide evidence-based support for new MW facilities to regulate the immune response following exposure to environmental toxins.

https://www.ncbi.nlm.nih.gov/pubmed/28067111

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Adverse and beneficial effects in Chinese hamster lung fibroblast cells following radiofrequency exposure

Sannino A, Zeni O, Romeo S, Massa R, Scarfi MR. Adverse and beneficial effects in Chinese hamster lung fibroblast cells following radiofrequency exposure.Bioelectromagnetics. 2017 Jan 10. doi: 10.1002/bem.22034. [Epub ahead of print]

Abstract

In this study, the effect of radiofrequency (RF) exposure to 1950 MHz, Universal Mobile Telecommunication System signal, was investigated in Chinese hamster lung fibroblast cell line (V79). Genotoxic and cytotoxic effects of 20-h exposure at specific absorption rate (SAR) values from 0.15 W/kg to 1.25 W/kg were measured by means of cytokinesis-block micronucleus (MN) assay. Exposure was carried out blinded under strictly controlled conditions of dosimetry and temperature. The effect of RF exposure alone at four SAR values was tested, that is, 0.15, 0.3, 0.6, and 1.25 W/kg. A statistically significant increase in MN frequency was found in

cultures exposed to 0.15 and 0.3 W/kg ($P < 0.05$) compared to sham-exposed ones, in the absence of cytotoxicity. SAR values of 0.6 and 1.25 W/kg did not exert any effect. Moreover, to evaluate the ability of RF to exert protective effects with respect to a chemical mutagen, cell cultures were also pre-exposed for 20 h at 0.3 or 1.25 W/kg, and then treated with 500 ng/ml of mitomycin-C (MMC). A significant reduction in the frequency of MN was detected in cultures pre-exposed to 1.25 W/kg compared to cultures treated with MMC alone ($P < 0.05$), indicating induction of adaptive response. Such a decrease was not induced by pre-exposure at 0.3 W/kg SAR. Taken together, our results indicated that V79 is a sensitive cell model to evidence either adverse or beneficial effects of RF exposure, depending on experimental conditions applied.

Excerpts

The results presented here indicated lack of MN increase in cultures exposed for 20 h to 1950 MHz, UMTS signal, at SAR values of 0.6 and 1.25 W/kg. On the contrary, exposure to 0.15 and 0.3 W/kg SAR resulted in a statistically significant increase in MN frequency ($P < 0.05$), compared to sham controls. Concerning 0.3 W/kg, such an increase was also detected in three more independent experiments, carried out to evaluate RF-induced AR (Table 3). On the whole, an average MN increase of 55% was gained on seven independent experiments, in absence of cytotoxicity, although some experimental variability was recorded.

The observed effect was non-thermal, since chromosomal damage has been recorded at 0.15 and 0.3 W/kg SAR but not at higher values (0.6 and 1.25 W/kg)....

Consistent with results presented here, Xu et al. [2013] identified Chinese hamster fibroblasts as a sensitive cell model in a comparative study where different cell types were exposed to RF. The authors exposed six cell types to 1800 MHz, GSM, 3 W/kg SAR, and 24 h exposure (5 min on/10 min off cycles), resulting in a significant increase in DNA damage, evaluated as gamma foci formation in Chinese hamster lung cells and human skin fibroblasts, but not in other cell types tested [Xu et al., 2013].

The dependency of the effect on cell type has been also reported by other authors, who demonstrated that the same RF exposure conditions resulted in affecting certain cell types but not others, when protein expression [Sanchez et al., 2006; Zimmerman et al., 2012; Lu et al., 2014], enzyme activity [Hoyto et al., 2007], oxidative stress [Lantow et al., 2006], or cell proliferation [Trillo et al., 2011] were investigated.

We do not have an explanation for the chromosomal damage detected in this investigation. Rather, due to dependence of the effect on SAR level, our findings seem in agreement with the theory of “window” effects, proposed to explain several non-linear results in bioelectromagnetic research [Postow and Swicord, 1986]. Effects have been reported at some frequencies but not at others, or at lower but not at higher SAR levels of the same frequency, or at certain modulations but not at others, either in vivo or in vitro [Dutta et al., 1992; Panagopoulos and Margaritis, 2010a,b].

https://www.ncbi.nlm.nih.gov/pubmed/28072461

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Study of potential health effects of electromagnetic fields of telephony and Wi-Fi, using chicken embryo development as animal model

Woelders H, de Wit A, Lourens A, Stockhofe N, Engel B, Hulsegge I, Schokker D, van Heijningen P, Vossen S, Bekers D, Zwamborn P. Study of potential health effects of electromagnetic fields of telephony and Wi-Fi, using chicken embryo development as animal model.Bioelectromagnetics. 2017 Jan 16. doi: 10.1002/bem.22026. [Epub ahead of print]

Abstract

The objective of this study is to investigate possible biological effects of radiofrequency electromagnetic fields

(RF-EMF) as used in modern wireless telecommunication in a well-controlled experimental environment using chicken embryo development as animal model. Chicken eggs were incubated under continuous experimental exposure to GSM (1.8 GHz), DECT (1.88 GHz), UMTS (2.1 GHz), and WLAN (5.6 GHz) radiation, with the appropriate modulation protocol, using a homogeneous field distribution at a field strength of approximately 3 V/m, representing the maximum field level in a normal living environment. Radiation-shielded exposure units/egg incubators were operating in parallel for exposed and control eggs in a climatized homogeneous environment, using 450 eggs per treatment in three successive rounds per treatment. Dosimetry of the exposure (field characteristics and specific absorption rate) were studied. Biological parameters studied included embryo death during incubation, hatching percentage, and various morphological and histological parameters of embryos and chicks and their organs, and gene expression profiles of embryos on day 7 and day 18 of incubation by microarray and qPCR. No conclusive evidence was found for induced embryonic mortality or malformations by exposure to the used EMFs, or for effects on the other measured parameters. Estimated differences between treatment groups were always small and the effect of treatment was not significant. In a statistical model that ignored possible interaction between rounds and exposure units, some of the many pairwise comparisons of exposed versus control had P-values lower than 0.05, but were not significant after correction for multiple testing.

https://www.ncbi.nlm.nih.gov/pubmed/28092407

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Effects of extremely low-frequency electromagnetic field on expression levels of some antioxidant genes in human MCF-7 cells

Mahmoudinasab H, Sanie-Jahromi F, Saadat M. Effects of extremely low-frequency electromagnetic field on expression levels of some antioxidant genes in human MCF-7 cells. Mol Biol Res Commun. 2016 Jun;5(2):77-85.

Abstract

In the past three decades, study on the biological effects of extremely low-frequency electromagnetic fields (ELF-EMFs) has been of interest to scientists. Although the exact mechanism of its effect is not fully understood, free radical processes has been proposed as a possible mechanism. This study was designed to evaluate the effect of 50-Hz EMFs on the mRNA levels of seven antioxidant genes (CAT, SOD1, SOD2, GSTO1, GSTM3, MSGT1, and MSGT3) in human MCF-7 cells. The EMF exposure patterns were: 1) 5 min field-on/5 min filed-off, 2) 15 min field-on/15 min field-off, 3) 30 min field-on continuously. In all three exposure conditions we tried to have total exposure time of 30 minutes. Control cultures were located in the exposure apparatus when the power was off. The experiments were done at two field intensities; 0.25 mT and 0.50 mT. The RNA extraction was done at two times; immediately post exposure and two hours post exposure. The mRNA levels were determined using quantitative real-time polymerase chain reaction. MTT assay for three exposure conditions in the two field intensities represented no cytotoxic effect on MCF-7 cells. Statistical comparison showed a significant difference between 0.25 mT and 0.50 mT intensities for "the 15 min field-on/15 min field-off condition" (Fisher's exact test, P=0.041), indicating that at 0.50 mT intensity field, the number of down-regulated and/or up-regulated genes increased compared with the other ones. However, there is no statistical significant difference between the field intensities for the two others EMF exposure conditions.

https://www.ncbi.nlm.nih.gov/pubmed/28097161

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Investigation of terahertz radiation influence on rat glial cells

Borovkova M, Serebriakova M, Fedorov V, Sedykh E, Vaks V, Lichutin A, Salnikova A, Khodzitsky M. Investigation of terahertz radiation influence on rat glial cells. Biomed Opt Express. 2016 Dec 14;8(1):273-280.

doi: 10.1364/BOE.8.000273. eCollection 2017.

Abstract

We studied an influence of continuous terahertz (THz) radiation (0.12 - 0.18 THz, average power density of 3.2 mW/cm2) on a rat glial cell line. A dose-dependent cytotoxic effect of THz radiation is demonstrated. After 1 minute of THz radiation exposure a relative number of apoptotic cells increased in 1.5 times, after 3 minutes it doubled. This result confirms the concept of biological hazard of intense THz radiation. Diagnostic applications of THz radiation can be restricted by the radiation power density and exposure time.

Excerpts

... It is known that THz radiation causes a variety of biological effects, including some at the cellular level. Detailed reviews on this issue can be found in papers [2–7]. Influence of THz radiation on cells is revealed in the change of genes activity and cell membrane status. It was also reported before, that THz radiation changes the electrical charge of the membrane of human red blood cells [8, 9], causes a violation of the adhesive properties of the nerve cell membrane of a snail and mollusk [10, 11]. An indication of the structural damage is the increase in membrane permeability, as it was shown in some experiments with human red blood cells and lymphocytes [12], and laboratory rats red blood cells [13, 14].

Among the cellular effects, the cytotoxic effect of THz radiation is also an issue of concern for many scientists. Currently, there is no consensus on this issue. Some studies have demonstrated that this effect does not occur [18–25], whereas in other works the effect was clearly displayed [10–12, 26–28]. Particularly, experiments in papers [19, 20, 25, 28] showed different results after exposure of THz radiation of approximately same frequency (0.10 – 0.15 THz) and power density (0.04 – 5 mW/cm2). In all mentioned experiments, registration of the effect was carried out using adequate methods; however, the samples under exposure were different. It is possible that presence or lack of the effect is associated with the properties and characteristics of some particular cells. For this investigation, glial cells were selected as the samples of the experiment. They are highly sensitive to the ionic changes in environment [29]. One of the mechanisms of THz radiation impact on living systems may be a disturbing effect on the status of the cell endogenous field, which will lead to changes in the ionic fluxes from a cell to environment and vice versa, and affect cell viability.

Conclusion In this investigation, we demonstrated a dose-dependent cytotoxic effect of THz radiation on rat glial cells. In the experiment, a C6 rat glial cell line was exposed by continuous THz radiation (0.12 – 0.18 THz) at average power density of 3.2 mW/cm^2. After one minute of exposure, a relative number of apoptotic cells increased by a factor of 1.5, after 5 minutes it became 2.4 times higher than the initial value. This result confirms the concept of biological hazard of intense THz radiation. Therefore, we claim that diagnostic applications of THz radiation can be restricted by the radiation power density and exposure time.

https://www.osapublishing.org/boe/abstract.cfm?uri=boe-8-1-273

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State of knowledge on biological effects at 40–60 GHz

Yves Le Dréan, Yonis Soubere Mahamoud, Yann Le Page, Denis Habauzit, Catherine Le Quément, Maxim Zhadobov, Ronan Sauleau. State of knowledge on biological effects at 40–60 GHz. Comptes Rendus Physique, 14(5):402-411. 2013.

Abstract

Millimetre waves correspond to the range of frequencies located between 30 and 300 GHz. Many applications exist and are emerging in this band, including wireless telecommunications, imaging and monitoring systems.

In addition, some of these frequencies are used in therapy in Eastern Europe, suggesting that interactions with the human body are possible. This review aims to summarise current knowledge on interactions between millimetre waves and living matter. Several representative examples from the scientific literature are presented. Then, possible mechanisms of interactions between millimetre waves and biological systems are discussed.

http://www.sciencedirect.com/science/article/pii/S1631070513000480

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Temperature distribution and Specific Absorption Rate inside a child's head

Vladimir Stanković, Dejan Jovanović, Dejan Krstić, Vera Marković, Nenad Cvetković. Temperature distribution and Specific Absorption Rate inside a child's head. International Journal of Heat and Mass Transfer, Volume 104, January 2017, Pages 559-565.

Highlights

• The numerical analysis of SAR and temperature distribution within a child head.
• Determination of SAR and increasing of temperature within biological tissues.
• Dependence of the SAR and temperature values on the distance.
• Comparison of results obtained by numerical calculation with experimental results.

Abstract

This paper represents the numerical analysis of Specific Absorption Rate (SAR) and temperature distribution within a real child head model exposed to mobile phone radiation at the frequency of f = 900 MHz. In this research the SAR and temperature distribution are obtained by numerical solutions of the equation of electromagnetic waves propagation and by bioheat equation, respectively, and are shown inside different biological tissues and organs during exposure to electromagnetic radiation from a mobile phone. As electromagnetic properties of tissues depend on the electromagnetic waves frequency, the value of SAR and temperature will be different for different tissues and organs. The maximum absorption of electromagnetic energy is in the surface layers of the model, whereby this value is greater than the maximum allowed value defined by standards. Furthermore, the increase in temperature is the highest in those biological tissues and organs that are closest to the source of radiation i.e. a mobile phone. Moving away from a mobile phone, the temperature decreases, but more slowly than the SAR values. In the analysis of the temperature rise resulting from tissues and organs heating due to the effects of electromagnetic fields on a child's head, special attention will be given to the maximum temperature increase in the brain.

Conclusion

This study investigated the distribution of SAR and temperature rise in the anatomical model of a child's head exposed to electromagnetic fields from mobile phones. It was determined that although the values of SAR and temperature decrease with the distance from the source of radiation, it is not possible to establish a direct connection between these quantities. This is primarily because the SAR represents instantaneous heating of tissue. The distribution of temperature will vary compared to the distribution of SAR due to different mechanisms of heat transfer in the thermal model of a child's head.

Although the value of SAR in the brain is below the maximum allowable values, the fact that the SAR levels in certain tissues and organs of the model are significantly above the maximum allowable value must not be disregarded. It is precisely these areas of a child's head that should be the focus of further research of possible unwanted effects of mobile phone radiation.

On the other hand, the temperature of the brain does not exceed 0.7 C, which is below the threshold for causing undesirable thermal effects on neurons [29], while in other parts of the head the temperature does not exceed 1 C.

Of course, it should be noted that the exposure to electromagnetic radiation for 15 min was simulated. Therefore, the obtained results suggest that, in addition to a dosimetry analysis, it is also necessary to perform the thermal analysis of the impact of mobile phone radiation.

http://bit.ly/2jcBjz9

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Personal radiofrequency electromagnetic field exposure measurements in Swiss adolescents

Roser K, Schoeni A, Struchen B, Zahner M, Eeftens M, Fröhlich J, Röösli M. Personal radiofrequency electromagnetic field exposure measurements in Swiss adolescents.Environ Int. 2016 Dec 27. pii: S0160-4120(16)30527-X. doi: 10.1016/j.envint.2016.12.008. [Epub ahead of print]

Abstract

BACKGROUND: Adolescents belong to the heaviest users of wireless communication devices, but little is known about their personal exposure to radiofrequency electromagnetic fields (RF-EMF).

OBJECTIVES: The aim of this paper is to describe personal RF-EMF exposure of Swiss adolescents and evaluate exposure relevant factors. Furthermore, personal measurements were used to estimate average contributions of various sources to the total absorbed RF-EMF dose of the brain and the whole body.

METHODS: Personal exposure was measured using a portable RF-EMF measurement device (ExpoM-RF) measuring 13 frequency bands ranging from 470 to 3600MHz. The participants carried the device for three consecutive days and kept a time-activity diary. In total, 90 adolescents aged 13 to 17years participated in the study conducted between May 2013 and April 2014. In addition, personal measurement values were combined with dose calculations for the use of wireless communication devices to quantify the contribution of various RF-EMF sources to the daily RF-EMF dose of adolescents.

RESULTS: Main contributors to the total personal RF-EMF measurements of 63.2μW/m2 (0.15V/m) were exposures from mobile phones (67.2%) and from mobile phone base stations (19.8%). WLAN at school and at home had little impact on the personal measurements (WLAN accounted for 3.5% of total personal measurements). According to the dose calculations, exposure from environmental sources (broadcast transmitters, mobile phone base stations, cordless phone base stations, WLAN access points, and mobile phones in the surroundings) contributed on average 6.0% to the brain dose and 9.0% to the whole-body dose.

CONCLUSIONS: RF-EMF exposure of adolescents is dominated by their own mobile phone use.

Environmental sources such as mobile phone base stations play a minor role.

https://www.ncbi.nlm.nih.gov/pubmed/28038972

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Where's Your Phone? A Survey of Where Women Aged 15-40 Carry Their Smartphone and Related Risk Perception: A Survey and Pilot Study

Redmayne M. Where's Your Phone? A Survey of Where Women Aged 15-40 Carry Their Smartphone and Related Risk Perception: A Survey and Pilot Study. PLoS One. 2017 Jan 6;12(1):e0167996. doi: 10.1371/journal.pone.0167996. eCollection 2017.

Abstract

Smartphones are now owned by most young adults in many countries. Installed applications regularly update while the phone is in standby. If it is kept near the body, this can lead to considerably higher exposure to radiofrequency electromagnetic radiation than occurred without internet access. Very little is known about current smartphone carrying habits of young women. This survey used an online questionnaire to ask about smartphone location under several circumstances to inform the power calculation for a women's health study. They were also asked about risk perceptions. Data was analysed using Pearson chi square. Three age categories were made: 15-20, 21-30, 31-40. Smartphones were generally kept on standby (96% by day, 83% at night). Of all participants, in the last week the most common locations of the phone when not in use or during passive use was off-body (86%), in the hand (58%), a skirt/trouser pocket (57%), or against the breast (15%). Pocket and near-the-breast storage were significant by age ($\chi 215.04$, $p = 0.001$ and $\chi 210.96$, $p = 0.04$, respectively), both positively influenced by the youngest group. The same influence lay in the association between holding the phone ($\chi 211.082$, $p = 0.004$) and pocket-storage ($\chi 219.971$, $p<0.001$) during passive use. For calls, 36.5% solely used the phone against the head. More than half kept the phone 20-50 cms from their head at night (53%), while 13% kept it closer than 20 cms. Many (36%) thought RF-EMR exposure was related to health problems while 16% did not. There was no relationship between thinking RF-EMR exposure causes health problems in general and carrying the phone against the upper or lower body ($p = 0.69$ and $p = 0.212$, respectively). However, calls with the phone against the head were positively related to perception of health risk ($\chi 2$ 6.695, $p = 0.035$). Our findings can be used in the power calculation for a case-control study.

http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0167996

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Effect of cell phone-like electromagnetic radiation on primary human thyroid cells

Silva V, Hilly O, Strenov Y, Tzabari C, Hauptman Y, Feinmesser R. Effect of cell phone-like electromagnetic radiation on primary human thyroid cells. Int J Radiat Biol. 2016;92(2):107-15. doi: 10.3109/09553002.2016.1117678. Epub 2015 Dec 21.

Abstract

PURPOSE: To evaluate the potential carcinogenic effects of radiofrequency energy (RFE) emitted by cell

phones on human thyroid primary cells.

MATERIALS AND METHODS: Primary thyroid cell culture was prepared from normal thyroid tissue obtained from patients who underwent surgery at our department. Subconfluent thyroid cells were irradiated under different conditions inside a cell incubator using a device that simulates cell phone-RFE. Proliferation of control and irradiated cells was assessed by the immunohistochemical staining of antigen Kiel clone-67 (Ki-67) and tumor suppressor p53 (p53) expression. DNA ploidy and the stress biomarkers heat shock protein 70 (HSP70) and reactive oxygen species (ROS) was evaluated by fluorescence-activated cell sorting (FACS).

RESULTS: Our cells highly expressed thyroglobulin (Tg) and sodium-iodide symporter (NIS) confirming the origin of the tissue. None of the irradiation conditions evaluated here had an effect neither on the proliferation marker Ki-67 nor on p53 expression. DNA ploidy was also not affected by RFE, as well as the expression of the biomarkers HSP70 and ROS.

CONCLUSION: Our conditions of RFE exposure seem to have no potential carcinogenic effect on human thyroid cells. Moreover, common biomarkers usually associated to environmental stress also remained unchanged. We failed to find an association between cell phone-RFE and thyroid cancer. Additional studies are recommended.

https://www.ncbi.nlm.nih.gov/pubmed/26689947

Note: This study did not expose the cell samples to cell phone radiation. The RFE exposure in this simulation did not resemble cell phone radiation.

"Subconfluent thyroid cells were irradiated ... using a device consisting of a Radio Frequency (RF) generator (Fluke 60602A, manufactured by Fluke, Everett, WA) and an RF power amplifier (EMPower 7044, Holbrook, NY). The RF generator, located outside the incubator, was set to the desired power and connected to the power amplifier, which was connected to a panel antenna that was fixed inside the incubator."

"... an antenna was placed inside the cell incubator and set at 900 or 895 MHz and 80 or 210 μW/cm2 to simulate the radiation emitted by mobile phones."

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Environmental and health aspects of mobile phone production and use: Suggestions for innovation and policy

Senthil velmurugan Manivannan. Environmental and health aspects of mobile phone production and use: Suggestions for innovation and policy. Environmental Innovation and Societal Transitions, 21:69-79. December 2016.

Abstract

Mobile phones are universally popular due to their convenience. But their production and use can cause various environmental, energy and health effects. The present study addresses the adverse effects of mobile phones, and proposed remedies to overcome them. It pays special attention to the role of technical innovation. It is suggested that governments and the mobile telecommunication industry need to work together to develop realistic and effective regulations for design, manufacture, energy consumption, recycling and reuse of mobile phones so as to mitigate and minimize the various negative impacts.

http://www.sciencedirect.com/science/article/pii/S2210422416300260

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Effects of smartphone use with and without blue light at night in healthy adults: A randomized, double-blind, cross-over, placebo-controlled comparison

Jung-Yoon Heo, Kiwon Kim, Maurizio Fava, David Mischoulon, George I. Papakostas, Min-Ji Kim, Dong Jun Kim, Kyung-Ah Judy Chang, Yunhye Oh, Bum-Hee Yu, Hong Jin Jeon. Effects of smartphone use with and without blue light at night in healthy adults: A randomized, double-blind, cross-over, placebo-controlled comparison. Journal of Psychiatric Research. Available online 12 December 2016

Abstract

Smartphones deliver light to users through Light Emitting Diode (LED) displays. Blue light is the most potent wavelength for sleep and mood. This study investigated the immediate effects of smartphone blue light LED on humans at night. We investigated changes in serum melatonin levels, cortisol levels, body temperature, and psychiatric measures with a randomized, double-blind, cross-over, placebo-controlled design of two 3-day admissions. Each subject played smartphone games with either conventional LED or suppressed blue light from 7:30 to 10:00PM (150 min). Then, they were readmitted and conducted the same procedure with the other type of smartphone. Serum melatonin levels were measured in 60-min intervals before, during and after use of the smartphones. Serum cortisol levels and body temperature were monitored every 120 min. The Profile of Mood States (POMS), Epworth Sleepiness Scale (ESS), Fatigue Severity Scale (FSS), and auditory and visual Continuous Performance Tests (CPTs) were administered. Among the 22 participants who were each admitted twice, use of blue light smartphones was associated with significantly decreased sleepiness (Cohen's $d = 0.49$, $Z = 43.50$, $p = 0.04$) and confusion-bewilderment (Cohen's $d = 0.53$, $Z = 39.00$, $p = 0.02$), and increased commission error (Cohen's $d = -0.59$, $t = -2.64$, $p = 0.02$). Also, users of blue light smartphones experienced a longer time to reach dim light melatonin onset 50% (2.94 vs. 2.70 h) and had increases in body temperature, serum melatonin levels, and cortisol levels, although these changes were not statistically significant. Use of blue light LED smartphones at night may negatively influence sleep and commission errors, while it may not be enough to lead to significant changes in serum melatonin and cortisol levels.

Conclusion

In conclusion, this study suggests that nighttime exposure to the blue light LED display of smartphones may negatively affect sleep and commission errors. This was reflected by the suppression of melatonin production, as indicated by the prolonged time to melatonin onset, and the increase in body temperature, although these changes were not great enough to be statistically significant. These findings indicate that sleep and cognitive functions may be more sensitive markers of exposure of blue light from smartphone LED displays than the physiological changes of melatonin, cortisol, and body temperature.

http://www.sciencedirect.com/science/article/pii/S0022395616307786

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Radiofrequency exposure in the Neonatal Medium Care Unit

I. Calvente, A. Vázquez-Pérez, M.F. Fernández, M.I. Núñez, A. Múñoz-Hoyos. Radiofrequency exposure in the Neonatal Medium Care Unit. Environmental Research, 152:66-72. January 2017.

Highlights

- The increasing use of RF-EMF suggests an urgent need for more research in this field.
- Health consequences of RF-EMF exposure on infants are not well known.
- Description of RF-EMF exposure is vital in further study mechanisms on infant health.
- Considering newborns vulnerability, it is wise to adopt a prudent avoidance strategy.

Abstract

The aims of this study were to characterize electromagnetic fields of radiofrequency (RF-EMF) levels generated in a Neonatal Medium Care Unit and to analyze RF-EMF levels inside unit's incubators. Spot and long-term measurements were made with a dosimeter. The spot measurement mean was 1.51±0.48 V/m. Higher values were found in the proximity to the window and to the incubator evaluated. Mean field strength for the entire period of 17 h was 0.81 (±0.07) V/m and the maximum value was 1.58 V/m for long-term RF-EMF measurements in the incubator. Values found during the night period were higher than those found during the day period. It is important to consider RF-EMF exposure levels in neonatal care units, due to some evidence of adverse health effects found in children and adults. Characterization of RF-EMF exposure may be important to further investigate the mechanisms and underlying effects of electromagnetic fields (EMF) on infant health. A prudent avoidance strategy should be adopted because newborns are at a vulnerable stage of development and the actual impact of EMF on premature infants is unknown.

http://www.sciencedirect.com/science/article/pii/S0013935116306570

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Long-term recall accuracy for mobile phone calls in young Japanese people

Kiyohara K, Wake K, Watanabe S, Arima T, Sato Y, Kojimahara N, Taki M, Cardis E, Yamaguchi N. Long-term recall accuracy for mobile phone calls in young Japanese people: A follow-up validation study using software-modified phones. J Expo Sci Environ Epidemiol. 2016 Dec 21. doi: 10.1038/jes.2016.73. [Epub ahead of print]

Abstract

This study examined changes in recall accuracy for mobile phone calls over a long period. Japanese students' actual call statuses were monitored for 1 month using software-modified phones (SMPs). Three face-to-face interviews were conducted to obtain information regarding self-reported call status during the monitoring period: first interview: immediately after the monitoring period; second interview: after 10-12 months; third interview: after 48-55 months. Using the SMP records as the "gold standard", phone call recall accuracy was assessed for each interview. Data for 94 participants were analyzed. The number of calls made was underestimated considerably and the duration of calls was overestimated slightly in all interviews. Agreement between self-report and SMP records regarding the number of calls, duration of calls and laterality (i.e., use of the dominant ear while making calls) gradually deteriorated with the increase in the interval following the monitoring period (number of calls: first interview: Pearson's r=0.641, third interview: 0.396; duration of calls: first interview: Pearson's r=0.763, third interview: 0.356; laterality: first interview: weighted-κ=0.677, third interview: 0.448). Thus, recall accuracy for mobile phone calls would be consistently imperfect over a long period, and the results of related epidemiological studies should be interpreted carefully.

https://www.ncbi.nlm.nih.gov/pubmed/28000687

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Assessment of General Public Exposure to LTE signals compared to other Cellular Networks Present in Thessaloniki, Greece

Gkonis F, Boursianis A, Samaras T. Assessment of General Public Exposure to LTE signals compared to other Cellular Networks Present in Thessaloniki, Greece. Radiat Prot Dosimetry. 2016 Dec 15. [Epub ahead of print]

Abstract

To assess general public exposure to electromagnetic fields from Long Term Evolution (LTE) base stations, measurements at 10 sites in Thessaloniki, Greece were performed. Results are compared with other mobile cellular networks currently in use. All exposure values satisfy the guidelines for general public exposure of the International Commission on Non-Ionizing Radiation Protection (ICNIRP), as well as the reference levels by the Greek legislation at all sites. LTE electric field measurements were recorded up to 0.645 V/m. By applying the ICNIRP guidelines, the exposure ratio for all LTE signals is between 2.9 × 10-5 and 2.8 × 10-2 From the measurements results it is concluded that the average and maximum power density contribution of LTE downlink signals to the overall cellular networks signals are 7.8% and 36.7%, respectively.

https://www.ncbi.nlm.nih.gov/pubmed/27986964

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Numerical compliance testing of human exposure to electromagnetic radiation from smart-watches

Hong SE, Lee AK, Kwon JH, Pack JK. Numerical compliance testing of human exposure to electromagnetic radiation from smart-watches. Phys Med Biol. 2016 Oct 7;61(19):6975-6992. Epub 2016 Sep 20.

Abstract

In this study, we investigated the electromagnetic dosimetry for smart-watches. At present, the standard for compliance testing of body-mounted and handheld devices specifies the use of a flat phantom to provide conservative estimates of the peak spatial-averaged specific absorption rate (SAR). This means that the estimated SAR using a flat phantom should be higher than the SAR in the exposure part of an anatomical human-body model. To verify this, we numerically calculated the SAR for a flat phantom and compared it with the numerical calculation of the SAR for four anatomical human-body models of different ages. The numerical analysis was performed using the finite difference time domain method (FDTD). The smart-watch models were used in the three antennas: the shorted planar inverted-F antenna (PIFA), loop antenna, and monopole antenna. Numerical smart-watch models were implemented for cellular commutation and wireless local-area network operation at 835, 1850, and 2450 MHz. The peak spatial-averaged SARs of the smart-watch models are calculated for the flat phantom and anatomical human-body model for the wrist-worn and next to mouth positions. The results show that the flat phantom does not provide a consistent conservative SAR estimate. We concluded that the difference in the SAR results between an anatomical human-body model and a flat phantom can be attributed to the different phantom shapes and tissue structures.

https://www.ncbi.nlm.nih.gov/pubmed/?term=27648862

These results show that the flat phantom does not always yield a conservative estimate of the spatial peak SAR for the implemented smart-watch model at all exposure scenarios. A conservative exposure estimate for limb-worn device can be obtained by applying a multiplication factor between 1.1 and 2.6 to conventionally estimated values.

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Effects of Simulated Mobile Phone Electromagnetic Radiation on Fertilization and Embryo Development

Chen H, Qu Z, Liu W. Effects of Simulated Mobile Phone Electromagnetic Radiation on Fertilization and Embryo Development. Fetal Pediatr Pathol. 2016 Dec 16:1-7. [Epub ahead of print]

Abstract

This study investigated the effects of 935-MHz electromagnetic radiation (ER) on fertilization and subsequent embryonic development in mice. Ovulating mice were irradiated at three ER intensities for 4 h/day (d) or 2 h/d for three consecutive days; the ova were then harvested for in vitro fertilization to observe the 6-h fertilization rate (6-FR), 72-h morula rate (72-MR), and 110-h blastula rate (110-BR). Compared with the control group, the 6-FR, 72-MR, and 110-BR were decreased in the low ER intensity group, but the differences were not significant; in the mid- and high-intensity ER groups, 72-MR and 110-BR in the 4 h/d and 2 h/d subgroups were decreased, showing significant differences compared with the control group. Moreover, the comparison between 4 h/d and 2 h/d subgroups showed significant differences. Mid- and high-intensity ER at 935 MHz can reduce the fertilization rate in mice, and reduce the blastulation rate, thus reducing the possibility of embryo implantation.

https://www.ncbi.nlm.nih.gov/pubmed/27983879

Excerpts

Electromagnetic radiation devices consisted of four parts: a signal source (with frequency ranging from 935 to 960 MHz and magnetic field strength ranging from –15 db to +15 db), a rectifier (220 VAC/27 VDC; 300 W), a power amplifier, and a specific antenna with a length of 15 cm.

The mice were divided into seven groups by using a random table method: low-intensity (2 h/d and 4 h/d subgroups), mid-intensity (570 μW/cm^2: 2 h/d and 4 h/d subgroups), high-intensity (1400 μW/cm^2: 2 h/d and 4 h/d subgroups), and control groups.

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Chronic Nonmodulated Microwave Radiations in Mice Produce Anxiety-like and Depression-like Behaviours and Calcium- and NO-related Biochemical Changes in the Brain

Kumar M, Singh SP, Chaturvedi CM. Chronic Nonmodulated Microwave Radiations in Mice Produce Anxiety-like and Depression-like Behaviours and Calcium- and NO-related Biochemical Changes in the Brain. Exp Neurobiol. 2016 Dec;25(6):318-327. doi: 10.5607/en.2016.25.6.318. Epub 2016 Dec 19.

Abstract

The present study was aimed to investigate behavioural and biochemical effects of chronic exposure of amplitude modulated and non-modulated microwave radiation on laboratory mice. Chronic microwave exposures were executed with 2.45 GHz of either modulated (power density, 0.029 mW/cm2; specific absorption rate, 0.019 W/Kg with sinusoidal modulation of 400 Hz) or nonmodulated continuous sinusoidal wave (power density, 0.033 mW/cm2; specific absorption rate, 0.023 W/Kg) for 2 hrs daily for 1 month. Mice subjected to non-modulated microwave exposure had significantly increased acetylcholinesterase activity and increased intracellular calcium and nitric oxide levels in the cerebral cortex and hippocampus, and also had increased glucose and corticosterone levels in blood compared to control mice. These non-modulated microwave-exposed mice exhibited anxiety-like and depression-like behaviours. In contrast, mice exposed to modulated microwave for the same period did not show such changes in concomitant biochemical and behavioural analyses. These results suggest that chronic non-modulated microwave, but not modulated microwave, radiation may cause anxiety-like and depression-like behaviours and calcium- and NO-related biochemical changes in the brain.

Open Access: http://bit.ly/2hHU23D

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Pulsed magnetic field improves seed quality of aged green pea seeds by homeostasis of free radical content

Bhardwaj J, Anand A, Pandita VK, Nagarajan S. Pulsed magnetic field improves seed quality of aged green pea seeds by homeostasis of free radical content. J Food Sci Technol. 2016 Nov;53(11):3969-3977. doi: 10.1007/s13197-016-2392-8. Epub 2016 Nov 30.

Abstract

To elucidate the mechanism responsible for magnetic field induced seed invigoration in aged seeds an experiment was conducted on six year old garden pea seeds stored under controlled (20 °C and 40% RH) condition. Aged seeds were magnetoprimed by exposing to pulsed magnetic field (PMF) of 100 mT for 1 h in three pulsed modes. The 6 min on and off PMF showed significant improvement in germination (7.6%) and vigor (84.8%) over aged seeds. Superoxide and hydrogen peroxide production increased in germinating primed seeds by 27 and 52%, respectively, over aged seeds. Nicotinamide adenine dinucleotide (reduced) (NADH) peroxidase and superoxide dismutase involved in generation of hydrogen peroxide showed increased activity in PMF primed seeds. Increase in catalase, ascorbate peroxidase and glutathione reductase activity after 36 h of imbibition in primed seeds demonstrated its involvement in seed recovery during magnetopriming. An increase in total antioxidants also helped in maintaining the level of free radicals for promoting germination of magnetoprimed seeds. A 44% increase in level of protein carbonyls after 36 h indicated involvement of protein oxidation for counteracting and/or utilizing the production of ROS and faster mobilization of reserve proteins. Higher production of free radicals in primed seeds did not cause lipid peroxidation as malondialdehyde content was low. Lipoxygenase was involved in the germination associated events as the magnitude of activity was higher in primed aged seeds compared to aged seeds. Our study elucidated that PMF mediated improvement in seed quality of aged pea seeds was facilitated by fine tuning of free radicals by the antioxidant defense system and protein oxidation.

https://www.ncbi.nlm.nih.gov/pubmed/28035152

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Lennart Hardell's lecture at the Royal Society of Medicine

Hardell L. Using the Bradford Hill viewpoints to evaluate the evidence on radio frequency radiation from mobile phones to head tumours. London: Royal Society of Medicine, Oct 13, 2016.

Professor Lennart Hardell discusses the risks of brain tumours in relation to wireless and mobile phones. Professor Hardell also describes how Bradford Hill's 1965 presidential address on association or causation provided a helpful framework for the evaluation of the brain tumour risk from electromagnetic fields.

This 31 minute lecture was filmed at the 'Association or causation in miasmas and mixtures: current reflections on Bradford Hill's 1965 contribution to public health' meeting at the Royal Society of Medicine in London.

http://bit.ly/HardellRSM

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When theory and observation collide: Can non-ionizing radiation cause cancer?

Havas, M. When theory and observation collide: Can non-ionizing radiation cause cancer? Environmental Pollution (2016). http://dx.doi.org/10.1016/j.envpol.2016.10.018

Highlights

• There is sufficient scientific evidence of cellular damage caused by non-ionizing radiation well below thermal guidelines.
• Applying the ionization model to non-ionizing radiation is inappropriate as mechanisms of biological interactions differ.
• Free radicals can and do cause cancer and non-ionizing radiation can and does increase free-radicals.

Abstract

This paper attempts to resolve the debate about whether non-ionizing radiation (NIR) can cause cancer–a debate that has been ongoing for decades. The rationale, put forward mostly by physicists and accepted by many health agencies, is that, “since NIR does not have enough energy to dislodge electrons, it is unable to cause cancer.” This argument is based on a flawed assumption and uses the model of ionizing radiation (IR) to explain NIR, which is inappropriate. Evidence of free-radical damage has been repeatedly documented among humans, animals, plants and microorganisms for both extremely low frequency (ELF) electromagnetic fields (EMF) and for radio frequency (RF) radiation, neither of which is ionizing. While IR directly damages DNA, NIR interferes with the oxidative repair mechanisms resulting in oxidative stress, damage to cellular components including DNA, and damage to cellular processes leading to cancer. Furthermore, free radical damage explains the increased cancer risks associated with mobile phone use, occupational exposure to NIR (ELF EMF and RFR), and residential exposure to power lines and RF transmitters including mobile phones, cell phone base stations, broadcast antennas, and radar installations.

Summary

This paper presents a highly probable mechanism that involves an increase in free-radicals, which–in turn–explains the increased risk of cancers documented in epidemiological studies that are associated with environmental exposure to RFR and ELF-EMFs at levels well below international guidelines.

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Mechanism of low-level microwave radiation effect on nervous system

Hiie Hinrikus, Maie Bachmann, Denis Karai & Jaanus Lass. Mechanism of low-level microwave radiation effect on nervous system. Electromagnetic Biology and Medicine. Pages 1-11. Published online: 22 Nov 2016

Abstract

The aim of this study is to explain the mechanism of the effect of low-level modulated microwave radiation on brain bioelectrical oscillations. The proposed model of excitation by low-level microwave radiation bases on the influence of water polarization on hydrogen bonding forces between water molecules, caused by this the enhancement of diffusion and consequences on neurotransmitters transit time and neuron resting potential. Modulated microwave radiation causes periodic alteration of the neurophysiologic parameters and parametric excitation of brain bioelectric oscillations. The experiments to detect logical outcome of the mechanism on physiological level were carried out on 15 human volunteers. The 450-MHz microwave radiation modulated at 7, 40 and 1000 Hz frequencies was applied at the field power density of 0.16 mW/cm2. A relative change in the EEG power with and without radiation during 10 cycles was used as a quantitative measure. Experimental data demonstrated that modulated at 40 Hz microwave radiation enhanced EEG power in EEG alpha and beta frequency bands. No significant alterations were detected at 7 and 1000 Hz modulation frequencies. These results are in good agreement with the theory of parametric excitation of the brain bioelectric oscillations caused by the periodic alteration of neurophysiologic parameters and support the proposed mechanism. The proposed theoretical framework has been shown to predict the results of experimental study. The suggested mechanism, free of the restrictions related to field strength or time constant, is the first one providing explanation of low-level microwave radiation effects.

Conclusions

The proposed mechanism of low-level microwave radiation effect on nervous system bases on the existing knowledge: rotation of water molecules, related to that perturbation of hydrogen bonds and alteration in diffusion. Alterations in diffusion affect neurophysiologic parameters as neurotransmitters transit time and neuron resting potential. Periodic alteration of the neurophysiologic parameters caused by modulated microwave radiation is expected to result in parametric excitation of brain bioelectric oscillation. Experimental results with a low-level 450-MHz microwave radiation pulse-modulated at 7, 40 and 1000 Hz showed a statistically significant enhancement of the EEG power in alpha, beta1 and beta2 frequency bands at 40 Hz and no significant effect at 7 and 1000 Hz modulation frequencies. The experimental results are in agreement with the nonlinear theory of parametric excitation of the brain bioelectric oscillations inside first zones on instability. The proposed theoretical framework predicts the results of experimental study. The suggested mechanism, free of the restrictions related to field strength or time constant, is the first one providing explanation of low-level microwave radiation effects.

http://www.tandfonline.com/doi/full/10.1080/15368378.2016.1251451

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Long-term Electromagnetic Field Measurement and Assessment for a Shopping Mall

Engiz BK, Kurnaz C. Long-term Electromagnetic Field Measurement and Assessment for a Shopping Mall. Radiat Prot Dosimetry. 2016 Nov 24. [Epub ahead of print]

Abstract

As a result of the dense deployment of wireless devices and base stations, measuring and evaluating the electromagnetic (EM) exposure levels they emit have become important to human health especially if they exceed the limits defined in the standards. Base stations, Wi-Fi equipment and other electronic devices are used heavily, especially in densely crowded places like shopping centers. In this study, electric field strength (E) measurements were conducted at one of the largest shopping malls in Turkey. Broadband E measurements were performed using PMM 8053 EM field strength meter for 24 h a day for the duration of one week while frequency selective measurements were carried out with SRM-3006 EM field strength meter. It is concluded from the measurements that the mean measured total E in the band between 100 kHz and 3 GHz is 0.59 V/m while the maximum E is 7.88 V/m, which are both below the limit determined by International Commission on Non-Ionizing Radiation Protection. Evolutions show that E can increase by up to 55% during the daytime. Analyses demonstrate that 71.3% of total E is caused by UMTS2100, 16.3% is produced by GSM900, 6.2% by LTE, 3.5% by Wi-Fi, and 2.7% is generated by devices that use the remaining frequency bands. Based on the detailed statistical analysis of long-term E measurement results, it can be concluded that the measured E levels are not in normal distribution and that they are statistically different with respect to days. Furthermore, distribution of E can be best modeled with the non-parametric approach.

https://www.ncbi.nlm.nih.gov/pubmed/27885087

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Multiple assessment methods of prenatal exposure to RF radiation from telecommunication in the Mothers and Children's Environmental Health (MOCEH) study

Choi KH, Ha M, Burm E, Ha EH, Park H, Kim Y, Lee AK, Kwon JH, Choi HD, KimN. Multiple assessment methods of prenatal exposure to radio frequency radiation from telecommunication in the Mothers and Children's Environmental Health (MOCEH) study. Int J Occup Med Environ Health. 2016 Nov 18;29(6):959-972. doi: 10.13075/ijomeh.1896.00803. Epub 2016 Nov 3.

Abstract

OBJECTIVES: To evaluate prenatal exposure to radiofrequency radiation (RFR) from telecommunication using a mobile phone questionnaire, operator data logs of mobile phone use and a personal exposure meter (PEM).

MATERIAL AND METHODS: The study included 1228 mother-infants pairs from the Mothers and Children's Environmental Health (MOCEH) study - a multicenter prospective cohort study ongoing since 2006, in which participants were enrolled at ≤ 20 weeks of pregnancy, with a follow-up of a child birth and growth to assess the association between prenatal environmental exposure and children's health. The questionnaire included the average calling frequency per day and the average calling time per day. An EME Spy 100 PEM was used to measure RFR among 269 pregnant women from November 2007 to August 2010. The operators' log data were obtained from 21 participants. The Spearman's correlation test was performed to evaluate correlation coefficient and 95% confidence intervals between the mobile phone use information from the questionnaire, operators' log data, and data recorded by the PEM.

RESULTS: The operators' log data and information from the self-reported questionnaire showed significantly high correlations in the average calling frequency per day ($\rho = 0.6$, $p = 0.004$) and average calling time per day ($\rho = 0.5$, $p = 0.02$). The correlation between information on the mobile phone use in the self-reported questionnaire and exposure index recorded by the PEM was poor. But correlation between the information of the operators' log data and exposure index for transmission of mobile communication was significantly high: correlation coefficient (p-value) was 0.44 (0.07) for calling frequency per day, and it was 0.49 (0.04) for calling time per day.

CONCLUSIONS: The questionnaire information on the mobile phone use showed moderate to high quality. Using multiple methods for exposure assessment might be better than using only one method.

https://www.ncbi.nlm.nih.gov/pubmed/27869246?dopt=Abstract

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Mobile phone signal exposure triggers a hormesis-like effect in Atm+/+ and Atm-/- mouse embryonic fibroblasts

Sun C, Wei X, Fei Y, Su L, Zhao X, Chen G, Xu Z. Mobile phone signal exposure triggers a hormesis-like effect in Atm+/+ and Atm-/- mouse embryonic fibroblasts. Sci Rep. 2016 Nov 18;6:37423. doi: 10.1038/srep37423.

Abstract

Radiofrequency electromagnetic fields (RF-EMFs) have been classified by the International Agency for Research on Cancer as possible carcinogens to humans; however, this conclusion is based on limited epidemiological findings and lacks solid support from experimental studies. In particular, there are no consistent data regarding the genotoxicity of RF-EMFs. Ataxia telangiectasia mutated (ATM) is recognised as a chief guardian of genomic stability. To address the debate on whether RF-EMFs are genotoxic, we compared the effects of 1,800 MHz RF-EMF exposure on genomic DNA in mouse embryonic fibroblasts (MEFs) with proficient (Atm+/+) or deficient (Atm-/-) ATM. In Atm+/+ MEFs, RF-EMF exposure for 1 h at an average special absorption rate of 4.0 W/kg induced significant DNA single-strand breaks (SSBs) and activated the SSB repair mechanism. This effect reduced the DNA damage to less than that of the background level after 36 hours of exposure. In the Atm-/- MEFs, the same RF-EMF exposure for 12 h induced both SSBs and double-strand breaks and activated the two repair processes, which also reduced the DNA damage to less than the control level after prolonged exposure. The observed phenomenon is similar to the hormesis of a toxic substance at a low dose. To the best of our knowledge, this study is the first to report a hormesis-like effect of an RF-EMF.

https://www.ncbi.nlm.nih.gov/pubmed/27857169?dopt=Abstract

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Effects of exposure to 2100 MHz GSM-like RF EMF on auditory system of rats

Çeliker M, Özgür A, Tümkaya L, Terzi S, Yılmaz M, Kalkan Y, Erdoğan E. Effects of exposure to 2100MHz GSM-like radiofrequency electromagnetic field on auditory system of rats. Braz J Otorhinolaryngol. 2016 Nov 5. pii: S1808-8694(16)30222-1. doi: 10.1016/j.bjorl.2016.10.004.

Abstract

INTRODUCTION: The use of mobile phones has become widespread in recent years. Although beneficial from the communication viewpoint, the electromagnetic fields (EMF) generated by mobile phones may cause unwanted biological changes in the human body.

OBJECTIVE: In this study, we aimed to evaluate the effects of 2100MHz Global System for Mobile communication (GSM-like) electromagnetic field (EMF), generated by an EMF generator, on the auditory system of rats by using electrophysiological, histopathologic and immunohistochemical methods.

METHODS: Fourteen adult Wistar albino rats were included in the study. The rats were divided randomly into two groups of seven rats each. The study group was exposed continuously for 30days to a 2100MHz EMF with a signal level (power) of 5.4dBm (3.47mW) to simulate the talk mode on a mobile phone. The control group was not exposed to the aforementioned EMF. After 30days, the Auditory Brainstem Responses (ABRs) of both groups were recorded and the rats were sacrificed. The cochlear nuclei were evaluated by histopathologic and immunohistochemical methods.

RESULTS: The ABR records of the two groups did not differ significantly. The histopathologic analysis showed increased degeneration signs in the study group (p=0.007). In addition, immunohistochemical analysis revealed increased apoptotic index in the study group compared to that in the control group (p=0.002).

CONCLUSION: The results support that long-term exposure to a GSM-like 2100MHz EMF causes an increase in neuronal degeneration and apoptosis in the auditory system.

https://www.ncbi.nlm.nih.gov/pubmed/27865708?dopt=Abstract

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Protective Role of Vitamin C on the Metabolic and Enzymatic Activities of the Liver in Male Rats After Exposure to Wi-Fi Routers

Shekoohi-Shooli F, Mortazavi SM, Shojaei-Fard MB, Nematollahi S, Tayebi M. Evaluation of the Protective Role of Vitamin C on the Metabolic and Enzymatic Activities of the Liver in the Male Rats After Exposure to 2.45 GHz Of Wi-Fi Routers. J Biomed Phys Eng. 2016 Sep 1;6(3):157-164. eCollection 2016.

Abstract

BACKGROUND: The use of devices emitted microwave radiation such as mobile phones, wireless fidelity (Wi-Fi) routers, etc. is increased rapidly. It has caused a great concern; the researchers should identify its effects on people's health. We evaluated the protective role of Vitamin C on the metabolic and enzymatic activities of the liver after exposure to Wi-Fi routers.

MATERIAL AND METHODS: 70 male Wistar rats weighing 200-250 g were randomly divided into 7 groups (10 rats in each group).The first stage one-day test: Group A (received vitamin C 250 mg/kg/day orally together

with 8- hour/day Wi-Fi exposure). Group B (exposed to Wi-Fi radiation). Group C (received vitamin C). Group D or Control (was neither exposed to radiation of Wi-Fi modem nor did receive vitamin C). The second phase of experiment had done for five consecutive days. It involved Group E (received vitamin C), Group F (exposed to Wi-Fi radiation), Group G (received vitamin C together with Wi-Fi radiation). The distance between animals' restrainers was 20 cm away from the router antenna. Finally, blood samples were collected and assayed the level of hepatic enzymes including alkaline phosphatase (ALP), alanine amino transferase (ALT) aspartate amino transferase (ASL), gamma glutamyl transferase (GGT) and the concentration of Blood Glucose, Cholesterol, Triglyceride (TG), High density lipoprotein (HDL) and low density lipoprotein (LDL).

RESULTS: Data obtained from the One day test showed an increase in concentration of blood glucose, decrease in Triglyceride level and GGT factor ($P<0.05$), however no observed significant difference on the Cholesterol, HDL, LDL level and hepatic enzymes activities in compare to control group. Groups of the five-day test showed reduction in the amount of blood glucose, elevation of cholesterol level and LDL relative to control group ($P<0.05$).

CONCLUSION: WiFi exposure may exert alternations on the metabolic parameters and hepatic enzymes activities through stress oxidative and increasing of free radicals, but the use of vitamin C protects them from changing induced. Also taking optimum dose of vitamin C is essential for radioprotective effect and maintaining optimum health.

https://www.ncbi.nlm.nih.gov/pubmed/27853723?dopt=Abstract

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Development of a source-exposure matrix for occupational EMF exposure assessment in the INTEROCC study

Vila J, Bowman JD, Figuerola J, Moriña D, Kincl L, Richardson L, Cardis E. Development of a source-exposure matrix for occupational exposure assessment of electromagnetic fields in the INTEROCC study. J Expo Sci Environ Epidemiol. 2016 Nov 9. doi: 10.1038/jes.2016.60.

Abstract

To estimate occupational exposures to electromagnetic fields (EMF) for the INTEROCC study, a database of source-based measurements extracted from published and unpublished literature resources had been previously constructed. The aim of the current work was to summarize these measurements into a source-exposure matrix (SEM), accounting for their quality and relevance. A novel methodology for combining available measurements was developed, based on order statistics and log-normal distribution characteristics. Arithmetic and geometric means, and estimates of variability and maximum exposure were calculated by EMF source, frequency band and dosimetry type. The mean estimates were weighted by our confidence in the pooled measurements. The SEM contains confidence-weighted mean and maximum estimates for 312 EMF exposure sources (from 0 Hz to 300 GHz). Operator position geometric mean electric field levels for radiofrequency (RF) sources ranged between 0.8 V/m (plasma etcher) and 320 V/m (RF sealer), while magnetic fields ranged from 0.02 A/m (speed radar) to 0.6 A/m (microwave heating). For extremely low frequency sources, electric fields ranged between 0.2 V/m (electric forklift) and 11,700 V/m (high-voltage transmission line-hotsticks), whereas magnetic fields ranged between 0.14 μT (visual display terminals) and 17 μT (tungsten inert gas welding). The methodology developed allowed the construction of the first EMF-SEM and may be used to summarize similar exposure data for other physical or chemical agents.

https://www.ncbi.nlm.nih.gov/pubmed/27827378

Excerpt

This work allowed the construction of a SEM containing estimated exposure statistics for the most common

occupational sources of EMF exposure, identified through the INTEROCC study questionnaire. This database represents a new approach for occupational exposure assessment, based on EMF sources independent of occupation. The SEM will be available online as a free-access tool at http://www.crealradiation.com/index.php/es/databases. Although the current version does not include all possible EMF sources, it can be updated with new or newly identified measurements and sources.

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Impact of RF EMF on cucumber and tomato plants

F. Al-Kathiri, K. Al-Raisi, K. Al-Hinai, M. Al-Droushi, M. Khan, Z. Nadir. Impact of RF electromagnetic field on cucumber and tomato plants. Information Technology, Electronics and Mobile Communication Conference (IEMCON), 2016 IEEE 7th Annual. 13-15 Oct 2016.

Abstract

Agriculture sector is one of the essential sectors to any nation. This sector is a challenging domain worldwide due to multiple biotic and abiotic stresses. The search for finding new agricultural technologies to enhance the crop productivity is a prime goal. Exposure of crop seeds or plants from short to longer term radio frequency and electromagnetic fields may have positive or negative effects on plant growth/development and final productivity. The focus of the research work was to study the impact of fixed radio frequency and electromagnetic field exposures on cucumber and tomato plants growth/development and leaf membrane stability. Initial results of studies showed that the electromagnetic field treatment generated a little stressed environment to crop plants. Both crop plants demonstrated reduced plant growth and development with impaired membrane. This phenomenon was more distinct as the treatment time proceeded. The higher electrolyte leakage coupled with reduced plant growth and development may be a function of free radical processes prompted by the EMF environment.

http://ieeexplore.ieee.org/document/7746234/

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An Investigation on the Effect of ELF Pulsed Electromagnetic Fields on Human Electrocardiograms

Fang Q, Mahmoud SS, Yan J, Li H. An Investigation on the Effect of Extremely Low Frequency Pulsed Electromagnetic Fields on Human Electrocardiograms (ECGs). Int J Environ Res Public Health. 2016 Nov 23;13(11). pii: E1171.

Abstract

For this investigation, we studied the effects of extremely low frequency pulse electromagnetic fields (ELF-PEMF) on the human cardiac signal. Electrocardiograms (ECGs) of 22 healthy volunteers before and after a short duration of ELF-PEMF exposure were recorded. The experiment was conducted under single-blind conditions. The root mean square (RMS) value of the recorded data was considered as comparison criteria. We also measured and analysed four important ECG time intervals before and after ELF-PEMF exposure. Results revealed that the RMS value of the ECG recordings from 18 participants (81.8% of the total participants) increased with a mean value of 3.72%. The increase in ECG voltage levels was then verified by a second experimental protocol with a control exposure. In addition to this, we used hyperbolic T-distributions (HTD) in the analysis of ECG signals to verify the change in the RR interval. It was found that there were small shifts in the frequency-domain signal before and after EMF exposure. This shift has an influence on all frequency components of the ECG signals, as all spectrums were shifted. It is shown from this investigation that a short time exposure to ELF-PEMF can affect the properties of ECG signals. Further study is needed to consolidate this finding and discover more on the biological effects of ELF-PEMF on human physiological processes.

https://www.ncbi.nlm.nih.gov/pubmed/27886102

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Effects of ELF pulsed electromagnetic fields on glioblastoma cells

Zeinab Akbarnejad, Hossein Eskandary, Cristian Vergallo, Seyed Noureddin Nematollahi-Mahani, Luciana Dini, Fatemeh Darvishzadeh-Mahani & Ahmadi Meysam. Effects of extremely low-frequency pulsed electromagnetic fields (ELF-PEMFs) on glioblastoma cells (U87)
Pages 1-10. Published online: 22 Nov 2016. http://dx.doi.org/10.1080/15368378.2016.1251452

Abstract

The impact of extremely low-frequency pulsed electromagnetic fields (ELF-PEMFs) at various frequencies and amplitudes was investigated on cell cycle, apoptosis and viability of the Glioblastoma Multiforme (GBM) cell line (U87), in vitro. The GBM is a malignant brain tumor with high mortality in humans and poorly responsive to the most common type of cancer treatments, such as surgery, chemotherapy and radiation therapy. U87 cells with five experimental groups (I–V) were exposed to various ELF-PEMFs for 2, 4 and 24 h, as follows: (I) no exposure, control; (II) 50 Hz 100 ± 15 G; (III) 100 Hz 100 ± 15 G; (IV) 10 Hz 50 ± 10 G; (V) 50 Hz 50 ± 10 G. The morphology properties, cell viability and gene expression of proteins involved in cell cycle regulation (Cyclin-D1 and P53) and apoptosis (Caspase-3) were investigated. After 24 h, the cell viability and Cyclin-D1 expression increased in Group II (30%, 45%), whereas they decreased in Groups III (29%, 31%) and IV (21%, 34%); P53 and Caspase-3 elevated only in Group III; and no significant difference was observed in Group V, respectively, compared with the control ($p < 0.05$). The data suggest that the proliferation and apoptosis of human GBM are influenced by exposure to ELF-PEMFs in different time-dependent frequencies and amplitudes. The fact that some of the ELF-PEMFs frequencies and amplitudes favor U87 cells proliferation indicates precaution for the use of medical devices related to the MFs on cancer patients. On the other hand, some other ELF-PEMFs frequencies and intensities arresting U87 cells growth could open the way to develop novel therapeutic approaches.

Conclusion

In conclusion, our findings showed that the antiproliferative and proliferative effects of ELF-PEMFs depend on frequency, amplitude and exposure time. There is no doubt that other MF properties should be further addressed. However, our results can offer significant preliminary indication on the appropriateness of the applied range to prevent cell proliferation and induce cell death in cancer patients. Thus, the up- and downregulation of Cyclin-D1, P53 and Caspase-3 in the presence of ELF-PEMF can be a starting point for further investigations on the relationship between ELF-PEMF exposure and cancer cells as well as the exploration of their possible adjuvant use in anticancer therapies.

http://www.tandfonline.com/doi/full/10.1080/15368378.2016.1251452

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Exposure of children to ELF magnetic fields in France: Results of the EXPERS study

Magne I, Souques M, Bureau I, Duburcq A, Remy E, Lambrozo J. Exposure of children to extremely low frequency magnetic fields in France: Results of the EXPERS study. J Expo Sci Environ Epidemiol. 2016 Nov 9. doi: 10.1038/jes.2016.59.

Abstract

The assessment of magnetic field exposure in children is an important point in the context of epidemiological

issues. EXPERS is the first study ever carried out measuring personal exposure to extremely low frequency magnetic fields at a national scale, involving 977 French children with 24 h personal measurements. Descriptive statistical analyses were performed for all the children, and only for children where no alarm clock was identified, as in some cases this requirement of the measurement protocol was not respected. The proportion of children with a 24 h arithmetic mean of ≥0.4 μT was 3.1% when considering all children and 0.8% when excluding alarm clocks. The alarm clocks were the main variable linked to the child exposure measurements. Magnetic field exposure increased when the home was located close to a high voltage power line. However, none of the 0.8% of children living at <125 m to a 225 kV line or <200 m to a 400 kV overhead line had a personal exposure of >0.4 μT. A multiple correspondence analysis showed the difficulty to build a statistical model predicting child exposure. The distribution of child personal exposure was significantly different from the distribution of exposure during sleep, questioning the exposure assessment in some epidemiological studies.

https://www.ncbi.nlm.nih.gov/pubmed/27827377

Conclusion

The EXPERS study is the first study of magnetic field personal exposure of children, with a significant number of subjects, at the scale of a country. It is also the first study on this subject in France. We looked for a relationship between the subjects' characteristics and their exposure, and observed differences depending on the indicator chosen (AM, GM or median). We studied the AM in more detail and found a strong correlation between the highest exposures and alarm clocks because of non-respect of the measurement protocol. That is why we performed two analyses, one over all the children, and one over the children for whom no alarm clock was identified on the magnetic field measurements during the night. The proportion of children with an AM ≥0.4 μT was 3.1% when considering all children and 0.8% when excluding those with alarm clocks.

The magnetic field exposure was found to be correlated and increased when the home was located close to a 63 to 400 kV overhead line. However, few children were concerned and none of them had a personal exposure of >0.4 μT.

On the contrary, the magnetic field exposure was found to be correlated and decreased when the home was located close to a MV overhead line. We hypothesize that this result is an artifact, because these grids are mainly found in rural areas, and the exposure was inversely correlated with the size of urban areas.

We looked for correlations between the 24 h exposure (AM, GM and median). Excepted the alarm clocks, no other variable was significantly linked to the child exposure. This result was confirmed by a multiple correspondence analysis that showed that it would be difficult to build a model to predict the child exposure from the collected variables.

The distribution of the 24 h AM, which is the personal exposure of children, was found to be significantly different from the distribution of the AM during the sleep of children, or of the TWA that was calculated from AM during sleep and school periods. This result questions the exposure assessment in some epidemiological studies.

The same work will be done for the adults of the EXPERS study. More detailed focus will be done for electric grids.

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Effects of repeated 9 and 30-day exposure to ELF EMF on social recognition behavior & estrogen receptors expression in olfactory bulb of female rats

Bernal-Mondragón C, Arriaga-Avila V, Martínez-Abundis E, Barrera-Mera B, Mercado-Gómez O, Guevara-

Guzmán R. Effects of repeated 9 and 30-day exposure to extremely low-frequency electromagnetic fields on social recognition behavior and estrogen receptors expression in olfactory bulb of Wistar female rats. Neurol Res. 2016 Nov 28:1-11. [Epub ahead of print]

Abstract

OBJECTIVE: We investigated the short- and long-term effects of extremely low-frequency electromagnetic fields (EMF) on social recognition behavior and expression of α- and β-estrogen receptors (ER).

METHODS: Rats were exposed to 60-Hz electromagnetic fields for 9 or 30 days and tested for social recognition behavior. Immunohistochemistry and western blot assays were performed to evaluate α- and β-ER expression in the olfactory bulb of intact, ovariectomized (OVX), and ovariectomized+estradiol (E2) replacement (OVX+E2).

RESULTS: Ovariectomization showed impairment of social recognition after 9 days of EMF exposure and a complete recovery after E2 replacement and so did those after 30 days. Short EMF exposure increased expression of β-ER in intact, but not in the others. Longer exposure produced a decrease in intact but an increase in OVX and OVX+E2.

DISCUSSION: Our findings suggest a significant role for β-estrogen receptors and a lack of effect for α-estrogen receptors on a social recognition task.

ABBREVIATIONS: EMF: extremely low frequency electromagnetic fields; ERs: estrogen receptors; OB: olfactory bulb; OVX: ovariectomized; OVX + E2: ovariectomized + estradiol replacement; IEI: interexposure interval; β-ER: beta estrogen receptor; E2: replacement of estradiol; GAPDH: glyceraldehyde-3-phosphate dehydrogenase; WB: Western blot; PBS: phosphate-buffer saline; PB: phosphate-buffer.

https://www.ncbi.nlm.nih.gov/pubmed/27892794

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Self-reported mobile phone use and semen parameters among men from a fertility clinic

Lewis RC, Mínguez-Alarcón L, Meeker JD, Williams PL, Mezei G, Ford JB, Hauser R; EARTH Study Team. Self-reported mobile phone use and semen parameters among men from a fertility clinic. Reprod Toxicol. 2016 Nov 9. pii: S0890-6238(16)30408-7.

Abstract

There is increasing concern that use of mobile phones, a source of low-level radio-frequency electromagnetic fields, may be associated with poor semen quality, but the epidemiologic evidence is limited and conflicting. The relationship between mobile phone use patterns and markers of semen quality was explored in a longitudinal cohort study of 153 men that attended an academic fertility clinic in Boston, Massachusetts. Information on mobile phone use duration, headset or earpiece use, and the body location in which the mobile phone was carried was ascertained via nurse-administered questionnaire. Semen samples (n=350) were collected and analyzed onsite. To account for multiple semen samples per man, linear mixed models with random intercepts were used to investigate the association between mobile phone use and semen parameters. Overall, there was no evidence for a relationship between mobile phone use and semen quality.

Conflict of Interest: Ryan Lewis and Gabor Mezei work for Exponent, Inc., a company that provides consultation on the potential human health risks associated with exposure to environmental agents, including RF- EMFs. All other authors declare no conflict of interest.

Acknowledgement: This research was supported by grant R01 ES009718 from the National Institute of Environmental Health Sciences, National Institutes of Health, and project 1-SP0239 from the **Electric Power Research Institute**.

https://www.ncbi.nlm.nih.gov/pubmed/27838386

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International Commission on Non-Ionizing Radiation Protection: Two announcements

Oct 2016

Update HF Guidelines

ICNIRP has been working on its new high-frequency (HF) guidelines, which will cover the 100 kHz – 300 GHz range of the non-ionizing radiation (NIR) spectrum. This will replace the HF portion of the 1998 ICNIRP guidelines. A draft of the new HF guidelines was presented at ICNIRP's 8th International NIR Workshop in Cape Town, South Africa, in May 2016. This provided an opportunity to share the direction of the ICNIRP thinking, and to obtain preliminary comments from the Workshop participants. At that time ICNIRP was planning to have a public consultation document ready by the end of 2016. However, as some of the issues that were raised regarding the HF guidelines are requiring considerable additional thought and development, this time frame is no longer feasible. ICNIRP will provide updates on the progress in due course.

http://www.icnirp.org/en/activities/news/news-article/update-on-hf-guidelines.html

Upcoming Workshop

An International Workshop on Non-Ionizing Radiation Protection will take place on 2nd December 2016 in Tokyo, Japan. ICNIRP technically co-sponsors the workshop which is financially sponsored by National Institute of Information and Communications Technology (NICT). The main topics of the workshop are the revision of the ICNIRP HF guidelines and NIR protection related to 5G system. The workshop is opened for scientific experts of NIR. Please contact nict-nir-ws@stage.ac, if you consider attending the workshop. Further information regarding the program will be posted shortly.

http://www.icnirp.org/en/activities/news/news-article/tokyo-workshop-2016.html

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Intracranial Distribution of Gliomas in Relation to Mobile Phone Exposure: Analyses From the INTERPHONE Study

Grell, K., Frederiksen, K., Schutz, J., Cardis, E., Armstrong, B., Siemiatycki, J., Krewski, D. R., McBride, M. L., Johansen, C.,Auvinen, A., Hours, M., Blettner, M., Sadetzki, S., Lagorio, S., Yamaguchi, N., Woodward, A., Tynes, T., Feychting, M., Fleming, S. J., Swerdlow, A. J., Andersen, P. K. The Intracranial Distribution of Gliomas in Relation to Exposure From Mobile Phones: Analyses From the INTERPHONE Study. Am J Epidemiol 2016 0: p. kww082v1-11.

Abstract

When investigating the association between brain tumors and use of mobile telephones, accurate data on tumor position are essential, due to the highly localized absorption of energy in the human brain from the radio-frequency fields emitted. We used a point process model to investigate this association using information that included tumor localization data from the INTERPHONE Study (Australia, Canada, Denmark, Finland, France,

Germany, Israel, Italy, Japan, New Zealand, Norway, Sweden, and the United Kingdom). Our main analysis included 792 regular mobile phone users diagnosed with a glioma between 2000 and 2004. Similar to earlier results, we found a statistically significant association between the intracranial distribution of gliomas and the self-reported location of the phone. When we accounted for the preferred side of the head not being exclusively used for all mobile phone calls, the results were similar. The association was independent of the cumulative call time and cumulative number of calls. However, our model used reported side of mobile phone use, which is potentially influenced by recall bias. The point process method provides an alternative to previously used epidemiologic research designs when one is including localization in the investigation of brain tumors and mobile phone use.

Excerpts

... the INTERPHONE Study (6) ... is the largest investigation of mobile phone use and brain tumors to have been carried out to date. INTERPHONE observed no increased glioma risk in mobile phone users except for the decile with the highest reported cumulative call time (>1,640 hours), with uncertain interpretation (6).

... increased occurrence of tumors in the part of the brain closest to the phone would be expected if there were a causal association.

... our aim was to use the 3-dimensional point process model of Grell et al. (31) to analyze the INTERPHONE localization data for glioma and thereby further investigate the association between glioma and mobile phone use. Our use of a case-only approach removed possible differential bias between cases and controls ...

Overall, levels of use were low compared with today's levels due to the period of data collection, 2000–2004, when mobile phones were less common.

The 3-dimensional distribution of gliomas within the brain was skewed towards the self-reported preferred ear for mobile phone use.

Our results concur with the observation of a statistically significant excess of gliomas on the self-reported side of mobile phone use (28).

Taken together, our results suggest that ever using a mobile phone regularly is associated with glioma localization in the sense that more gliomas occurred closer to the ear on the side of the head where the mobile phone was reported to have been used the most. However, this trend was not related to amount of mobile phone use, making it less likely that the association observed is caused by a relationship between mobile phone use and cancer risk. We cannot draw firm conclusions about cause and effect, but our approach has several strengths in comparison with traditional epidemiologic approaches. Our results may have been affected by recall bias in the reported side of phone use. Nevertheless, it provides an alternative for future research related to mobile phone use.

http://aje.oxfordjournals.org/cgi/content/abstract/kww082v1

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Inferring the 1985–2014 impact of mobile phone use on selected brain cancer subtypes

Frank de Vocht. Inferring the 1985–2014 impact of mobile phone use on selected brain cancer subtypes using Bayesian structural time series and synthetic controls. Environment International. 97:100-107. December 2016.

Highlights

• English brain cancer subtypes incidences were compared to synthetic control trends.

• No evidence of increases in GBM, glioma and parietal lobe neoplasms not predicted.
• Malignant neoplasms of the temporal lobe however, have increased faster than expected.
• This corresponded to additional 35% increase, or 188 (95%CI 48–324) cases annually.
• Tumour location and temporal associations correspond with mobile phone use as risk factor.

Abstract

Background Mobile phone use has been increasing rapidly in the past decades and, in parallel, so has the annual incidence of certain types of brain cancers. However, it remains unclear whether this correlation is coincidental or whether use of mobile phones may cause the development, promotion or progression of specific cancers. The 1985–2014 incidence of selected brain cancer subtypes in England were analyzed and compared to counterfactual 'synthetic control' timeseries.

Methods Annual 1985–2014 incidence of malignant glioma, glioblastoma multiforme, and malignant neoplasms of the temporal and parietal lobes in England were modelled based on population-level covariates using Bayesian structural time series models assuming 5,10 and 15 year minimal latency periods. Post-latency counterfactual 'synthetic England' timeseries were nowcast based on covariate trends. The impact of mobile phone use was inferred from differences between measured and modelled time series.

Results There is no evidence of an increase in malignant glioma, glioblastoma multiforme, or malignant neoplasms of the parietal lobe not predicted in the 'synthetic England' time series. Malignant neoplasms of the temporal lobe however, have increased faster than expected. A latency period of 10 years reflected the earliest latency period when this was measurable and related to mobile phone penetration rates, and indicated an additional increase of 35% (95% Credible Interval 9%:59%) during 2005–2014; corresponding to an additional 188 (95%CI 48–324) cases annually.

Conclusions A causal factor, of which mobile phone use (and possibly other wireless equipment) is in agreement with the hypothesized temporal association, is related to an increased risk of developing malignant neoplasms in the temporal lobe.

http://www.sciencedirect.com/science/article/pii/S0160412016303865

Excerpts

The annual incidence of malignant neoplasms of the temporal lobe however, has been increasing faster than expected, with a period of 10 years post-1995 reflecting the earliest latency period when this additional increase was measurable. Post-2005 an additional increase of 35% (95%CI 9%:59%) was evident compared to the counterfactual time series in the 'synthetic England'; corresponding to an average of an additional 188 (95%CI 48–324) cases of malignant neoplasms of the temporal lobe annually. Addition of mobile phone penetration in the models showed a reduction of 15% in the effect size for 5-year latency (Table 2), indicating observed increased incidence can, at least in part, by attributed to mobile phone use (Note that unfortunately longer latencies cannot be explored in these time series).

These analyses indicate excess brain cancer risk is observed in the lobes where most of the electromagnetic energy is absorbed (depending on side of the head where the phone is held when calling) (Cardis et al., 2008), which has been observed previously (Barchana et al., 2012 and Khurana et al., 2009). As such, it does not specifically exclude a specific association with gliomas (if these occur in the temporal lobe), which was reported in Interphone (Interphone Study Group, 2010), and of which about one in three occur in the temporal lobe (Larjavaara et al., 2007). A stronger causal argument could have been made if these analyses could have been stratified by laterality, with ipsilateral RF exposure having been linked to increased cerebral blood flow (Huber et al., 2005) and glucose metabolism (Volkow et al., 2011), as well as to increased risk of glioma in the temporal lobe (Barchana et al., 2012 and Hardell and Carlberg, 2015), although not in all studies (Hartikka et al., 2009 and Larjavaara et al., 2011), but this was not possible.

In summary, these analyses indicate that a causal factor, of which mobile phone use (and possibly other wireless equipment) is in agreement with the hypothesized spatial and temporal associations, is related to an increased risk of developing a malignant neoplasm in the temporal lobe. More specifically, if the calculated population impact is interpreted as a causal effect and is completely contributed to mobile phone use, then the population impact is an additional 188 cases annually in England; corresponding to about 1700 cases (range 436 to 2918) in the period 2005–2014 that would not have occurred otherwise. For reference, this corresponds to 0.02%–0.12% of new cancers during this period. If the relative effect is interpreted as a population relative risk, then a very moderate 1.35 (95%CI 1.09:1.59) is observed after a minimum 10-year latency.

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Electrosmog and Autoimmune Disease

Marshall, T.G. & Heil, T.J.R. Electrosmog and Autoimmune Disease. Immunol Res (2016). doi:10.1007/s12026-016-8825-7

Abstract

Studies in mice have shown that environmental electromagnetic waves tend to suppress the murine immune system with a potency similar to NSAIDs, yet the nature of any Electrosmog effects upon humans remains controversial. Previously, we reported how the human Vitamin-D receptor (VDR) and its ligand, 1,25-dihydroxyvitamin-D (1,25-D), are associated with many chronic inflammatory and autoimmune diseases. We have shown how olmesartan, a drug marketed for mild hypertension, acts as a high-affinity partial agonist for the VDR, and that it seems to reverse disease activity resulting from VDR dysfunction. We here report that structural instability of the activated VDR becomes apparent when observing hydrogen bond behavior with molecular dynamics, revealing that the VDR pathway exhibits a susceptibility to Electrosmog. Further, we note that characteristic modes of instability lie in the microwave frequency range, which is currently populated by cellphone and WiFi communication signals, and that the susceptibility is ligand dependent. A case series of 64 patient-reported outcomes subsequent to use of a silver-threaded cap designed to protect the brain and brain stem from microwave Electrosmog resulted in 90% reporting “definite” or “strong” changes in their disease symptoms. This is much higher than the 3–5% rate reported for electromagnetic hypersensitivity in a healthy population and suggests that effective control of environmental Electrosmog immunomodulation may soon become necessary for successful therapy of autoimmune disease.

https://www.ncbi.nlm.nih.gov/pubmed/27412293

Excerpt

There is no reason to suspect that a pulsed electromagnetic wave of 1 ls duration (1000 times slower than a typical molecular response) might cause any less damage to biology than a continuous wave of the same magnitude. It is therefore important to have very-fast-acting peak reading signal level meters when measuring the biological interaction potential of electromagnetic waves. Much of the research literature in this field is criticized as not being sufficiently authoritative because experiments have not been conducted under the current pragma of placebo control and simplistic (p = 0.05) analysis of results. Research in this area will only move forward when critics start to examine qualitative study outcomes—for example, observations which might indicate that a Faraday cage should have been an element of a study’s experimental methodology, or that a 2–3 days acclimatization or immune—washout might have changed the study results.

Furthermore, it seems likely that signals a million times lower than those currently being used in research may be sufficient to elicit a tangible change in human biology. In order to better understand the amplitude at which bioeffects become apparent, it is important that experimental guidelines be delineated which ensure that Electrosmog does not confound a study’s results.

Finally, we need to plan how to handle subjects whose symptoms become untenable (due to

immunopathology) during acclimatization to an Electrosmog-quiet environment, or during immune washout. We cannot ignore the increasing body of evidence showing electromagnetic effects on the immune system. The ‘‘controversial’’ nature of electromagnetic hypersensitivity will not diminish until we grasp the complexity of the task we face in defining exactly how electromagnetic waves interact with human biology.

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A cross-sectional study of the association between mobile phone use and symptoms of ill health

Cho YM, Lim HJ, Jang H, Kim K, Choi JW, Shin C, Lee SK, Kwon JH, Kim N. A cross-sectional study of the association between mobile phone use and symptoms of ill health. Environ Health Toxicol. 2016 Oct 26. doi: 10.5620/eht.e2016022. [Epub ahead of print]

Abstract

Objectives: This study analyzed the associations between mobile phone call frequency and duration with non-specific symptoms.

Methods: This study was conducted with a population group including 532 non-patient adults established by the Korean Genome Epidemiology Study. The pattern of phone call using a mobile phone was investigated through face-to-face interview. Structured methods applied to quantitatively assess health effects are Headache Impact Test-6 (HIT-6), Psychosocial Well-being Index-Short Form, Beck Depression Inventory, Korean-Instrumental Activities of Daily Living, Perceived Stress Scale (PSS), Pittsburgh Sleep Quality Index, and 12-Item Short Form Health Survey where a higher score represents a higher greater health effect.

Results: The average daily phone call frequency showed a significant correlation with the PSS score in female subjects. Increases in the average duration of one phone call were significantly correlated with increases in the severity of headaches in both sexes. The mean (standard deviation) HIT-6 score in the subgroup of subjects whose average duration of one phone call was 5 minutes or longer was 45.98 (8.15), as compared with 42.48 (7.20) in those whose average duration of one phone call was <5 minutes. The severity of headaches was divided into three levels according to the HIT-6 score (little or no impact/moderate impact/substantial or severe impact), and a logistic regression analysis was performed to investigate the association between an increased phone call duration and the headache severity. When the average duration of one phone call was 5 minutes or longer, the odds ratio (OR) and the 95% confidence intervals (CI) for the moderate impact group were 2.22 and 1.18-4.19, respectively. The OR and 95% CI for the substantial or severe impact group were 4.44 and 2.11-8.90, respectively.

Conclusions: Mobile phone call duration was not significantly associated with stress, sleep, cognitive function, or depression, but was associated with the severity of headaches.

https://www.ncbi.nlm.nih.gov/pubmed/27802500?dopt=Abstract

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Association Between Portable Screen-Based Media Device Access or Use and Sleep Outcomes: A Systematic Review and Meta-analysis

Carter B, Rees P, Hale L, Bhattacharjee D, Paradkar MS. Association Between Portable Screen-Based Media Device Access or Use and Sleep Outcomes: A Systematic Review and Meta-analysis.JAMA Pediatr. 2016 Oct 31. doi: 10.1001/jamapediatrics.2016.2341. [Epub ahead of print]

Abstract

Importance: Sleep is vital to children's biopsychosocial development. Inadequate sleep quantity and quality is a

public health concern with an array of detrimental health outcomes. Portable mobile and media devices have become a ubiquitous part of children's lives and may affect their sleep duration and quality.

Objective: To conduct a systematic review and meta-analysis to examine whether there is an association between portable screen-based media device (eg, cell phones and tablet devices) access or use in the sleep environment and sleep outcomes.

Data Sources: A search strategy consisting of gray literature and 24 Medical Subject Headings was developed in Ovid MEDLINE and adapted for other databases between January 1, 2011, and June 15, 2015. Searches of the published literature were conducted across 12 databases. No language restriction was applied.

Study Selection: The analysis included randomized clinical trials, cohort studies, and cross-sectional study designs. Inclusion criteria were studies of school-age children between 6 and 19 years. Exclusion criteria were studies of stationary exposures, such as televisions or desktop or personal computers, or studies investigating electromagnetic radiation.

Data Extraction and Synthesis: Of 467 studies identified, 20 cross-sectional studies were assessed for methodological quality. Two reviewers independently extracted data.

Main Outcomes and Measures: The primary outcomes were inadequate sleep quantity, poor sleep quality, and excessive daytime sleepiness, studied according to an a priori protocol.

Results: Twenty studies were included, and their quality was assessed. The studies involved 125 198 children (mean [SD] age, 14.5 [2.2] years; 50.1% male). There was a strong and consistent association between bedtime media device use and inadequate sleep quantity (odds ratio [OR], 2.17; 95% CI, 1.42-3.32) ($P < .001$, $I2 = 90\%$), poor sleep quality (OR, 1.46; 95% CI, 1.14-1.88) ($P = .003$, $I2 = 76\%$), and excessive daytime sleepiness (OR, 2.72; 95% CI, 1.32-5.61) ($P = .007$, $I2 = 50\%$). In addition, children who had access to (but did not use) media devices at night were more likely to have inadequate sleep quantity (OR, 1.79; 95% CI, 1.39-2.31) ($P < .001$, $I2 = 64\%$), poor sleep quality (OR, 1.53; 95% CI, 1.11-2.10) ($P = .009$, $I2 = 74\%$), and excessive daytime sleepiness (OR, 2.27; 95% CI, 1.54-3.35) ($P < .001$, $I2 = 24\%$).

Conclusions and Relevance: To date, this study is the first systematic review and meta-analysis of the association of access to and the use of media devices with sleep outcomes. Bedtime access to and use of a media device were significantly associated with the following: inadequate sleep quantity, poor sleep quality, and excessive daytime sleepiness. An integrated approach among teachers, health care professionals, and parents is required to minimize device access at bedtime, and future research is needed to evaluate the influence of the devices on sleep hygiene and outcomes.

https://www.ncbi.nlm.nih.gov/pubmed/27802500?dopt=Abstract

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Mapping of RF EMF exposure levels in outdoor environment and comparing with reference levels for general public health

Cansiz M, Abbasov T, Kurt MB, Celik AR. Mapping of radio frequency electromagnetic field exposure levels in outdoor environment and comparing with reference levels for general public health. J Expo Sci Environ Epidemiol. 2016 Nov 2. doi: 10.1038/jes.2016.64. [Epub ahead of print].

Abstract

In this study, radio frequency electromagnetic field exposure levels were measured on the main streets in the city center of Diyarbakır, Turkey. Measured electric field levels were plotted on satellite imagery of Diyarbakır and were compared with exposure guidelines published by the International Commission on Non-Ionizing

Radiation Protection (ICNIRP). Exposure measurements were performed in dense urban, urban and suburban areas each day for 7 consecutive days. The measurement system consisted of high precision and portable spectrum analyzer, three-axis electric field antenna, connection cable and a laptop which was used to record the measurement samples as a data logger. The highest exposure levels were detected for two places, which are called Diclekent and Batıkent. It was observed that the highest instantaneous electric field strength value for Batıkent was 7.18 V/m and for Diclekent was 5.81 V/m. It was statistically determined that the main contributor band to the total exposure levels was Universal Mobile Telecommunications System band. Finally, it was concluded that all measured exposure levels were lower than the reference levels recommended by ICNIRP for general public health.

https://www.ncbi.nlm.nih.gov/pubmed/27805622?dopt=Abstract

Excerpt

There are several reasons for why these two places have the highest exposure levels. Each place has a base station for mobile phone and these two base stations have common features. They have both GSM and UMTS antennas, which were installed on the first floor level. Moreover, these base stations are very close to the main streets. As seen in Figure 2, one base station is 115 m far away from Batıkent point and the other one is 165 m far away from Diclekent point. Therefore, exposure levels around these places were measured high. On the contrary, FM and terrestrial TV transmitters were far away from the streets where mobile measurements were taken.

The RF EMF exposure levels on the main streets in the city center of Diyarbakır were shown on the satellite map and then two highest RF EMF exposure levels were detected. By means of this method, considering these thematic maps for public health, RF planning engineers who work for mobile network operators may avoid the installation of new base stations in locations where existing RF exposure levels are already very high.

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The influence of prenatal 10 GHz microwave radiation exposure on a developing mice brain

Sharma A, Kesari KK, Saxena VK, Sisodia R. The influence of prenatal 10 GHz microwave radiation exposure on a developing mice brain.Gen Physiol Biophys. 2016 Oct 27. [Epub ahead of print]

Abstract

Our objective was to investigate alterations in the developing mice brain after intrauterine microwave exposure from different gestation days (0.25 and 11.25) till term. Pregnant mice from 0.25 and 11.25 days of gestation were isolated from an inbred colony and divided into sham-exposed (control) and microwave-exposed (10 GHz) groups. The follow-up study of mice at 3 weeks of age showed significant reduction in the brain and body weight of microwave-exposed group. Results showed an increased level of lipid peroxidation, decreased level of glutathione and protein after microwave exposure on both 0.25 and 11.25 day of gestation. Moreover, changes in cytoarchitechure of hippocampus and cerebellum of the brain and reduction in Purkinje cell number were observed statistically significant after microwave exposure from both 0.25 and 11.25 days of gestation. In conclusion, the degree of severity of damage in neonatal mice brain was much higher, when exposure started from 0.25 day of gestation compared to 11.25 days of gestation.

https://www.ncbi.nlm.nih.gov/pubmed/27787231

Also see: http://www.saferemr.com/2014/06/joint-statement-on-pregnancy-and.html

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Thermal Response of Human Skin to Microwave Energy: A Critical Review

Foster KR, Ziskin MC, Balzano Q.Thermal Response of Human Skin to Microwave Energy: A Critical Review. Health Phys. 2016 Dec;111(6):528-541.

Abstract

This is a review/modeling study of heating of tissue by microwave energy in the frequency range from 3 GHz through the millimeter frequency range (30-300 GHz). The literature was reviewed to identify studies that reported RF-induced increases in skin temperature. A simple thermal model, based on a simplified form of Pennes' bioheat equation (BHTE), was developed, using parameter values taken from the literature with no further adjustment. The predictions of the model were in excellent agreement with available data. A parametric analysis of the model shows that there are two heating regimes with different dominant mechanisms of heat transfer. For small irradiated areas (less than about 0.5-1 cm in radius) the temperature increase at the skin surface is chiefly limited by conduction of heat into deeper tissue layers, while for larger irradiated areas, the steady-state temperature increase is limited by convective cooling by blood perfusion. The results support the use of this simple thermal model to aid in the development and evaluation of RF safety limits at frequencies above 3 GHz and for millimeter waves, particularly when the irradiated area of skin is small. However, very limited thermal response data are available, particularly for exposures lasting more than a few minutes to areas of skin larger than 1-2 cm in diameter. The paper concludes with comments about possible uses and limitations of thermal modeling for setting exposure limits in the considered frequency range.

https://www.ncbi.nlm.nih.gov/pubmed/27798477?dopt=Abstract

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Magnetic Fields Modulate Blue-Light-Dependent Regulation of Neuronal Firing by Cryptochrome

Giachello CN, Scrutton NS, Jones AR, Baines RA. Magnetic Fields Modulate Blue-Light-Dependent Regulation of Neuronal Firing by Cryptochrome. J Neurosci. 2016 Oct 19;36(42):10742-10749.
https://www.ncbi.nlm.nih.gov/pubmed/27798129?dopt=Abstract

Abstract

Many animals are able to sense the Earth's geomagnetic field to enable behaviors such as migration. It is proposed that the magnitude and direction of the geomagnetic field modulates the activity of cryptochrome (CRY) by influencing photochemical radical pair intermediates within the protein. However, this proposal will remain theoretical until a CRY-dependent effect on a receptor neuron is shown to be modified by an external magnetic field (MF). It is established that blue-light (BL) photoactivation of CRY is sufficient to depolarize and activate Drosophila neurons. Here, we show that this CRY-dependent effect is significantly potentiated in the presence of an applied MF (100 mT). We use electrophysiological recordings from larval identified motoneurons, in which CRY is ectopically expressed, to show that BL-dependent depolarization of membrane potential and increased input resistance are markedly potentiated by an MF. Analysis of membrane excitability shows that these effects of MF exposure evoke increased action potential firing. Almost nothing is known about the mechanism by which a magnetically induced change in CRY activity might produce a behavioral response. We further report that specific structural changes to the protein alter the impact of the MF in ways that are strikingly similar to those from recent behavioral studies into the magnetic sense of Drosophila These observations provide the first direct experimental evidence to support the hypothesis that MF modulation of CRY activity is capable of influencing neuron activity to allow animal magnetoreception.

SIGNIFICANCE STATEMENT: The biophysical mechanism of animal magnetoreception is still unclear. The photoreceptor protein cryptochrome has risen to prominence as a candidate magnetoreceptor molecule based on multiple reports derived from behavioral studies. However, the role of cryptochrome as a magnetoreceptor remains controversial primarily because of a lack of direct experimental evidence linking magnetic field (MF) exposure to a change in neuronal activity. Here, we show that exposure to an MF (100 mT) is sufficient to potentiate the ability of light-activated cryptochrome to increase neuronal action potential firing. Our results provide critical missing evidence to show that the activity of cryptochrome is sensitive to an external MF that is capable of modifying animal behavior.

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Athermal effects of continuous microwave irradiation on growth and antibiotic sensitivity of Pseudomonas aeruginosa PAO1

Nakouti I, Hobbs G, Teethaisong Y, Phipps D. A demonstration of athermal effects of continuous microwave irradiation on the growth and antibiotic sensitivity of Pseudomonas aeruginosa PAO1. Biotechnol Prog. 2016 Oct 28. doi: 10.1002/btpr.2392. [Epub ahead of print]

Abstract

Stress, caused by exposure to microwaves (2.45GHz) at constant temperature (37± 0.5o C), alters the growth profile of Pseudomonas aeruginosa PAO1. In the absence of microwave treatment a simple, highly reproducible growth curve was observed over 24 hours or more. Microwave treatment caused no reduction in growth during the first 6 hours, but at a later stage (>12hours) the growth was markedly different to the controls. Secondary growth, typical of the presence of persisters clearly became apparent, as judged by both the dissolved oxygen and the cell density profiles. These treated cells showed distinct morphological changes, but on re-growth these cells reverted to normal. The Microwave Induced Persisters were subject to antibiotic challenge (tobramycin) and showed increased sensitivity when compared to the un-stressed planktonic cells. This is in marked contrast to antibiotic induced persisters which show increased resistance. This provides evidence for both a non-thermal effect of microwaves

https://www.ncbi.nlm.nih.gov/pubmed/27792273

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Exposure to extremely low frequency electromagnetic fields alters the behaviour, physiology and stress protein levels of desert locusts

Wyszkowska J, Shepherd S, Sharkh S, Jackson CW, Newland PL.Exposure to extremely low frequency electromagnetic fields alters the behaviour, physiology and stress protein levels of desert locusts.Sci Rep. 2016 Nov 3;6:36413. doi: 10.1038/srep36413.

Abstract

Electromagnetic fields (EMFs) are present throughout the modern world and are derived from many man-made sources including overhead transmission lines. The risks of extremely-low frequency (ELF) electromagnetic fields are particularly poorly understood especially at high field strengths as they are rarely encountered at ground level. Flying insects, however, can approach close to high field strength transmission lines prompting the question as to how these high levels of exposure affect behaviour and physiology. Here we utilise the accessible nervous system of the locust to ask how exposure to high levels of ELF EMF impact at multiple levels. We show that exposure to ELF EMFs above 4 mT leads to reduced walking. Moreover, intracellular recordings from an identified motor neuron, the fast extensor tibiae motor neuron, show increased spike latency and a broadening of its spike in exposed animals. In addition, hind leg kick force, produced by

stimulating the extensor tibiae muscle, was reduced following exposure, while stress-protein levels (Hsp70) increased. Together these results suggest that ELF EMF exposure has the capacity to cause dramatic effects from behaviour to physiology and protein expression, and this study lays the foundation to explore the ecological significance of these effects in other flying insects.

https://www.ncbi.nlm.nih.gov/pubmed/27808167?dopt=Abstract

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Environmental risk factors for dementia: a systematic review

Lewis O. J. Killin, John M. Starr, Ivy J. Shiue, Tom C. Russ. Environmental risk factors for dementia: a systematic review. BMC Geriatrics. DOI: 10.1186/s12877-016-0342-y. Published: 12 October 2016

Abstract

Background Dementia risk reduction is a major and growing public health priority. While certain modifiable risk factors for dementia have been identified, there remains a substantial proportion of unexplained risk. There is evidence that environmental risk factors may explain some of this risk. Thus, we present the first comprehensive systematic review of environmental risk factors for dementia.

Methods We searched the PubMed and Web of Science databases from their inception to January 2016, bibliographies of review articles, and articles related to publically available environmental data. Articles were included if they examined the association between an environmental risk factor and dementia. Studies with another outcome (for example, cognition), a physiological measure of the exposure, case studies, animal studies, and studies of nutrition were excluded. Data were extracted from individual studies which were, in turn, appraised for methodological quality. The strength and consistency of the overall evidence for each risk factor identified was assessed.

Results We screened 4784 studies and included 60 in the review. Risk factors were considered in six categories: air quality, toxic heavy metals, other metals, other trace elements, occupational-related exposures, and miscellaneous environmental factors. Few studies took a life course approach. There is at least moderate evidence implicating the following risk factors: air pollution; aluminium; silicon; selenium; pesticides; vitamin D deficiency; and electric and magnetic fields.

Conclusions Studies varied widely in size and quality and therefore we must be circumspect in our conclusions. Nevertheless, this extensive review suggests that future research could focus on a short list of environmental risk factors for dementia. Furthermore, further robust, longitudinal studies with repeated measures of environmental exposures are required to confirm these associations.

Excerpt: Two systematic reviews examined low and extremely low frequency **electric and magnetic fields** and, while the evidence is mixed, there seems to be an association with dementia risk and this was corroborated by a prospective study in Switzerland which found that living close to power lines for over 15 years was associated with a doubling of Alzheimer's disease mortality (but not the occupational study mentioned above [63]) [73, 74]. Its findings are difficult to interpret, but a prospective study in Denmark found that **mobile phone** subscription was associated with a decreased risk of subsequent hospital admission with dementia [75].

http://bmcgeriatr.biomedcentral.com/articles/10.1186/s12877-016-0342-y

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RF EMF exposures in kindergarten children

Bhatt CR, Redmayne M, Billah B, Abramson MJ, Benke G.Radiofrequency-electromagnetic field exposures in kindergarten children.J Expo Sci Environ Epidemiol. 2016 Oct 19. doi: 10.1038/jes.2016.55.

Abstract

The aim of this study was to assess environmental and personal radiofrequency-electromagnetic field (RF-EMF) exposures in kindergarten children. Ten children and 20 kindergartens in Melbourne, Australia participated in personal and environmental exposure measurements, respectively. Order statistics of RF-EMF exposures were computed for 16 frequency bands between 88 MHz and 5.8 GHz. Of the 16 bands, the three highest sources of environmental RF-EMF exposures were: Global System for Mobile Communications (GSM) 900 MHz downlink (82 mV/m); Universal Mobile Telecommunications System (UMTS) 2100MHz downlink (51 mV/m); and GSM 900 MHz uplink (45 mV/m). Similarly, the three highest personal exposure sources were: GSM 900 MHz downlink (50 mV/m); UMTS 2100 MHz downlink, GSM 900 MHz uplink and GSM 1800 MHz downlink (20 mV/m); and Frequency Modulation radio, Wi-Fi 2.4 GHz and Digital Video Broadcasting-Terrestrial (10 mV/m). The median environmental exposures were: 179 mV/m (total all bands), 123 mV/m (total mobile phone base station downlinks), 46 mV/m (total mobile phone base station uplinks), and 16 mV/m (Wi-Fi 2.4 GHz). Similarly, the median personal exposures were: 81 mV/m (total all bands), 62 mV/m (total mobile phone base station downlinks), 21 mV/m (total mobile phone base station uplinks), and 9 mV/m (Wi-Fi 2.4 GHz). The measurements showed that environmental RF-EMF exposure levels exceeded the personal RF-EMF exposure levels at kindergartens.

https://www.ncbi.nlm.nih.gov/pubmed/27759027?dopt=Abstract

Excerpt

In conclusion, this study provides evidence to support that of the 16 frequency bands measured the mobile phone base station DL exposure of GSM 900 MHz is the largest contributor to the total environmental and personal RF-EMF exposures in kindergartens in Melbourne. Wi-Fi exposure was found to be very low compared with mobile phone base station exposure. Environmental exposure levels at kindergartens located <300 m away from the nearest base station were higher compared with those located >300 m. The measurements suggested that the personal RF-EMF exposure levels were lower compared with the environmental RF-EMF levels at kindergartens.

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Personal exposure from RF EMF in Australia and Belgium using on-body calibrated exposimeters

Bhatt CR, Thielens A, Billah B, Redmayne M, Abramson MJ, Sim MR, Vermeulen R, Martens L, Joseph W, Benke G.Assessment of personal exposure from radiofrequency-electromagnetic fields in Australia and Belgium using on-body calibrated exposimeters.Environ Res. 2016 Nov;151:547-563. doi: 10.1016/j.envres.2016.08.022.

Abstract

The purposes of this study were: i) to demonstrate the assessment of personal exposure from various RF-EMF sources across different microenvironments in Australia and Belgium, with two on-body calibrated exposimeters, in contrast to earlier studies which employed single, non-on-body calibrated exposimeters; ii) to systematically evaluate the performance of the exposimeters using (on-body) calibration and cross-talk measurements; and iii) to compare the exposure levels measured for one site in each of several selected microenvironments in the two countries. A human subject took part in an on-body calibration of the exposimeter in an anechoic chamber. The same subject collected data on personal exposures across 38 microenvironments (19 in each country) situated in urban, suburban and rural regions. Median personal RF-EMF exposures were estimated: i) of all microenvironments, and ii) across each microenvironment, in two

countries. The exposures were then compared across similar microenvironments in two countries (17 in each country). The three highest median total exposure levels were: city center (4.33V/m), residential outdoor (urban) (0.75V/m), and a park (0.75V/m) [Australia]; and a tram station (1.95V/m), city center (0.95V/m), and a park (0.90V/m) [Belgium]. The exposures across nine microenvironments in Melbourne, Australia were lower than the exposures across corresponding microenvironments in Ghent, Belgium ($p<0.05$). The personal exposures across urban microenvironments were higher than those for rural or suburban microenvironments. Similarly, the exposure levels across outdoor microenvironments were higher than those for indoor microenvironments.

https://www.ncbi.nlm.nih.gov/pubmed/?term=27588949

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November/December 2016 issue of the *Journal of Exposure Science & Environmental Epidemiology:* three EMF papers

Kosuke Kiyohara, Kanako Wake, Soichi Watanabe, Takuji Arima, Yasuto Sato, Noriko Kojimahara, Masao Taki and Naohito Yamaguchi.Recall accuracy of mobile phone calls among Japanese young people. J Expo Sci Environ Epidemiol 26: 566-574; advance online publication, March 18, 2015; doi:10.1038/jes.2015.13.
https://www.ncbi.nlm.nih.gov/pubmed/?term=25783661

Benjamin Struchen, Ilaria Liorni, Marta Parazzini, Stephanie Gängler, Paolo Ravazzani and Martin Röösli. Analysis of personal and bedroom exposure to ELF-MFs in children in Italy and Switzerland. J Expo Sci Environ Epidemiol 26: 586-596; advance online publication, December 16, 2015; doi:10.1038/jes.2015.80.
https://www.ncbi.nlm.nih.gov/pubmed/?term=26669849

Madhuri Sudan, Jørn Olsen,Torben Sigsgaard and Leeka Kheifets. Trends in cell phone use among children in the Danish national birth cohort at ages 7 and 11 years. J Expo Sci Environ Epidemiol 26: 606-612; advance online publication, March 23, 2016; doi:10.1038/jes.2016.17.
https://www.ncbi.nlm.nih.gov/pubmed/?term=27005743

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Electromagnetic Shielding of Building Walls: From Roman times to the present age

Davide Micheli, Paolo Gianola, Giorgio Bertin, Andrea Delfini, Roberto Pastore, Mario Marchetti, Roberto Diana. Electromagnetic Shielding of Building Walls: From Roman times to the present age. IEEE Antennas and Propagation Magazine. 58(5). Oct. 2016.

Abstract

We have investigated the electromagnetic (EM) shielding effectiveness (SE) of building walls built in different ages. The measurements were carried out in the city of Rome, analyzing different building typologies from Roman Empire historical ruins up to modern reinforced concrete and steel/glass buildings. The method consisted of a measurement performed by means of a portable two-port vector network analyzer (VNA) connected to a couple of light antennas located in opposite positions with respect to the middle wall. The explored frequencies were in the range of 0.7-5.0 GHz, which many countries have currently adopted for mobile-phone radio access network (RAN) and satellite positioning services. The SE measurements showed values of up to 100 dB, and the analysis of the results showed that ancient Romans building walls and steel/glass building structures have the highest shielding capability. A numerical simulation of the outdoor-to-indoor transition attenuation and a statistical analysis of the signal code power in the live RAN of Telecom Italia integrate the discussion of the results.

http://ieeexplore.ieee.org/document/7551182/

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Biological and health effects of radiofrequency fields: Good study design and quality publications

Vijayalaxmi. Biological and health effects of radiofrequency fields: Good study design and quality publications. http://dx.doi.org/10.1016/j.mrgentox.2016.09.007.

Highlights

• Good study design for in vitro, in vivo and human investigations.
• Methods for statistical analyses.
• Check-list in quality publications.
• Conclusions.

Abstract

During recent decades, researchers have used several different parameters to evaluate the biological and health effects of in vitro and in vivo exposure to non-ionizing radiofrequency fields in animals, humans and their isolated cells. The data reported in many of publications in peer-reviewed scientific journals were reviewed by the international and national expert groups of scientists for human risk assessment of exposure to radiofrequency fields. The criteria used for such assessment depended on the study design, methodology and reporting of the data in the publication. This paper describes the requirements for good study design and quality publications, and provides guidance and a checklist for researchers studying radiofrequency fields and other environmental agents.

Conclusions

Investigations on the biological and health effects of RF exposure require close collaboration between biologists and engineers who have expertise in RF exposure assessment. The design of the studies as well as reporting the data in peer-reviewed publications should be of high quality. Detailed description of RF dosimetry is crucial and essential. Independent investigators should be able to replicate/confirm the observations under the same/improved experimental conditions. Such data are invaluable in strengthening the scientific knowledge which is essential for international and national evaluation of risk from RF exposure.

http://www.sciencedirect.com/science/article/pii/S1383571816302376

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Preliminary evidence that nanoparticle devices protect against EMR by reducing oxidative stress & inflammatory status

Francisco Ortiz, Beatriz I. Fernández-Gil, Ana Guerra-Librero, Luis C. López, Darío Acuña-Castroviejo, Germaine Escames. Preliminary evidence suggesting that nonmetallic and metallic nanoparticle devices protect against the effects of environmental electromagnetic radiation by reducing oxidative stress and inflammatory status. European Journal of Integrative Medicine, 8(5):835-840, October 2016.

Abstract

Introduction There is increasing interest in evaluating the potential health risks and biologic effects of exposure to extremely low-frequency magnetic fields (ELF-MF) and electromagnetic radiation (EMR), like those associated with personal computers, cellular phones, and environmental radiation (e.g., cellular towers, high-voltage power lines, radar). ELF-MF may generate free radicals in biological organisms, which leads to hyperoxidative status. Here, we investigated the potential efficacy of protective devices constructed with

nonmetallic and metallic nanoparticles, which are conductors and semiconductors of electromagnetic energy.

Methods In a before and after study, 20 healthy subjects who regularly used cellular phones and were exposed to typical environmental EMF were given one of three different (ELF-MF) protective devices. Blood samples were drawn at baseline and one month after using the devices to examine redox and inflammatory status.

Results We found that, 30 days after using the devices, plasma levels of lipid peroxidation, nitrites, and interferon-γ decreased significantly. Furthermore, the disulfide glutathione/glutathione ratio decreased, which indicated reduced intracellular oxidative damage. These data suggested that continuous use of devices that contain nonmetallic and metallic nanoparticles could protect healthy subjects from EMF-induced oxidative/inflammatory damage.

Conclusion Thus, for the first time, we have shown that the devices tested could be useful in counteracting the deleterious effects of EMF pollution by neutralizing harmful radiation before it reaches the body.

Funding. This work was partially supported by Pranan Technologies Ltd. (Pamplona, Spain). This study was partially supported by grants from Pranan Technologies (Navarra, Spain) and from the Consejería de Innovación, Ciencia, y Empresa, Junta de Andalucía, Spain (CTS-101).

http://www.sciencedirect.com/science/article/pii/S1876382016301111

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The electromagnetic basis of social interactions

A. R. Liboff. The electromagnetic basis of social interactions. Electromagnetic Biology & Medicine. Published online: 27 Oct 2016 http://dx.doi.org/10.1080/15368378.2016.1241180

Abstract

It has been established that living things are sensitive to extremely low-frequency magnetic fields at vanishingly small intensities, on the order of tens of nT. We hypothesize, as a consequence of this sensitivity, that some fraction of an individual's central nervous system activity can be magnetically detected by nearby individuals. Even if we restrict the information content of such processes to merely simple magnetic cues that are unconsciously received by individuals undergoing close-knit continuing exposure to these cues, it is likely that they will tend to associate these cues with the transmitting individual, no less than would occur if such signals were visual or auditory. Furthermore, following what happens when one experiences prolonged exposure to visual and like sensory inputs, it can be anticipated that such association occurring magnetically will eventually also enable the receiving individual to bond to the transmitting individual. One can readily extrapolate from single individuals to groups, finding reasonable explanations for group behavior in a number of social situations, including those occurring in families, animal packs, gatherings as found in concerts, movie theaters and sports arenas, riots and selected predatory/prey situations. The argument developed here not only is consistent with the notion of a magnetic sense in humans, but also provides a new approach to electromagnetic hypersensitivity, suggesting that it may simply result from sensory overload.

http://www.tandfonline.com/doi/full/10.1080/15368378.2016.1241180

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Protozoa: A Method for Monitoring of the Morphofunctional Disorders in Cells Exposed in the Cell Phone EMF

Uskalova DV, Igolkina YV, Sarapultseva EI. Intravital Computer Morphometry on Protozoa: A Method for

Monitoring of the Morphofunctional Disorders in Cells Exposed in the Cell Phone Communication Electromagnetic Field. Bull Exp Biol Med. 2016 Aug;161(4):554-7. doi: 10.1007/s10517-016-3459-2. Epub 2016 Sep 3.

Abstract

Morphofunctional disorders in unicellular aquatic protozoa - Spirostomum ambiguum infusorians after 30-, 60-, and 360-min exposure in electromagnetic field at a radiation frequency of 1 GHz and energy flow density of 50 μW/cm(2) were analyzed by intravital computer morphometry. Significant disorders in morphometric values correlated with low mobility of the protozoa. The results suggested the use of intravital computer morphometry on the protozoa for early diagnosis of radiation-induced effects of the mobile communication electromagnetic field, for example, low mobility of spermatozoa.

Excerpt

In 2003 sanitary epidemiological regulations and Sanitary Regulations and Standards 2.1.8/2.2.4.1190-03 were introduced in Russia. These regulations set up the **most stringent in the world maximal allowable values for energy flow density (EFD) – 10 μW/cm**2 **at a frequency of 900-1800 MHz for whole-body absorbed energy flow (SAR0 of 44 mW/kg**) [5]. These standards are based on observations carried out with participation of few volunteers and in model experiments on warm-blooded animals, cultured cells, lower animals, and plants [13]. It should be noted that communication network operators use several technologies and wireless communication standards simultaneously, as a result of which the mean EMF levels in the Moscow region increased by an order of magnitude higher than the allowed values [2].

https://www.ncbi.nlm.nih.gov/pubmed/?term=27591872

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Microwaves and Alzheimer's disease

Zhang X, Huang WJ, Chen WW. Microwaves and Alzheimer's disease. Exp Ther Med. 2016 Oct;12(4):1969-1972.

Abstract

Alzheimer's diseases (AD) is the most common type of dementia and a neurodegenerative disease that occurs when the nerve cells in the brain die. The cause and treatment of AD remain unknown. However, AD is a disease that affects the brain, an organ that controls behavior. Accordingly, anything that can interact with the brain may affect this organ positively or negatively, thereby protecting or encouraging AD. In this regard, modern life encompasses microwaves for all issues including industrial, communications, medical and domestic tenders, and among all applications, the cell phone wave, which directly exposes the brain, continues to be the most used. Evidence suggests that microwaves may produce various biological effects on the central nervous system (CNS) and many arguments relay the possibility that microwaves may be involved in the pathophysiology of CNS disease, including AD. By contrast, previous studies have reported some beneficial cognitive effects and that microwaves may protect against cognitive impairment in AD. However, although many of the beneficial effects of microwaves are derived from animal models, but can easily be extrapolated to humans, whether microwaves cause AD is an important issue that is to be addressed in the current review.

Open Access Paper: http://bit.ly/ADwireless

Also see: http://www.saferemr.com/2016/10/does-wireless-radiation-from-cell.html

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Environmental risk factors for dementia: a systematic review

Lewis O. J. Killin, John M. Starr, Ivy J. Shiue, Tom C. Russ. Environmental risk factors for dementia: a systematic review. BMC Geriatrics. 12 October 2016. DOI: 10.1186/s12877-016-0342-y

Abstract

Background Dementia risk reduction is a major and growing public health priority. While certain modifiable risk factors for dementia have been identified, there remains a substantial proportion of unexplained risk. There is evidence that environmental risk factors may explain some of this risk. Thus, we present the first comprehensive systematic review of environmental risk factors for dementia.

Methods We searched the PubMed and Web of Science databases from their inception to January 2016, bibliographies of review articles, and articles related to publically available environmental data. Articles were included if they examined the association between an environmental risk factor and dementia. Studies with another outcome (for example, cognition), a physiological measure of the exposure, case studies, animal studies, and studies of nutrition were excluded. Data were extracted from individual studies which were, in turn, appraised for methodological quality. The strength and consistency of the overall evidence for each risk factor identified was assessed.

Results We screened 4784 studies and included 60 in the review. Risk factors were considered in six categories: air quality, toxic heavy metals, other metals, other trace elements, occupational-related exposures, and miscellaneous environmental factors. Few studies took a life course approach. There is at least moderate evidence implicating the following risk factors: air pollution; aluminium; silicon; selenium; pesticides; vitamin D deficiency; and electric and magnetic fields.

Conclusions Studies varied widely in size and quality and therefore we must be circumspect in our conclusions. Nevertheless, this extensive review suggests that future research could focus on a short list of environmental risk factors for dementia. Furthermore, further robust, longitudinal studies with repeated measures of environmental exposures are required to confirm these associations.

http://bmcgeriatr.biomedcentral.com/articles/10.1186/s12877-016-0342-y

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Review paper: Proteomic impacts of electromagnetic fields on the male reproductive system

Sepehrimanesh, M. & Davis, D.L. Proteomic impacts of electromagnetic fields on the male reproductive system. Comp Clin Pathol (2016). doi:10.1007/s00580-016-2342-x Published online Oct 13, 2016.

Abstract

The use of mobile phones and other wireless transmitting devices is increasing dramatically in developing and developed countries, as is the rate of infertility. A number of respected infertility clinics in Australia, India, USA, and Iran are reporting that those who regularly use mobile phones tend to have reduced sperm quantity and quality. Some experimental studies have found that human sperm exposed to electromagnetic fields (EMF), either simulated or from mobile phones, developed biomarkers of impaired structure and function, as well as reduced quantity. These encompass pathological, endocrine, and proteomic changes. Proteins perform a vast array of functions within living organisms, and the proteome is the entire array of proteins—the ultimate biomolecules in the pathways of DNA transcription to translation. Proteomics is the art and science of studying all proteins in cells, using different techniques. This paper reviews proteomic experimental and clinical evidence that EMF acts as a male-mediated teratogen and contributor to infertility.

http://link.springer.com/article/10.1007%2Fs00580-016-2342-x

Not yet archived in PubMed.

Also see: http://www.saferemr.com/2015/09/effect-of-mobile-phones-on-sperm.html

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Investigation of bias related to differences between case and control interview dates in five INTERPHONE countries

Michelle C. Turner, Siegal Sadetzki, Chelsea E. Langer, Rodrigo Villegas, Jordi Figuerola, Bruce K. Armstrong, Angela Chetrit, Graham G. Giles,
Daniel Krewski, Martine Hours, Mary L. McBride, Marie-Elise Parent, Lesley Richardson, Jack Siemiatycki, Alistair Woodward, Elisabeth Cardis.
Investigation of bias related to differences between case and control interview dates in five INTERPHONE countries. Annals of Epidemiology. http://dx.doi.org/10.1016/j.annepidem.2016.09.013, Epub first Oct 8, 2016.

Abstract

Purpose Associations between cellular telephone use and glioma risk have been examined in several epidemiological studies including the 13-country INTERPHONE study. Although results showed no positive association between cellular telephone use and glioma risk overall, no increased risk for long term users, and no exposure-response relationship, there was an elevated risk for those in the highest decile of cumulative call time. However, results may be biased as data were collected during a period of rapidly increasing cellular telephone use, and as controls were usually interviewed later in time than cases.

Methods Further analyses were conducted in a subset of five INTERPHONE study countries (Australia, Canada, France, Israel, New Zealand) using a post-hoc matching strategy to optimize proximity of case to control interview dates and age.

Results Though results were generally similar to the original INTERPHONE study, there was some attenuation of the reduced odds ratios and stronger positive associations among long term users and those in the highest categories for cumulative call time and number of calls (8-9th and 10th decile).

Conclusions Proximity and symmetry in timing of case to control interviews should be optimized when exposure patterns are changing rapidly with time.

http://www.sciencedirect.com/science/article/pii/S1047279716303702

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Carl Blackman discusses ELF and RF health effects

Carl F. Blackman.Comment on “Milham & Stetzer (2016) Tumor-specific frequencies and ocular melanoma.” Electromag Biol Med http://dx.doi.org/10.1080/15368378.2016.1234390
http://www.tandfonline.com/doi/full/10.1080/15368378.2016.1234390

Bio

Dr. Blackman is a biophysicist who worked as a research scientist in the US Environmental Protection Agency (EPA) from 1970 until his recent retirement. He researched electric and magnetic field interactions with biological systems until the U.S. Congress cut off EPA funding for EMF research in the 1990's. His work resulted in several discoveries including multiple effect "windows" of intensity and frequency, and the demonstration that the earth's magnetic field was involved in biological responses to EMF. He collaborated on the development of math models used to predict EMF conditions that cause biological responses. He and his

colleagues discovered that melatonin can modulate gap junction intercellular communication and partially oppose the action of tumor-promoting agents to close this communication.They also demonstrated that the biological action of melatonin can be altered by magnetic field exposure. He is one of six founders of the Bioelectromagnetics Society (BEMS) in 1978, served as president in 1990-1991, and as a member of the editorial board of the Society's journal for 14 years. He served on the WHO committee to evaluate the health implications of radiofrequency radiation exposure (Environmental Health Criteria #137, 1993), and on an IARC committee that evaluated the carcinogenic potential of low frequency electric and magnetic fields in 2001 (Volume 80, 2002). In 2014 he received the BEMS d'Arsonval Award to recognize extraordinary accomplishment in bioelectromagnetics.

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RF Exposure Amongst Employees of Mobile Network Operators and Broadcasters

Ian Litchfield, Martie van Tongeren, Tom Sorahan. Radiofrequency Exposure Amongst Employees of Mobile Network Operators and Broadcasters. Radiation Protection Dosimetry. *doi: 10.1093/rpd/ncw283* First published online: October 13, 2016

Abstract

Little is known about personal exposure to radiofrequency (RF) fields amongst employees in the telecommunications industry responsible for installing and maintaining transmitters. IARC classified RF exposure as a possible carcinogen, although evidence from occupational studies was judged to be inadequate. Hence, there is a need for improved evidence of any potentially adverse health effects amongst the workforce occupationally exposed to RF radiation. In this study, results are presented from an exposure survey using data from personal monitors used by employees in the broadcasting and telecommunication industries of the UK. These data were supplemented by spot measurements using broadband survey metres and information on daily work activities provided by employee questionnaires. The sets of real-time personal data were categorised by four types of site determined by the highest powered antenna present (high, medium or low power and ground-level sites). For measurements gathered at each type of site, the root mean square and a series of box plots were produced. Results from the daily activities diaries suggested that riggers working for radio and television broadcasters were exposed to much longer periods as compared to colleagues working for mobile operators. Combining the results from the measurements and daily activity diaries clearly demonstrate that exposures were highest for riggers working for broadcasting sites. This study demonstrates that it is feasible to carry out exposure surveys within these populations that will provide reliable estimates of exposure that can be used for epidemiological studies of occupational groups exposed to RF fields.

Open Access Paper: http://m.rpd.oxfordjournals.org/content/early/2016/10/13/rpd.ncw283.full

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Treatment of Neuropathic Pain Using Pulsed Radiofrequency: A Meta-analysis

Shi Y, Wu W. Treatment of Neuropathic Pain Using Pulsed Radiofrequency: A Meta-analysis.Pain Physician. 2016 Sep-Oct;19(7):429-44.

Abstract

BACKGROUND: Neuropathic pain (NP) is a major public health problem worldwide. Because of the unclear mechanism of NP, its treatment is one of the most difficult medical problems. As a targeted, noninvasive, safe therapy, pulsed radiofrequency (PRF) provides a new method for the treatment of NP; however, its effect on this treatment still lacks support from evidence-based medicine.

OBJECTIVE: To conduct a meta-analysis of available randomized controlled trials and to evaluate the

effectiveness and clinical utility of PRF for the treatment of NP.

STUDY DESIGN: Meta-analysis.

SETTING: All selected studies were randomized controlled trials.

METHOD: A systematic and comprehensive database search was performed of the PubMed, CENTRAL, EMBASE.com, Cochrane Library, Chinese Biomedical Literature, and Wanfang databases for literature published from the establishment of the databases to December 19, 2015. According to inclusion and exclusion criteria, the results of randomized controlled trials supporting PRF for NP treatment were collected. The risk of bias tool described in the Cochrane Handbook version 5.1.0 was used to assess the quality of each trial. Meta-analysis was performed using RevMan 5.3 software.

RESULTS: A total of 12 randomized controlled trials involving 592 patients met the inclusion criteria. Overall, the results of the meta-analysis showed that, compared with the control group, PRF had a better effect on postherpetic neuralgia (PHN) in terms of pain score (one week, one month, and 3 months), excellent and good rate (one day, one month), and efficiency rate (one day). But PRF did not have a better effect on radicular pain in pain score (3 months). Side effects were less frequently found with the PRF treatment.

LIMITATIONS: Although we repeatedly tested the key words and used a manual method to prevent the loss of studies, due to the limitation of the included studies, some of the data were insufficient to complete the meta-analysis, and we were unable to obtain the original data from some studies. Some studies did not report the blind design, which decreased the quality of the current study.

CONCLUSION: PRF did not have a better effect on radicular pain, and PRF is an effective and safe therapeutic alternative for the analgesia of PHN. However, for a high recurrence rate over a long period, repeated PRF treatment has limitations.

https://www.ncbi.nlm.nih.gov/pubmed/27676660?dopt=Abstract

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Effect of Electromagnetic Interference on Human Body Communication

Jung-Hwan Hwang ; Tae-Wook Kang ; Jong-Hwa Kwon ; Seong-Ook Park. Effect of Electromagnetic Interference on Human Body Communication.
IEEE Transactions on Electromagnetic Compatibility. PP(99):1-10. 22 September 2016.DOI: 10.1109/TEMC.2016.2598582

Abstract

In human body communication (HBC), the human body is used as a medium for transmitting data between devices as a replacement for wired and wireless technologies. The human body functions as an antenna in the low-frequency band used by HBC. Owing to this antenna function, electromagnetic waves radiating from electronic devices or wireless services cause electromagnetic interference (EMI) in HBC devices. This paper addresses such EMI in HBC devices. The interference signal caused by EMI was measured while the human subject, who was using an HBC device, was exposed to a general EMI environment at multiple sites. Using the interference model obtained from the measured interference signals, bit-error-rate degradation caused by the interference signal was simulated. The interference model presented in this paper can be effectively used to achieve reliable data communication in various HBC devices.

http://ieeexplore.ieee.org/document/7574274/

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Effect of DECT non-ionizing radiation on cultivated plants of Arabidopsis thaliana

Aikaterina L. Stefia, Lukas H. Margaritisb, Nikolaos S. Christodoulakisa. The effect of the non-ionizing radiation on cultivated plants of Arabidopsis thaliana (Col.). Flora - Morphology, Distribution, Functional Ecology of Plants. Volume 223, August 2016, Pages 114–120. http://dx.doi.org/10.1016/j.flora.2016.05.008

Highlights

• Arabidopsis thaliana plants grow under long term microwave radiation.
• Minor structural changes observed.
• Chloroplast number affected.
• Photosynthetic pigment content affected.
• Total biomass reduced.

Abstract

A series of experiments was carried out to investigate any structural or biochemical alterations on Arabidopsis thaliana (Col.) plants after a long term exposure to non ionizing radiation emitted from the base unit of a cordless DECT system. Exposed plants, compared to their control counterparts, seem to be affected concerning their biomass and leaf structure. Their leaves are thinner and possess fewer chloroplasts. SEM observations of the exposed leaves reveal that the only feature affected is the pubescence which almost disappears while TEM investigation revealed minor structural effects in the chloroplasts. The reduction in the number of chloroplasts as well as the decrease of stroma thylakoids and photosynthetic pigments are probably the main reasons for a weak photosynthetic potential and a consequent reduction of the biomass production.

http://www.sciencedirect.com/science/article/pii/S0367253016300780?np=y

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RF radiation (900 MHz)-induced DNA damage and cell cycle arrest in testicular germ cells in mice

Pandey N, Giri S, Das S, Upadhaya P. Radiofrequency radiation (900 MHz)-induced DNA damage and cell cycle arrest in testicular germ cells in swiss albino mice. Toxicol Ind Health. 2016 Oct 13. pii: 0748233716671206.

Abstract

Even though there are contradictory reports regarding the cellular and molecular changes induced by mobile phone emitted radiofrequency radiation (RFR), the possibility of any biological effect cannot be ruled out. In view of a widespread and extensive use of mobile phones, this study evaluates alterations in male germ cell transformation kinetics following RFR exposure and after recovery. Swiss albino mice were exposed to RFR (900 MHz) for 4 h and 8 h duration per day for 35 days. One group of animals was terminated after the exposure period, while others were kept for an additional 35 days post-exposure. RFR exposure caused depolarization of mitochondrial membranes resulting in destabilized cellular redox homeostasis. Statistically significant increases in the damage index in germ cells and sperm head defects were noted in RFR-exposed animals. Flow cytometric estimation of germ cell subtypes in mice testis revealed 2.5-fold increases in spermatogonial populations with significant decreases in spermatids. Almost fourfold reduction in spermatogonia to spermatid turnover (1C:2C) and three times reduction in primary spermatocyte to spermatid turnover (1C:4C) was found indicating arrest in the premeiotic stage of spermatogenesis, which resulted in loss of post-meiotic germ cells apparent from testis histology and low sperm count in RFR-exposed animals. Histological alterations such as sloughing of immature germ cells into the seminiferous tubule lumen, epithelium depletion and maturation arrest were also observed. However, all these changes showed recovery to varied degrees following the post-exposure period indicating that the adverse effects of RFR on mice germ cells are detrimental but reversible. To conclude, RFR exposure-induced oxidative stress causes DNA damage

in germ cells, which alters cell cycle progression leading to low sperm count in mice.

https://www.ncbi.nlm.nih.gov/pubmed/27738269?dopt=Abstract

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Effects of long-term exposure to 900 MHz EMF on heart morphology and biochemistry of male adolescent rats

Kerimoğlu G, Mercantepe T, Erol HS, Turgut A, Kaya H, Çolakoğlu S, Odacı E. Effects of long-term exposure to 900 megahertz electromagnetic field on heart morphology and biochemistry of male adolescent rats. Biotech Histochem. 2016 Aug 11:1-10.

Abstract

The pathological effects of exposure to an electromagnetic field (EMF) during adolescence may be greater than those in adulthood. We investigated the effects of exposure to 900 MHz EMF during adolescence on male adult rats. Twenty-four 21-day-old male rats were divided into three equal groups: control (Cont-Gr), sham (Shm-Gr) and EMF-exposed (EMF-Gr). EMF-Gr rats were placed in an EMF exposure cage (Plexiglas cage) for 1 h/day between postnatal days 21 and 59 and exposed to 900 MHz EMF. Shm-Gr rats were placed inside the Plexiglas cage under the same conditions and for the same duration, but were not exposed to EMF. All animals were sacrificed on postnatal day 60 and the hearts were extracted for microscopic and biochemical analyses. Biochemical analysis showed increased levels of malondialdehyde and superoxide dismutase, and reduced glutathione and catalase levels in EMF-Gr compared to Cont-Gr animals. Hematoxylin and eosin stained sections from EMF-Gr animals exhibited structural changes and capillary congestion in the myocardium. The percentage of apoptotic myocardial cells in EMF-Gr was higher than in either Shm-Gr or Cont-Gr animals. Transmission electron microscopy of myocardial cells of EMF-Gr animals showed altered structure of Z bands, decreased myofilaments and pronounced vacuolization. We found that exposure of male rats to 900 MHz EMF for 1 h/day during adolescence caused oxidative stress, which caused structural alteration of male adolescent rat heart tissue.

https://www.ncbi.nlm.nih.gov/pubmed/27715326?dopt=Abstract

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Effect of Radiofrequency Radiation on Human Hematopoietic Stem Cells

Gläser K, Rohland M, Kleine-Ostmann T, Schrader T, Stopper H, Hintzsche H. Effect of Radiofrequency Radiation on Human Hematopoietic Stem Cells. Radiat Res. 2016 Oct 6.

Abstract

Exposure to electromagnetic fields in the radiofrequency range is ubiquitous, mainly due to the worldwide use of mobile communication devices. With improving technologies and affordability, the number of cell phone subscriptions continues to increase. Therefore, the potential effect on biological systems at low-intensity radiation levels is of great interest. While a number of studies have been performed to investigate this issue, there has been no consensus reached based on the results. The goal of this study was to elucidate the extent to which cells of the hematopoietic system, particularly human hematopoietic stem cells (HSC), were affected by mobile phone radiation. We irradiated HSC and HL-60 cells at frequencies used in the major technologies, GSM (900 MHz), UMTS (1,950 MHz) and LTE (2,535 MHz) for a short period (4 h) and a long period (20 h/66 h), and with five different intensities ranging from 0 to 4 W/kg specific absorption rate (SAR). Studied end points included apoptosis, oxidative stress, cell cycle, DNA damage and DNA repair. In all but one of these end points, we detected no clear effect of mobile phone radiation; the only alteration was found when quantifying DNA damage. Exposure of HSC to the GSM modulation for 4 h caused a small but statistically significant

decrease in DNA damage compared to sham exposure. To our knowledge, this is the first published study in which putative effects (e.g., genotoxicity or influence on apoptosis rate) of radiofrequency radiation were investigated in HSC. Radiofrequency electromagnetic fields did not affect cells of the hematopoietic system, in particular HSC, under the given experimental conditions.

https://www.ncbi.nlm.nih.gov/pubmed/27710704?dopt=Abstract

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Effects of ELF EMF and cisplatin on mRNA levels of some DNA repair genes

Sanie-Jahromi F, Saadat 2, Saadat M. Effects of extremely low frequency electromagnetic field and cisplatin on mRNA levels of some DNA repair genes. Life Sci. 2016 Oct 6. pii: S0024-3205(16)30588-4. doi: 10.1016/j.lfs.2016.10.006.

Highlights

• Extremely-low frequency electromagnetic field (ELF-EMF) can affect gene expression.
• mRNA levels of seven genes involved in DNA repair pathways were evaluated.
• The examined genes had tendency to be down-regulated in the cells treated with EMF.
• *GADD45A* mRNA levels in cells co-treated with cisplatin (CDDP) + EMF were increased.
• Co-treatment of CDDP + EMF enhances down-regulation of the genes of NHEJ pathway.
• Elevation in IC_{50} of CDDP when cells co-treated with CDDP + EMF was observed.

Abstract

AIMS: It has been shown that exposure to extremely-low frequency (<300Hz) oscillating electromagnetic field (EMF) can affect gene expression. The effects of different exposure patterns of 50-Hz EMF and co-treatment of EMF plus cisplatin (CDDP) on mRNA levels of seven genes involved in DNA repair pathways (GADD45A, XRCC1, XRCC4, Ku70, Ku80, DNA-PKcs and LIG4) were evaluated.

MAIN METHODS: Two 50-Hz EMF intensities (0.25 and 0.50mT), three exposure patterns (5min field-on/5min field-off, 15min field-on/15min field-off, 30min field-on continuously) and two cell lines (MCF-7 and SH-SY5Y) were used. The mRNA levels were measured using quantitative real-time PCR.

KEY FINDINGS: The examined genes had tendency to be down-regulated in MCF-7 cells treated with EMF. In the pattern of 15min field-on/15min field-off of the 0.50mT EMF, no increase in mRNA levels were observed, but the mRNA levels of GADD45A, XRCC1, XRCC4, Ku80, Ku70, and LIG4 were down-regulated. A significant elevation in IC50 of CDDP was observed when MCF-7 and SH-SY5Y cells were co-treated with CDDP+EMF in comparison with the cells treated with CDDP alone. GADD45A mRNA levels in MCF-7 and SH-SY5Y cells co-treated with CDDP+EMF were increased and at the same time the mRNA levels of XRCC4, Ku80, Ku70 and DNA-PKcs were down-regulated.

SIGNIFICANCE: Present study provides evidence that co-treatment of CDDP+EMF can enhance down-regulation of the genes involved in non-homologous end-joining pathway. It might be suggested that co-treatment of CDDP+EMF could be more promising for sensitizing cancer cells to DNA double strand breaks.

https://www.ncbi.nlm.nih.gov/pubmed/27721000?dopt=Abstract