



## Published Scientific Research on 5G, 4G Small Cells, Wireless Radiation and Health

Published peer reviewed science already indicates that the current wireless technologies of 2G, 3G and 4G – in use today with our cell phones, computers and wearable tech – creates (create) radiofrequency exposures which poses (pose) a serious health risk to humans, animals and the environment. Scientists are cautioning that before rolling out 5G, research on human health effects urgently needs to be done first to ensure the public and environment are protected.

“Small cells” are microwave antennas (basically shorter cell towers) rapidly being installed in public areas on utility poles and street lights in front of homes, parks and schools. Just like cell towers, these wireless antennas generate and emit microwave radiofrequency (RF) radiation to transmit 2G, 3G and 4G network signals. Companies soon plan to add a new technology called 5G which will use current 4G technology plus even higher frequencies. The higher frequencies include millimeter-wave emissions that were not previously released into public areas.

Companies state that these 4G and 5G antennas will increase the wireless radiation levels in the area so much that they are working to loosen several governments’ radiation limits in order to roll it out. More than 240 scientists published an appeal to the United

Nations to reduce public exposure and called for a [moratorium on 5G](#) citing “established” adverse biological effects of RF radiation.

5G will utilize not only the frequencies currently in use, but also higher millimeter wave and sub-millimeter wave frequencies. Small cells being installed in cities are usually 4G technology with a wide variety of frequencies. Thus, when we consider the health impacts of 5G and small cells we are looking at research on current technologies and frequencies in use in addition to research on sub-millimeter and millimeter waves. The 5G standard is new there are no studies that have looked at long term human exposure to 5G. However the current body of research finding effects from current wireless technology provides enough data for scientists to call for a moratorium.

## Published Reviews on 5G

“[5G Wireless Expansion: Public Health and Environmental Implications](#)” published in *Environmental Research* is a research review that documents the range of reported adverse effects of RF and millimeter waves—effects range from cancer to bacteria growth changes to DNA damage. The study concludes that “a moratorium on the deployment of 5G is warranted” and “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 ... from both physical and mental health perspectives” ([Russell, 2018](#)).

[“Adverse Health Effects of 5G Mobile Networking Technology Under Real Life Conditions”](#) published in *Toxicology Letters* identifies the wide-spectrum of adverse health effects of non-ionizing non-visible radiation and concludes that 5 G mobile networking technology will affect not only the skin and eyes, but will have adverse systemic effects as well. They state that 5G will increase the cell tower densities by an order of magnitude. The researchers conclude that in aggregate, for the high frequency (radiofrequency-RF) part of the spectrum, currently published reviews show that RF radiation below the FCC guidelines can result in: carcinogenicity (brain tumors/glioma, breast cancer, acoustic neuromas, leukemia, parotid gland tumors), genotoxicity (DNA damage, DNA repair inhibition, chromatin structure), mutagenicity, teratogenicity, neurodegenerative diseases (Alzheimer’s Disease, Amyotrophic Lateral Sclerosis), neurobehavioral problems, autism, reproductive problems, pregnancy outcomes, excessive reactive oxygen species/oxidative stress, inflammation, apoptosis, blood-brain barrier disruption, pineal gland/melatonin production, sleep disturbance, headache, irritability, fatigue, concentration difficulties, depression, dizziness, tinnitus, burning and flushed skin, digestive disturbance, tremor, cardiac irregularities, adverse impacts on the neural, circulatory, immune, endocrine, and skeletal systems” and “from this perspective, RF is a highly pervasive cause of disease” ([Kostoff et al., 2020](#)).

[“Towards 5G communication systems: Are there health implications?”](#) published in the *International Journal of Hygiene and Environmental Health* is a research review detailing research findings that millimeter waves can alter gene expression, promote cellular proliferation and synthesis of proteins linked with oxidative stress, inflammatory and metabolic processes.” The researchers conclude, “available findings seem sufficient to demonstrate the existence of biomedical effects, to invoke the precautionary principle” ([Di Ciaula, 2018](#)).

“Systematic Derivation of Safety Limits for Time-Varying 5G Radiofrequency Exposure Based on Analytical Models and Thermal Dose” published in *Health Physics* documents how significant tissue heating can be generated by 5G technology’s rapid short bursts of energy. “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” (Neufeld and Kuster, 2018).

A review of studies on 6 to 100 GHz (Simkó and Mattsson 2019) funded by Deutsche Telekom of Germany found that “the available studies do not provide adequate and sufficient information for a meaningful safety assessment, or for the question about non-thermal effects.” The review stated, “here is a need for research regarding local heat developments on small surfaces, e.g., skin or the eye, and on any environmental impact.” This study cited research that found “the presence of sweat glands [120,121] and also capillaries in the dermis can cause locally elevated SAR levels [122]. The latter study showed that SAR levels in vessels could be up to 30 times higher than in the surrounding skin, depending on the diameter of the vessels.”

Simkó and Mattsson 2019 analyzed the quality of the selected studies according to specific criteria. The studies were categorized by the presence of sham/ control, dosimetry, positive control, temperature control, and whether the study was blinded. Of the 45 in vivo studies, 78% (35) demonstrated biological responses after exposure to MMW. However when analyzed for quality criteria, “only three publications were identified that met all five criteria [26,51,53].” (EHT note: These three publications found an effect.) Similarly, 31 of the 53 in vitro studies found an effect. However only 13 studies had 3 of the 5 criteria satisfied and the authors conclude that “the number of examinations and the quality criteria are insufficient for a statistical analysis. It should be stressed that this quality analysis covers all publications dealing with the responses/effects of exposure to 6 to 100 GHz MMW, irrespective of the endpoints tested. To perform a correlation analysis, a larger number of comparable studies (e.g., identical endpoints in a frequency group) would be required.”

# 5G and Human Skin

“The Human Skin as a Sub-THz Receiver – Does 5G Pose a Danger to It or Not?”, published in *Environmental Research*, and “The Modeling of the Absorbance of Sub-THz Radiation by Human Skin”, published in *IEEE Transactions on Terahertz Science and Technology*, are two papers by physicists presenting research that found higher 5G frequencies are intensely absorbed into human sweat ducts (in skin), at a much higher absorption levels than other parts of our skin’s tissues (Betzael et al., 2017, Betzael et al., 2018). In an article published in *Environmental Research*, researchers conclude, “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” (Betzael, et al., 2018).

“Exposure of Insects to Radio-Frequency Electromagnetic Fields from 2 to 120 GHz” published in *Scientific Reports* is the first study to investigate how insects (including the Western honeybee) absorb the higher frequencies (2 GHz to 120 GHz) to be used in the 4G/5G rollout. The scientific simulations showed increases in absorbed power between 3% to 370% when the insects were exposed to the frequencies. Researchers concluded, “This could lead to changes in insect behaviour, physiology, and morphology over time....” (Thielens et al., 2018)

According to Belyaev 2019, “the health effects of chronic MMW exposures may be more significant than for any other frequency range.” The abstract states that, “ 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 inconsistency 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 extent 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.”

## The Bioeffects of Millimeter Waves Documented Years Ago

“[Biological Effect of Millimeter Waves](#)”, a Russian review on millimeter waves declassified by the CIA in 2012, reported multiple research findings and concluded that, “Morphological, functional and biochemical studies conducted in humans and animals revealed that millimeter wave caused changes in the body manifested in structural alterations in the skin and internal organs, qualitative and quantitative changes of the blood and bone marrow composition and changes of the conditioned reflex activity, tissue respiration, activity of enzymes participating in the process of tissue respiration and nucleic metabolism” ([Zalyubovskaya, 1977](#)).

“[Current State And Implications Of Research On Biological Effects Of Millimeter Waves: A Review Of The Literature](#)” published in *BioElectroMagnetics* reviewed dozens of research findings on low-intensity millimeter waves and determined that the reported, “MMW effects could not be readily explained by temperature changes during irradiation.” The review concludes by questioning the adequacy of regulatory limits stating that, “Safety limits for these types of exposure are based solely on predictions of energy deposition and MMW heating, but in view of recent studies this approach is not necessarily adequate” ([Pakhomov et al., 1998](#)).

[“Skin Heating and Injury by Prolonged Millimeter-Wave Exposure: Theory Based on a Skin Model Coupled to a Whole Body Model and Local Biochemical Release From Cells at Supraphysiologic Temperatures”](#), published in *IEEE Transactions On Plasma Science* concludes that a consequence of MMW heating is the alteration of cell-membrane permeability. Nearby skin layers are affected by the biophysical mechanism of biochemical release through cell membranes. “The released molecules are delivered to other skin regions by diffusion and into the bloodstream by perfusion, where according to our hypothesis, the molecules interact with susceptible cells. This raises the possibility of additional indirect injury at nearby deeper skin regions that experience insignificant heating. Biochemical release may also lead to injury at distant sites within the body by perfusion clearance that transfers molecules into the systemic circulation to reach other susceptible cells” (Stewart et al., 2006).

[Siegel et al, 2010](#) published in [Electronics Records](#) reviewed a series of experiments “which show changes in cell membrane potential and the action potential firing rate of cortical neurons under short (1 min) exposures to continuous-wave 60 GHz radiation at mW/cm<sup>2</sup> power levels, more than 1000 times below the US government maximum permissible exposure.” “At power levels of approximately 300 nW/cm<sup>2</sup> and above, we observed strong inhibition of the action potential firing rate in some of the neurons, and increased firing in others, perhaps indicating the functional heterogeneity in the studied neuronal population. ...These results are believed to be the first positive correlative measurements of real-time changes in neuronal activity with ultra-low-power millimetre-wave exposures. The experiments point to changes in membrane channel opening...”

Yes, Adding More Cell Antennas Will Increase Exposures in Communities

A [2018 study](#) published in *Annals of Telecommunications* found increased RF-EMF exposure from small cell LTE networks in two urban cities in France and the Netherlands. Researchers measured the RF-EMF from LTE (Long-Term Evolution) MC (macro cells meaning large cell towers) and SC networks (low-powered small cell base stations) and found that the small cell networks increased the radio emissions from base stations (called downlink) by a factor of 7–46 while decreasing the radio emissions from user

equipment exposure (called ) by a factor of 5–17. So while the devices themselves could emit less radiation, the cell antennas will increase the levels from cell antennas (Mazloum et al., 2019). This study shows the increased exposures would be involuntary. We can turn our phones off, but we cannot turn off the antennas in the neighborhood.

An [Australian study](#) published in the *Journal of Exposure Science & Environmental Epidemiology* also found that children in kindergartens with nearby antenna installations had nearly three-and-a-half times higher RF exposures than children with installations further away by more than 300 meters (Bhatt et al., 2016).

A [2018 multi-country study](#) published in *Environment International* measured RF in several countries. It found that cell phone tower radiation is the dominant contributor to RF exposure in most outdoor areas; exposure in urban areas was higher and that exposure has drastically increased. As an example, the measurements the researchers took in Los Angeles, USA were 70 times higher than the US EPA estimate 40 years ago (Sagar et al., 2018).

As an example of how rapidly RF is increasing from wireless antennas, a [2014 published study](#) from *Environmental Research* looked at RF in three European cities and found in just one year (between April 2011 and March 2012) that the total RF-EMF exposure levels in all outdoor areas in combination increased by 57.1% in Basel, by 20.1% in Ghent and by 38.2% in Brussels. “Exposure increase was most consistently observed in outdoor areas due to emissions from mobile phone base stations” (Urbinello et al., 2014).

[Another study](#), published in *Environment International*, looked at 529 children in Denmark, the Netherlands, Slovenia, Switzerland and Spain who wore meters around



the waist or carried in a backpack during the day and placed close to the bed at night. Researchers found “the largest contributors to total personal environmental RF-EMF exposure were downlink (meaning from cell tower base stations) and broadcast” (Birks et al., 2018).

Cell tower radiation is a significant contribution to our daily exposure to RF. A study recently published in the *International Journal of Environmental Research and Public Health* equipped Australian adults with an RF measuring device in a small hip bag for approximately 24 consecutive hours. The study found “downlink and broadcast are the main contributors to total RF-EMF personal exposure.” Downlink (RF from mobile phone base station) contributed 40.4% of the total RF-EMF exposure (Zelege et al., 2018).

Another published study in the *Science of The Total Environment* journal, gave 50 Korean parents and their child a measuring device for 48 hours found that “the contribution of base-station exposure to total RF-EMF exposure was the highest both in parents and children” (Choi et al., 2018).

## **Experts Warn that Measurement Techniques Do Not Adequately Measure 5G Exposures**

A 2019 Report for the European Parliament Committee on Industry, Research and Energy published for the Policy Department for Economic, Scientific and Quality of Life Policies, entitled “5G Deployment: State of Play in Europe, USA, and Asia” explained that “5G radio emission fields are quite different to those of previous generations because of their complex beamformed transmissions in both directions – from base station to handset and for the return. Although fields are highly focused by beams, they vary rapidly with time and movement and so are unpredictable, as the signal levels and patterns interact as a closed loop system. This has yet to be mapped reliably for real situations, outside the laboratory.” “While the International Commission on Non-Ionizing Radiation Protection (ICNIRP) issues guidelines for limiting exposure to electric,

magnetic and electromagnetic fields (EMF), and EU member states are subject to Council Recommendation 1999/519/EC which follows ICNIRP guidelines, the problem is that currently it is not possible to accurately simulate or measure 5G emissions in the real world” (Blackman & Forge, 2019).

A 2020 European Parliament Briefing on the “[Effects of 5G wireless communication on human health](#)” reiterates the issues with measurements and also comments on how radiation limits are outdated stating in [this summary](#), “The EU’s current provisions on exposure to wireless signals, the Council Recommendation on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz), is now 20 years old, and thus does not take the specific technical characteristics of 5G into account” (Karaboytcheva, 2020).

“[Human Exposure to RF Fields in 5G Downlink](#)” in IEEE International Communications Conference found “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” (Nasim & Kim, 2017).

The study “[Human EMF Exposure in Wearable Networks for Internet of Battlefield Things](#)” published in [MILCOM 2019 – 2019 IEEE Military Communications Conference \(MILCOM\)](#) is the first work that explicitly compares the human EMF exposure at different operating frequencies for on-body wearable communications. The study investigates the exposure effects of the human electromagnetic field (EMF) from on-

body wearable devices and compares the results to illustrate how the technology evolution to higher frequencies can impact one's health. It concludes that the results suggest the average specific absorption rate (SAR) at 60 GHz can exceed the regulatory guidelines within a certain separation distance between a wearable device and the human skin surface (Nasim & Kim, 2019).

## Review Publications on Electromagnetic Radiation and RF

A 2019 literature review “[Oxidative mechanisms of biological activity of low-intensity radiofrequency radiation](#)” published in *Electromagnetic Biology and Medicine* found that 93 of the 100 peer-reviewed studies dealing with oxidative effects of low-intensity RFR, confirmed that RFR induces oxidative effects in biological systems (Yakymenko et al., 2016).

“[Planetary Electromagnetic Pollution: It Is Time to Assess Its Impact](#)” published in *The Lancet Planetary Health* documents the significant increase in environmental levels of radio-frequency (RF) electromagnetic wireless radiation over the past two decades. The study cites an evaluation that found 68.2% of 2,266 studies in humans, animals, and plants demonstrated significant biological or health effects associated with exposure to electromagnetic fields. 89% of experimental studies that investigated oxidative stress endpoints showed significant effects and “radiofrequency electromagnetic radiation causes DNA damage apparently through oxidative stress.” The paper also highlights research that has associated RF exposure with altered neurodevelopment and behavioural disorders, structural and functional changes in the brain and the sensitivity of pollinators. “These findings deserve urgent attention. This weight of scientific evidence refutes the prominent claim that the deployment of wireless technologies poses no health risks at the currently permitted non-thermal radiofrequency exposure levels” (Bandara & Carpenter, 2018).

The review “[Thermal and non-thermal health effects of low intensity non-ionizing radiation: An international perspective](#)” published in *Environmental Pollution* by researchers of the European Cancer Environment Research Institute in Brussels, Belgium and the Institute for Health and the Environment, University at Albany, NY, USA reviews current research findings and states that, “the mechanism(s) responsible include induction of reactive oxygen species, gene expression alteration and DNA damage through both epigenetic and genetic processes.” The paper affirms that “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” ([Belpomme et al., 2018](#)).

The literature review “[Effect of radiofrequency radiation on reproductive health](#)” published by the Division of Reproductive Biology & Maternal Health, Child Health, Indian Council of Medical Research documents research that has found a link between radiofrequency radiation and oxidative stress and changes to the reproductive system including sperm count, motility, normal morphology and viability. The review concludes that the “available data indicate that exposure to EMF can cause adverse health effects. It is also reported that biological effects may occur at very low levels of exposure” ([Singh et al., 2018](#)).

*Environmental Review* published a 2010 landmark [review study](#) on 56 studies that reported biological effects found at very low intensities, including impacts on reproduction, permeability of the blood-brain barrier, behavior, cellular and metabolic changes, and increases in cancer risk ([Lai & Levitt, 2010](#)).

## Cancer

“Cancer epidemiology update, following the 2011 IARC evaluation of radiofrequency electromagnetic fields” published in *Environmental Research* is a comprehensive research review of RF effects in human and animal research. The review concludes that scientific evidence is now adequate to conclude radiofrequency radiation is carcinogenic to humans (Miller, 2018). Several previously published studies also concluded that RF causes various types of cancer, for example, Carlberg & Hardell, 2017 published in *BioMed Research International*; Atzman et al., 2016 published in the *International Journal Cancer Clinical Research*; and Peleg et al., 2018 published in *Environmental Research*.

The US National Toxicology Program (NTP) is a federal, interagency program that conducted a \$30-million study designed to test the basis for federal safety limits. The study on, “Cell Phone Radio Frequency Radiation” found “clear evidence” of cancer, heart damage and DNA damage (NIEHS, 2018). The heart and brain cancers found in the NTP rats are the same cell type as tumors that researchers have found to be increasing in humans who have used cell phones for over 10 years as published in *BioMed Research* (Carlberg & Hardell, 2017). Thus, researchers assert in the *International Journal of Oncology* that the animal evidence from the NTP study confirms the human evidence associating radio frequency radiation exposure to cancer occurrences/developments (Carlberg & Hardell, 2019).

The 2018 report of final brain and heart tumor results from the The Ramazzini Institute (RI) Study on Base Station RF, published in *Environmental Research* was another large scale rat study that also found increases in the same heart cancers that the US National

Toxicology Program (NTP) study found—yet the Ramazzini rats were exposed to much lower levels of RF than the NTP rats. In fact, all the RI radiation exposures were below FCC limits, as the study was specifically designed to test the safety of RF limits for cell tower/base stations (Falconi et al., 2018.) Thus, the Ramazzini study corroborates the [NTP findings](#) as published on the National Institutes of Health website.

[“Tumor promotion by exposure to radiofrequency electromagnetic fields below exposure limits for humans”](#) published in *Biochemical and Biophysical Research Communications* is a replication study that used very, very low RF exposures (lower than the Ramazzini and NTP study) and combined the RF with a known carcinogen. Researchers found elevated lymphoma and significantly higher numbers of tumors in the lungs and livers in animals exposed to both RF and the carcinogen, leading researchers to state that previous research published in the *International Journal of Radiation Biology* (Tillman et al., 2010) was confirmed and that “our results show that electromagnetic fields obviously enhance the growth of tumors” (Lerchl et al., 2015).

## Environment

[“A review of the ecological effects of radiofrequency electromagnetic fields \(RF-EMF\)”](#) published in *Environment International* reviewed 113 studies finding RF-EMF had a significant effect on birds, insects, other vertebrates, other organisms and plants in 70% of the studies (Cucurachi et al., 2013). Development and reproduction in birds and insects were the most strongly affected. As an example of the several studies on wildlife impacts, a study published in the *Bulletin of Environmental Contamination and Toxicology* focused on RF emissions from antennas found increased sperm abnormalities in mice exposed to RF from GSM antennas (Otitoloju et al., 2009).

Published studies, in *Toxicology International* and *Apidologie*, on bees have found behavioral effects (Kumar et al., 2011; Favre 2011), while other studies from the

*International Journal of Environmental Sciences* and the *IIAS-InterSymp Conference* attest to disrupted navigation ([Goldsworthy, 2009](#); [Sainudeen, 2011](#); [Kimmel et al., 2007](#)). Decreasing egg laying rate and reduced colony strength are documented in *Science Direct* and the *Acta Systemica-IIAS International Journal* ([Sharma & Kumar, 2010](#); [Harst et al., 2006](#)).

Research has also found high levels of damage to trees from cell antenna radiation. For example, a field monitoring study, “[Radiofrequency radiation injures trees around mobile phone base stations](#)” published in the *Science of The Total Environment* –spanning 9 years, involving over 100 trees–found trees sustained more damage on the side of the tree facing the antenna ([Waldmann-Selsam et al., 2016](#)).

Expanded 4G, 5G and the Internet of Things (IoT) will increase overall use of all types of wireless frequencies.

A published review, in *Environmental Research*, of effects of Wi-Fi radiation entitled, “[Wi-Fi is an important threat to human health](#)” found that “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 ([Pall, 2018](#)).

“[The Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base station](#)” is a research study that compared people living close (within 80 meters) and far (more than 300 meters away) from cellular antennas found that the people living closer had several significant changes in their blood predictive of cancer development ([Zothansanga et al.,](#)

2017). An earlier 2016 study, [on genetic damage in humans populations exposed to radiation from mobile towers](#) published in *Archives of Environmental Contamination and Toxicology*, evaluated 116 persons exposed to radiation from mobile towers and 106 control subjects, found DNA damage in peripheral blood lymphocytes ([Gulati et al., 2016](#)).

“[Mortality by neoplasia and cellular telephone base stations](#)”, published in *Science of The Total Environment*, is a 10 year study by the Belo Horizonte, Brazil Health Department and several universities in Brazil that found an elevated relative risk of cancer mortality at residential distances of 500 meters or less from cell installations ([Dode et al., 2011](#)). Shortly after this study was published, the city prosecutor sued several cell phone companies and requested that almost half of the city’s antennas be removed. Many antennas were dismantled.

The 2018 study, “[Mobile Phone Base Station Tower Settings Adjacent to School Buildings: Impact on Students’ Cognitive Health](#)” published in the *American Journal of Men’s Health*, investigated male students in schools near cell towers. The researchers concluded that exposure to higher RF levels is associated with negative impacts on motor skills, memory and attention ([Meo et al., 2019](#)). Examples of other effects linked to cell towers in research studies include [neuropsychiatric problems](#), published in *NeuroToxicology*; [elevated diabetes](#), published in the *International Journal of Environmental Research and Public Health*; [headaches](#), published in *Occupational and Environmental Medicine*; [sleep problems and genetic damage](#) published in the French journal *Pathologie Biologie*.

A study published in 2018 *International Conference on Power Energy, Environment and Intelligent Control (PEEIC)* by IEEE entitled, “[Effect of Mobile Tower Radiation on Microbial Diversity in Soil and Antibiotic Resistance](#)” took soil samples from four different base stations located in Dausa city, India and control samples from soil far from stations and then isolated and evaluated the microorganisms in the soil. The researchers found greater antibiotic resistance in microbes present in soil near base stations compared to the control. The study concludes, “our findings suggest that mobile tower radiation can significantly alter the vital systems in microbes and turn them multidrug



resistant (MDR) which is the most important current threat to public health” (Sharma et al., 2018).

## Research on 3G and 4G

3G and 4G technology is still very much in use around the world. In addition, 5G devices will also have 4G emissions and 5G will utilize the frequencies currently used in 2G, 3G and 4G.

Published in *General Physiology and Biophysics*, a 2019 study titled, “[Chromosome damage in human cells induced by UMTS mobile telephony radiation](#)” examined human blood from healthy donors. The study found that 3G ) EMF/microwave radiation emissions from mobile telephones, within the current exposure limits, has significant genotoxic effects on human cells and advises that “human exposure to this EMF/radiation should be kept at levels as low as possible” (Panagopoulos, 2019). A series of landmark studies found that effects from microwaves on human lymphocytes can be dependant on carrier frequency (Markova et al., 2005), that Universal Mobile Telecommunications System (UMTS) 3G microwaves can affect chromatin and inhibit formation of DNA double-strand breaks (Belyaev et al., 2009), and that stem cells are most sensitive to microwave exposure (Markova et al., 2010) published in *Environmental Health Perspectives*, *Bio Electro Magnetism*, and *Environmental Health Perspectives* respectively. Children have more active stem cells.

The fourth generation (4G) of cellular technology called Long Term Evolution (LTE) was launched without premarket safety testing for long term exposure. Published research has found behavioral changes in mice ([Broom et al., 2019](#)), damage to the testes and reproductive potential in mice ([Yu et al., 2019](#)), reduction to EEG alpha power ([Vecsei et al., 2018](#)), modulation to resting state EEG on alpha and beta bands ([Yang et al., 2017](#)), and the ; alteration of spontaneous low frequency fluctuations induced by the acute LTE RF-EMF exposure ([Lv et al., 2014](#)); published in *Bio Electro Magnetism*, *Science of the Total Environment*, *Scientific Reports*, *Clinical EEG and Neuroscience*, and *Clinical Neurophysiology* respectively.

Published in *Bio Electro Magnetism*, a 2018 double-blind, crossover, randomized, and counterbalanced design study about the [modulation of brain functional connectivity by exposure to 4G LTE cell phone radiation](#) found that acute LTE-EMF exposure did modulate connectivity in some brain regions. The authors conclude that, “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” ([Wei et al., 2018](#)).

## The Building Industry

Published in *Building and Environment* the article, “[Building Science and Radiofrequency Radiation: What Makes Smart and Healthy Buildings](#)” with a long list of authors, including former Microsoft Canada President Frank Clegg as well as Anthony Miller MD former Director of the Epidemiology Unit of the National Cancer Institute of Canada, review research studies finding adverse health effects below regulatory limits. The authors recommend reducing radiofrequency radiation in buildings by installing wired

rather than wired internet connections and corded rather than cordless phones (Clegg et al., 2019).

The Collaborative for High Performance Schools (CHPS) has developed “Best Practices for LOW EMF Classrooms” that details how schools can replace wireless networks with wired networks. See [CHPS Low EMF Criteria](#)

## Cell Towers and Health

“[Mobile Phone Infrastructure Regulation in Europe: Scientific Challenges and Human Rights Protection](#)”, a 2014 publication in *Environmental Science & Policy* by human rights experts argue that cell tower placement is a human rights issue for children because “the protection of children is a high threshold norm in Human Right law and the binding language of the Convention on the Rights of the Child obliges States Parties to provide a higher standard of protection for children than adults” and “any widespread or systematic form of environmental pollution that poses a long-term threat to a child’s rights to life, development or health may constitute an international human rights violation.” The article concludes that the “dearth of legislation to regulate the installation of base stations (cell towers) in close proximity to children’s facilities and schools clearly constitutes a human rights concern...” (Roda & Perry, 2014).

“Safety Zone Determination for Wireless Cellular Tower – A Case Study from Tanzania” published in the *International Journal of Research in Engineering and Technology* evaluated the radiation levels and concluded that “respective authorities should ensure that people reside far from the tower by 120m or more depending on the power transmitted to avoid severe health effect” (Nyakyi et al., 2013).

“Long-term Exposure to Microwave Radiation Provokes Cancer Growth: Evidences from Radars and Mobile Communication Systems”, published in *Experimental Oncology* reviews research findings on RF-EMF and states that it is “becoming increasingly evident that [the] assessment of biological effects of non-ionizing radiation based on physical (thermal) approach used in recommendations of current regulatory bodies, including the International Commission on Non-Ionizing Radiation Protection (ICNIRP) Guidelines, requires urgent reevaluation.” The paper concluded that “everyday exposure of both occupational and general public to MW radiation should be regulated based on a precautionary principles which imply maximum restriction of excessive exposure” (Yakymenko et al., 2011).

Published in *Electromagnetic Biology and Medicine*, a cross-sectional case control study on genetic damage in individuals living near cell towers found genetic damage parameters of DNA were significantly elevated. “The genetic damage evident in the participants of this study needs to be addressed against future disease-risk, which in addition to neurodegenerative disorders, may lead to cancer” (Gandhi et al., 2015).

[“Neurobehavioral Effects Among Inhabitants Around Mobile Phone Base Stations”](#) published in *NeuroToxicology*, concludes that, “Inhabitants living nearby mobile phone base stations are at risk for developing neuropsychiatric problems and some changes in the performance of neurobehavioral functions either by facilitation or inhibition” and called for the revision of standard guidelines for public exposure to RER from mobile phone base station antennas” ([Abdel-Rassoul et al., 2006](#)).

[“Epidemiological Evidence for a Health Risk from Mobile Phone Base Stations”](#) published in the *International Journal of Occupational Environmental Health* reviewed ten epidemiological studies that assessed for health effects of mobile phone base stations and found that 8 of the 10 studies reported increased prevalence of adverse neurobehavioral symptoms or cancer in populations living at distances less than 500 meters from base stations. The review concludes that “current guidelines may be inadequate in protecting the health of human populations” ([Khurana et al., 2010](#)).

[“How Does Long Term Exposure To Base Stations And Mobile Phones Affect Human Hormone Profiles?”](#) published in *Clinical Biochemistry* followed volunteers for six years and found that high radio frequency radiation had effects on pituitary–adrenal axis represented in the reduction of ACTH, cortisol, thyroid hormones, prolactin in young females, and testosterone levels ([Eskander et al., 2012](#)).

Published in the French journal, *Pathologie Biologie* a [study of 530 people](#) living near mobile phone masts reported more symptoms of headache, sleep disturbance, discomfort, irritability, depression, memory loss and concentration problems the closer they lived to the cellular antennas ([Santini et al., 2002](#)).

A study, [“The Microwave Syndrome: A Preliminary Study in Spain”](#) published in *Electromagnetic Biology and Medicine* found statistically significant associations between field intensity and the symptoms of fatigue, irritability, headaches, nausea, loss of

appetite, sleeping disorder, depressive tendency, feeling of discomfort, difficulty in concentration, loss of memory, visual disorder, dizziness and cardiovascular problems (Navarro et al., 2003). “Subjective Symptoms, Sleeping Problems, And Cognitive Performance In Subjects Living Near Mobile Phone Base Stations” published in *Occupational and Environmental Medicine* found a significant correlation between measured power density and headaches, fatigue, and difficulty in concentration in 365 subjects (Hutter et al., 2006). Published in *NeuroToxicology*, Abdel-Rassoul et al., 2007 found residents living beneath and opposite a long established mobile phone mast reported significantly higher occurrences of headaches, memory changes, dizziness, tremors, depressive symptoms and sleep disturbance than a control group.

“Increased Incidence of Cancer Near a Cell-Phone Transmitter Station” published in the *International Journal of Cancer Prevention* found a four-fold increase in the incidence of cancer among residents living within a 300 meter radius of a mobile phone mast after three and seven years of exposure (Wolf & Wolf, 2004).

“The Influence of Being Physically Near to a Cell Phone Transmission Mast on the Incidence of Cancer” published in *Umwelt Medizin Gesellschaft*, found a three-fold increase in the incidence of malignant tumours after five years of exposure in people living within a 400 meter radius of a mobile phone mast (Eger et al., 2004).

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Published in the *Electromagnetic Biology and Medicine* journal, “[The Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base station](#)” is a research study that compared people living close (within 80 meters) and far (more than 300 meters away) from cellular antennas and found that the people living closer had several significant changes in their blood predictive of cancer development. The researchers controlled for various demographics, including the use of microwaves and wireless in the homes (Zothansiyama et al., 2017).

“[Mortality by neoplasia and cellular telephone base stations](#)” is a 10 year study by the Belo Horizonte Brazil Health Department and several universities in Brazil that found an elevated relative risk of cancer mortality at residential distances of 500 meters or less from cell installations (Dode 2011). Shortly after this study was published, the city prosecutor sued several cell phone companies and requested that almost half of the city’s antennas be removed. Many antennas were dismantled.

A 2019 [study](#) of students in schools near cell towers found their higher RF exposure was associated with impacts on motor skills, memory and attention (Meo 2019). Examples of other effects linked to cell towers in research studies include [neuropsychiatric problems](#), [elevated diabetes](#), [headaches](#), [sleep problems](#) and [genetic damage](#). Such research continues to accumulate after the 2010 landmark [review study](#) on 56 studies that reported biological effects found at very low intensities, including impacts on reproduction, permeability of the blood-brain barrier, behavior, cellular and metabolic changes, and increases in cancer risk (Lai and Levitt, 2010).

A published study entitled, “[Effect of Mobile Tower Radiation on Microbial Diversity in Soil and Antibiotic Resistance](#)” took soil samples from four different base stations located in Dausa city, and control samples from soil far from stations and then isolated and evaluated the microorganisms in the soil. The researchers found greater antibiotic resistance in microbes present in soil near base stations compared to the control and a



statistical significant difference in pattern of antibiotic resistance was found with Nalidixic acid, and cefixime when used as antimicrobial agents. The study concludes, “our findings suggest that mobile tower radiation can significantly alter the vital systems in microbes and turn them multidrug resistant (MDR) which is most important current threat to public health.”

## **Cellular Antennas Create Measurable Increases in Radiation in the Area**

A [2018 article published](#) in The Lancet Planetary Health points to unprecedented increasing RF exposures ([Bandara and Carpenter 2018](#)). Another key finding from [Zothansiana 2017](#) was that homes closer to antennas had measurably higher radiation levels—adding to the documentation that antennas increase RF levels. An [Australian study also](#) found that children in kindergartens with nearby antenna installations had nearly three-and-a-half times higher RF exposures than children with installations further away (more than 300 meters ([Bhatt 2016](#))).

## **Research Finds that Cell Tower Base Station Radiation is the Dominant Contributor to Overall Environmental Radiation Exposures**

A 2018 multi-country [study that](#) measured RF in several countries found that cell phone tower radiation is the dominant contributor to RF exposure in most outdoor areas exposure in urban areas was higher and that exposure has drastically increased. As an example, the measurements the researchers took in Los Angeles, USA were 70 times higher than the US EPA estimate 40 years ago ([Sagar 2018](#)).

As an example of how rapidly RF is increasing from wireless antennas, a [2014 published study looked](#) at RF in three European cities and found in just one year (between April 2011 and March 2012) that the total RF-EMF exposure levels in all outdoor areas in

combination increased by 57.1% in Basel by 20.1% in Ghent and by 38.2% in Brussels ([Urbinello 2014](#)). “Exposure increase was most consistently observed in outdoor areas due to emissions from mobile phone base stations.”

Another study, [Birks 2018](#), looked at 529 children in Denmark, the Netherlands, Slovenia, Switzerland and Spain who wore meters around the waist or carried in a backpack during the day and placed close to the bed at night. Researchers found “the largest contributors to total personal environmental RF-EMF exposure were downlink (meaning from cell tower base stations) and broadcast.”

A study on Australian adults where participants carried a measuring device in a small hip bag for approximately 24 consecutive hours also found “downlink and broadcast are the main contributors to total RF-EMF personal exposure.” Downlink (RF from mobile phone base station) contributed 40.4% of the total RF-EMF exposure ([Zelege 2018](#)).

Another published study ([Choi 2018](#)) that gave 50 Korean adult child pairs a special radiation measuring device for 48 hours evaluated the types of radiation the participants were exposed to and found that “the contribution of base-station exposure to total RF-EMF exposure was the highest both in parents and children.” These two studies are an important example of the research that shows that radiation from base stations is the dominant contributor to a person’s cumulative exposure. Therefore we cannot only focus on a persons cell phone use as the way people are exposed to this radiation. People are exposed to wireless radiation even when they are not using a mobile device due to cell towers, antennas and hotspots and they have no control over this.

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