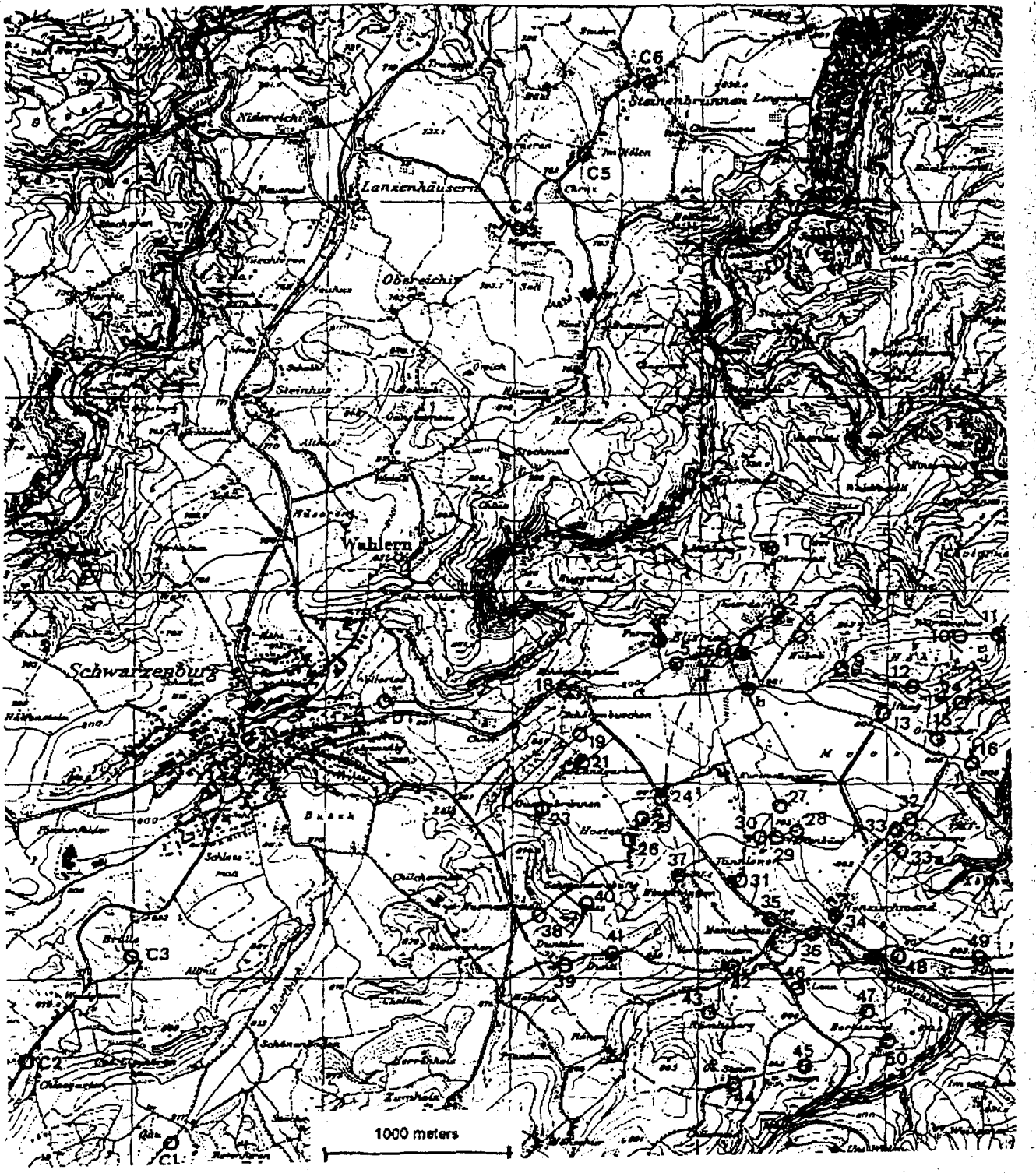

Figure 4.2: Map of outdoor Measurement sites (Study I)
(Reproduced with the permission of the Federal Office of Topography of June 30, 1995)

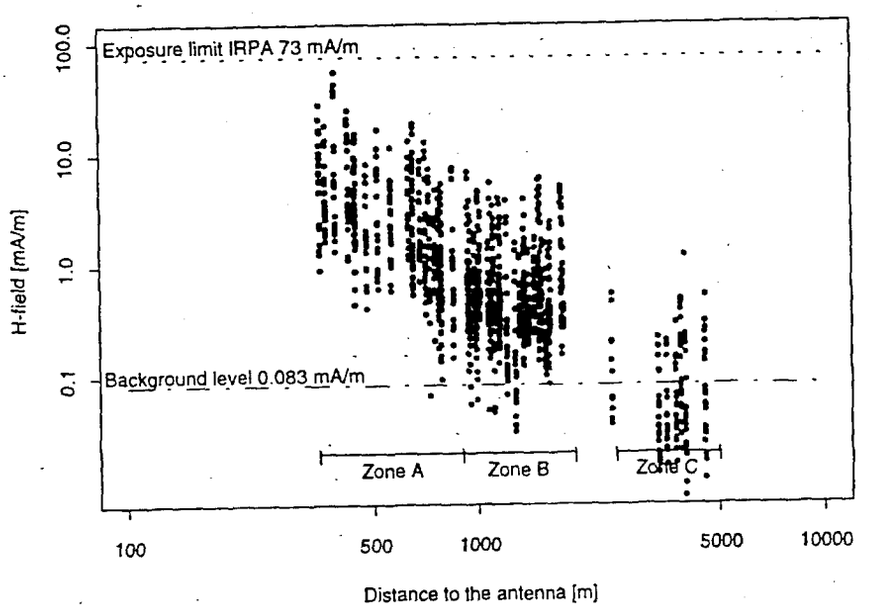

Figure 4.3: *Each dot represents a mean value over an emission period (in general 105 minutes) at a particular location. Indicated is the distance to the transmitter-antenna.*
Only fields from the Schwarzenburg transmitter are included.

Shortwave Transmitter Schwarzenburg: Outdoor Magnetic Field Strength

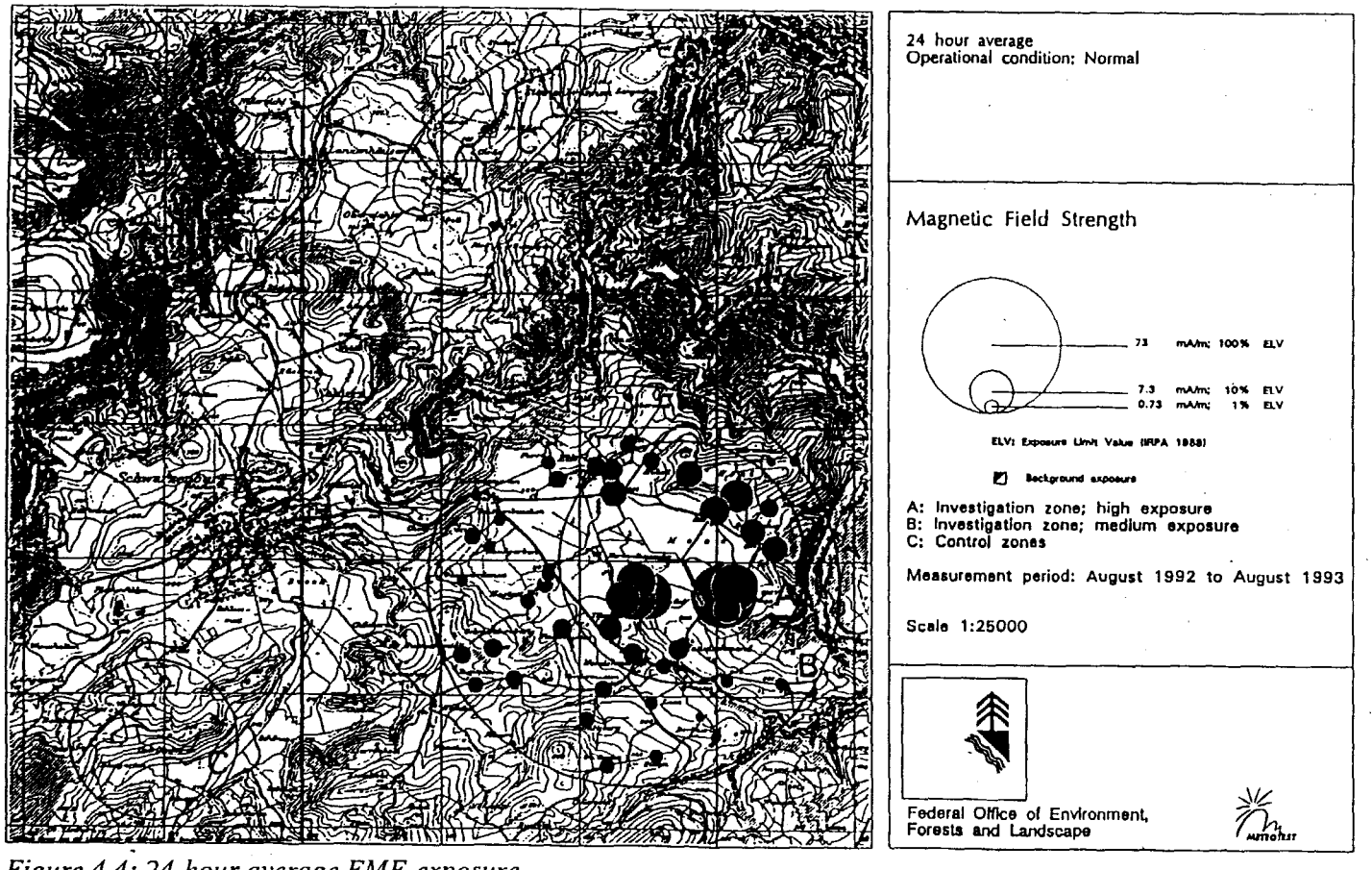

Figure 4.4: 24-hour average EMF-exposure
(Reproduced with the permission of the Federal Office of Topography of June 30, 1995

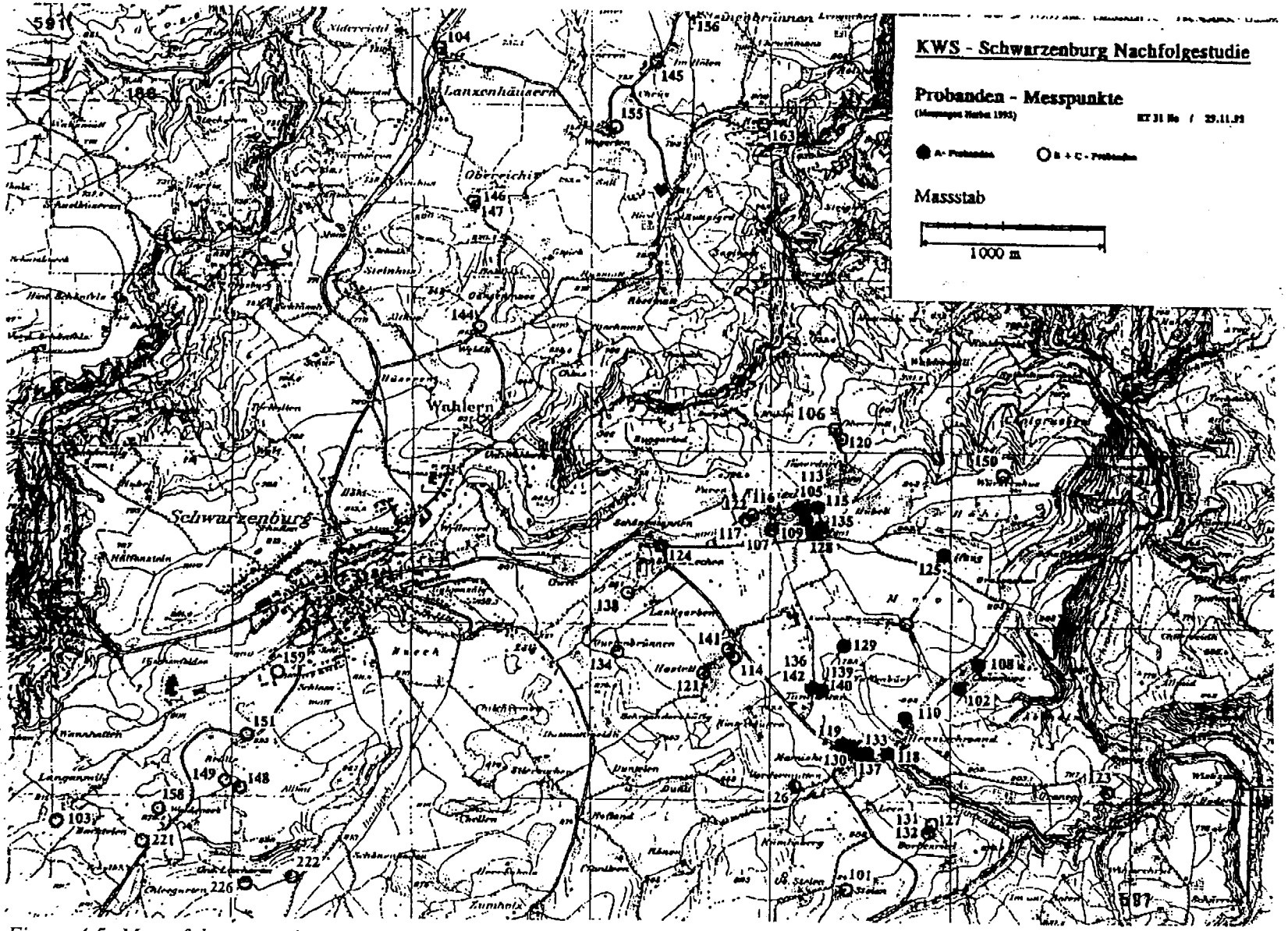

Figure 4.5: Map of the transmitter environment indicating locations of indoor measurements (Study II) (Reproduced with the permision of the Federal Office of Topography of June 30, 1995)

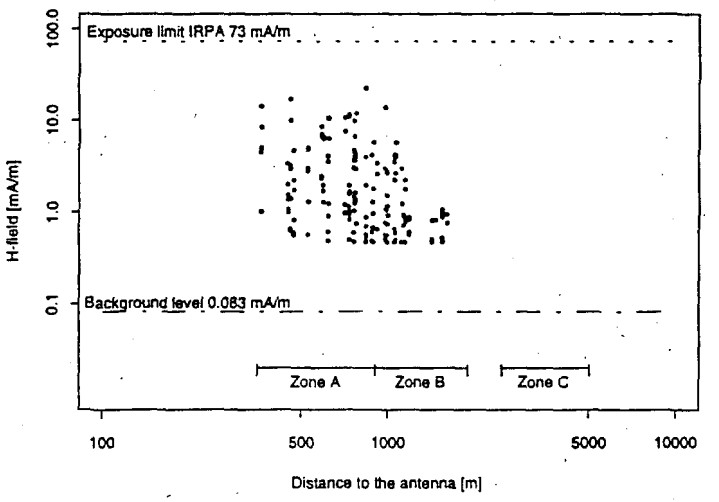

Figure 4.6: *EMF-Exposure inside the bedrooms: Each dot represents a mean value over an emission period (in general 105 minutes), at a particular location. Indicated is the distance to the transmitter-antenna.*
The sensitivity of the sensor EH30KW being limited by physical reasons to 0.5 mA/m, values below that level could not be recorded.

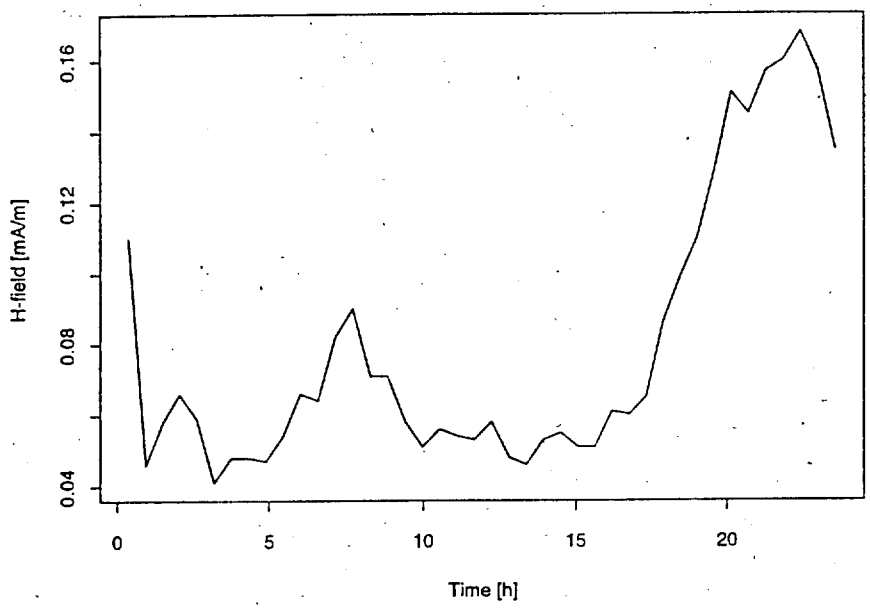

Figure 4.7: *24 hours profile of background exposure, measured on September 8th, 1993*

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Chapter 5

The Schwarzenburg health interview survey: Health complaints and ill health in the surroundings of a shortwave transmitter

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Abstract:

Objective: The purpose of the present study was to answer the question: 'Are ill health and health complaints of the population who live in the neighbourhood of the Transmitter more frequent than in an unexposed rural area?'
Design: Cross-sectional comparative study
Results: The participation was 60%. Four hundred and four persons completed the health interview survey: 233 women and 171 men, aged 14 - 91 years, with maximal daily exposure of 0.3 to 41 mA/m and 24–hour average exposure of 0.3 to 15.5 mA/m.

No increased prevalences of self-reported serious diseases could be established in exposed areas. The low number of participants, however, did not allow to exclude the presence of a potential increased risk although it might be there (Type II error).

Nervosity and restlessness, difficulties in falling asleep, difficulties in maintaining sleep, general weakness and tiredness, limb pain, joint pain, feeling body excitement and constipation were more frequently reported in the exposed areas. Only joint pains and insomnias showed a consistent association with the electromagnetic field of the Transmitter.

There was no evidence, that the health complaints would have been associated with a specific personality characteristics such as health worries. *Conclusion:* Insomnias and joint pains were more frequent in the exposed areas. This required a further investigation.

5.1 Introduction

Since the early Nineteen-Seventies the population living in the vicinity to the Shortwave Radio Transmitter Schwarzenburg, have complained about their ill health and various health disturbances which they related to the Transmitter's electromagnetic field.

On the 2nd of March 1990 a group of inhabitants addressed a petition to the Swiss Federal Government. They asked for a scientific investigation of their health complaints which they believed to be caused by the Transmitter's electromagnetic field.

The Swiss Federal Government initiated and funded the present study, the purpose of which was to reply to the following questions:

1. Are ill health and health complaints of the population who live in the neighbourhood of the Transmitter more frequent than in an unexposed area ?
2. If yes, is there a plausible biological mechanism, which causes them ?
3. If the population in the vicinity to the transmitter were too small to answer certain questions conclusively, are there any suspicions, which would justify further investigation, and which would be the required population sample size?
4. Does the electromagnetic field exposure exceed the IRPA guidelines at any site in the neighbourhood of the Transmitter?

The health interview focused on the first question.

5.2 Methodology

5.2.1 Sampling

The population of the municipality of Wahlern was informed about the health interview survey by an advertisement in the local official information journal (Amtsanzeiger Schwarzenburg, 3rd of April 1992). The addresses of potential study participants were made available by the municipality officials.

The area around the Shortwave Transmitter was divided into 3 Zones (see Chapter 3). Then all families (n=215) in the exposed area (Zone A and

B) received a personal letter. In the control area (Zone C) a simple random sample of 397 families was taken and the selected persons were contacted as well. In the next step we tried to contact all persons who had received a letter on telephone. Non-responders in the exposed area were later contacted again in an attempt to convince them of the need of their participation.

The participants were interviewed face to face. At the end of the interview they were invited to fill in a personality test.

5.2.2 Interview

The interview included questions about age, sex, height, weight, marital status, living, housing conditions, occupation, education. These questions were extracted from the Swiss Health Survey, Oct. 23, 1991, Federal Office of Statistics, health complaints and ill health (these questions were extracted from 'Univox-Gesundheit', [Noack and Junker (1991)]), disturbances of electrical equipment, opinions on environment and environmental protection. At the end of the person-to-person interview, the interviewer added his or here assessment of the families' standard of living.

5.2.3 Personality Test (FPI-R)

The revised version of the Freiburg Personality inventory [Fahrenberg, Hampel and Selg (1989)] is a multidimensional personality test, which is composed by 12 different scales. The participants replied to 138 questions with 'right' or 'wrong'. The following characteristics are tested:

1. Contentedness in live
2. Social orientation- social responsibility.
3. achievement motivation
4. self-consciousness.
5. excitability
6. aggressiveness
7. distress
8. body complaints
9. health worries
10. openness
11. Being extraverted
12. Being emotional, emotional stability

5.2.4 Exposure measurement

(see Chapter 4)

5.2.5 Statistical analysis

The data analysis consisted of descriptive statistics, crosstable calculation, standard linear regression and logistic regression. The FPI-R was evaluated by means of nonparametric tests for group comparison (Kruskal-Wallis rank sum test).

Confounding: A variable was considered a confounder if it was associated with exposure as well as disease status. If it could have been established that a variable was independent of exposure, it was no longer considered as a confounder.

Graphical Modelling:

In order to establish a path model, we performed graphical modelling by MIM 2.3β made available by D. Edwards. A graph consists of nodes and edges. In this model a node corresponds to a variable. If two variables are related, they are combined by an edge. Graphical modelling allows to estimate undirected graphs. The direction can be added by reasoning.

In this context sum definitions are required.

Definition 1 *Two events A and B are* ***independent*** *if and only if the probability that A and B occur $P(A \cap B)$ is equal to the product of probabilities $P(A) \cdot P(B)$.*

Definition 2 *Three events A, B and C are* ***mutually independent*** *if and only if each pair of events is independent.*

Definition 3 *The events A and B are* ***conditionally independent*** *given the event C if and only if the probability that A and B occur given C, noted $P(A \cap B|C)$ is equal to the product of the conditional probabilities that A and B occur given C, noted $P(A \cap B|C) = P(A|C) \cdot P(B|C)$.*

The graph of the three events (variables) which are mutually independent consists of the nodes which are not connected by edges. The graph of three events (variables), which are conditionally independent is either represented by

$$A \longleftrightarrow C \longleftrightarrow B$$

or

$$A \qquad C \qquad B.$$

The calculated model was estimated by coherent forward selection starting with the model of mutual independence. An edge was added to the model

if the difference in the $-\log$ likelihood and the corresponding degrees of freedom between the model without the edge and the model including the edge exceeded α 0.05 (operational definition of independence). In the case of sparse data, adjustments described in the Manual of MIM 2.2 were done. The final model was checked by means of the option of exact tests on edge-deletion and edge-additing.

Graphical models calculated by MIM are undirected independence graphs. The direction is added by common sense, e.g. if there is an association between 'exposure' and a 'symptom', the arrow shows from the variable 'exposure' to the 'symptom', since the 'symptom' merely influences 'exposure'.

5.3 Results

The participation rates are summarized in Table 5.1. Persons in Zone A were more motivated to participate than those in other Zones which resulted in higher participation rates.

Zone	Participation	Number of questionnaires analyzed
A	109 (73.7%)	107 (98.2%)
B	120 (55.0%)	119 (99.2%)
C	179 (56.3%)	178 (99.4%)
Total	408	404

Table 5.1: *Response rates*

5.3.1 Exposure

The results of the exposure measurements are presented in more detail in Chapter 4. The maximum daily exposure varied from 14 to 41 mA/m in Zone A (median: 28 mA/m, mean: 30 mA/m), from 3 to 37 mA/m in Zone B (median 20.8 mA/m, mean: 23 mA/m), from 1 to 2 mA/m in Zone C (median 1 mA/m, mean: 1.4mA/m). The 24-hour average exposure ranged from 0.9 to 15.5 mA/m in Zone A (median: 1.6 mA/m, mean: 2.5 mA/m), from 0.3 to 1.4 mA/m in Zone B (median: 0.8 mA/m, mean: 0.8 mA/m) and from 0.11 to 0.14 mA/m in Zone C (median: 0.1 mA/m, mean: 0.1 mA/m).

The measurements confirmed the validity of our exposure classification. We applied the $\log_{10}$ transformed values of the magnetic field component for logistic regression models.

5.3.2 Possible confounders

There are no significant differences between Zones according to age, sex, nutritional status (measured by means of the body mass index), marital

status and education (see Table 5.3, 5.2, 5.4, 5.5, 5.6).

Zone	women	men	Total
A	65 (62%)	40 (38%)	105
B	62 (52%)	57 (48%)	119
C	106 (59%)	74 (41%)	180

Table 5.2: *Sex distribution by Zones*

Zone	Min.	Median	Max.
A	14	44	91
B	15	44	81
C	14	46	84

Table 5.3: *Descriptive statistics of age by Zones*

Zone	Min.	Median	Max.
A	15.43	24.8	34.72
B	16.71	25.2	42.97
C	16.98	24.0	36.30
ALL	15.43	25.0	42.97

Table 5.4: *Body Mass Index*

Profession groups and form of employment vary slightly but significantly between the three Zones (see Table 5.7, 5.8). Thirty-seven per cent of the interviewed persons of Zone B worked in agriculture compared to 21% in Zone A , respectively 24% in Zone C (χ^2, $p = 0.02$). Sixty per cent in Zone B are self-employed compared to 38% in Zone A, respectively 44% in Zone C (χ^2, $p = 0.03$). This indicates a slightly different socioeconomic structure between Zone B and Zone A and C. Zone A and C, however, are very similar.

One part of the interview asked questions about the knowledge of and the opinions on the influence of environmental pollution on health, especially about the influence of the Transmitter. There were no significant differences between the answers in the three Zones to the question concerning the influence of environmental pollution on health. Thirty-five per cent of the interviewed persons answered that the influence is considerable. The answers to the question: "Do you believe, that health of someone who live 1.5 km or less from the Shortwave Transmitter might be impaired by the Transmitter ?" varied significantly and in a substantial amount between the Zones (χ^2, $p < 0.001$). Ninety-five per cent in Zone C denied the Transmitter's influence whereas 12% and 16% in Zone A respectively Zone B either thought that there might be an influence or they expressed that they were even sure that there was some (see Table 5.9).

Zone	Single	Married	Divorced	Widowed	Total
A	20 (19.0%)	69 (66.3%)	2 (1.9%)	13 (12.5%)	104
B	15 (12.6%)	96 (80.7%)	1 (0.8%)	7 (5.9%)	119
C	25 (13.9%)	134 (74.4%)	2 (1.1%)	19 (10.5%)	180
Total	60 (14.8%)	281 (69.7%)	5 (1.2%)	39 (9.6%)	403

Table 5.5: *Marital status by Zones*

Zone	Compulsory school	Apprenticeship	Further training	Total
A	41 (39%)	46 (44%)	18 (17%)	105
B	36 (30%)	65 (55%)	18 (15%)	119
C	51 (28%)	100 (56%)	28 (16%)	179
Total	128 (32%)	211 (52%)	64 (16%)	403

Table 5.6: *Education by Zones*

Zone	Agriculture	Industry and trade	Service	Total
A	22 (21%)	15 (14%)	68 (65%)	105
B	44 (37%)	20 (17%)	55 (46%)	119
C	43 (24%)	23 (13%)	114 (63%)	180
Total	109	58	237	404

Table 5.7: *Profession groups by Zones*

Zone	Employees	Self-employed	Total
A	55 (62%)	34 (38%)	89
B	46 (43%)	60 (57%)	106
C	63 (56%)	49 (44%)	112
Total	164	143	307

Table 5.8: *Form of employment by Zones*

Zone	Yes	No	Total
A	13 (12%)	92 (88%)	105
B	19 (16%)	100 (64%)	119
C	9 (5%)	171 (95%)	180
Total	41	363	404

Table 5.9: *"Do you believe, that the Transmitter causes illness in someone who lives in a distance of up to 1.5 km from the Transmitter?" by Zones*

In this context it is worthwhile to note that 41.9% and 34.4 % in Zone A respectively Zone B spent their leisure not at home. Ninety four point four per cent in Zone C spent their spare time at home. It might be concluded that people living in Zone A and B try to flee the Transmitter's influence (see Table 5.10).

	Spare time spent		
Zone	at home	out of home	Total
A	61 (58.1%)	44 (41.9%)	105
B	78 (65.6%)	41 (34.4%)	119
C	170 (94.4%)	10 (5.6%)	180
Total	309 (100%)	95 (100%)	404

Table 5.10: *Spare time behaviour*

5.3.3 Health, Ill health and Health complaints

Seeing a doctor:

People living in Zone A see their physician more frequently than those in Zone B and C. The differences, however, did not marginally reach the level of significance (χ^2, $p = 0.09$, see Table 5.11).

Seeing physician	Zone A	Zone B	Zone C
Yes	45 (43.7%)	36 (30.5%)	59 (33.0%)
No	58 (56.3%)	82 (69.5%)	120 (67.0%)
Total	103(100%)	118 (100%)	179 (100%)

Table 5.11: *Current frequency of seeing a physician by Zones A, B, and C*

Cardiovascular Diseases:

Asked about their blood pressure levels, only 55% and 56% in Zone A respectively Zone B answered that they had normal levels, whereas in Zone C 74% said that they had a normal blood pressure. Since these differences reached the level of statistical significance (χ^2, $p = 0.01$, see Table 5.12), we tried to verify this result by measuring blood pressure (see Chapter 9). In addition arterial hypertension was reported more frequently in Zone A (14%), than in Zone B (8.4%) or Zone C (7.9%). There was, however, no evidence that cardiovascular disease without hypertension would have been more frequent in the exposed areas than in unexposed ones (Zone A: 6.6%, Zone B: 5.9%, Zone C: 6.7%).

Blood pressure	Zone A	Zone B	Zone C
normal	58 (55.3%)	67 (56.3%)	133 (73.9%)
too low	17 (16.2%)	22 (18.5%)	14 (7.8%)
too high	18 (17.1%)	18 (15.1%)	22 (12.2%)
Do not know	12 (11.4%)	12 (10.1%)	11 (6.1%)
Total	105 (100%)	119 (100%)	180 (100%)

Table 5.12: *Self-reported blood pressure by Zones*

Other Chronic Diseases:

Apart from cardiovascular disease, only diseases of the sceletomuscular system were frequent enough to perform statistical inference. Eleven per cent in Zone A, 8% in Zone B and 11 % in Zone C reported diagnosis of this kind established by a physician. All other diseases were too rare to perform statistical inference (see Table 5.13).

Chronic disease	Zone A	Zone B	Zone C
Diabetus mellitus, adult form	5	5	5
Diabetus mellitus, juvenile form	1	1	0
Glaucoma	1	1	2
Cataract	1	6	5
Breast cancer (women)	1	1	1
Uterus cancer	1	1	1
Cancer of testis	2	0	0
Cancer of the bladder	0	0	1
Affektive Psychosis	4	5	2
Other non-organic Psychosis	2	1	1
Nervosity	1	0	0
Senile and presenile organic Psychosis	0	1	0

Table 5.13: *Chronic diseases by Zones*

Health Complaints and Ill Health:

Nervosity, restlessness, difficulties in falling asleep, difficulties in maintaining sleep, general weakness and tiredness, limb pain, joint pain, feeling body excitement and constipation were more frequently reported in the exposed area. They might be summarized under the term psychovegetative disorders and be the expression of a higher prevalence of depression in the exposed area (see Table 5.14). In order to obtain Table 5.14, we dichotomized the answers to the question 'Do you suffer never (scored 1), rarely (scored 2), sometimes (scored 3), often (scored 4), always (scored 5) from ...?' at the score > 3. A similar question about intensity was finally neglected, since it

provided no additional information. The sum of the 26 dichotomized items defined the Psychovegetative Index, a discrete variable with 0 to 26 levels, which itself is a global measure of health complaints. The Psychovegetative Index itself was dichotomized at the 5% quantile of Zone C which was equal to 4. In order to increase the specificity of this index, we truncated the latter at a score of > 4. Therefore, 3.4% in Zone C showed an increased Psychovegetative Index.

Symptoms	Zone A (%)	Zone B (%)	Zone C (%)	p-value
Nervosity, restlessness	25.0	18.0	7.0	<0.001
Diff. in falling asleep	22.9	17.6	6.7	<0.001
Diff. in maintaining sleep	32.4	18.5	8.9	<0.001
General weakness and tiredness	22.0	13.0	6.0	<0.001
Limb pain	14.3	6.7	3.3	0.003
Joint pain	22.9	10.1	10.0	0.004
Psychovegetative Index	12.5	5.2	3.4	0.010
Feeling body excitement	7.6	5.9	1.1	0.018
Constipation	7.6	6.7	1.7	0.034
Disturbed concentration	7.6	2.5	2.8	0.083
Irregular heartbeat	0.0	0.0	1.7	0.151
Stomac complaints	9.5	5.9	3.9	0.152
Neck- and shoulder pain	17.1	15.1	10.0	0.182
Palpitation at small effort	7.6	4.2	3.3	0.247
Rapid Heatbeat	1.9	0.0	2.2	0.272
Cough and sputum	7.6	5.9	3.4	0.273
Short breath at small effort	6.7	2.5	4.4	0.324
Headache	14.3	16.2	10.7	0.362
Vertigo	9.0	6.7	4.4	0.363
Low back pain	19.0	17.6	13.9	0.472
Sudden fits of perspiration	8.6	6.7	5.0	0.490
Back pain	7.6	10.1	6.7	0.566
Strong heartbeat	3.8	1.7	2.2	0.570
undefined gastrointestinal complaints	2.9	2.5	4.4	0.622
Diarrhora	1.9	1.7	1.1	0.848
Strong and rapid heartbeat	6.7	6.7	5.6	0.899
Fever	0.0	0.0	0.0	n.a.

Table 5.14: *Complaints by Zones*

Since age is known to be one of the major confounders in epidemiology, we decided to perform an age stratified analysis, although there were no significant age differences between the zones. As the total number of 404 participants is rather small, we had to dichotomize age at the level of 45 years which is the median age of the total population. According to this analysis, the same symptoms occurred mainly among the elderly. The $p - values$ in Table 5.15 and 5.16 are calculated by means of a χ^2 within each stratum. This led to expected values within some cells which were less than 5. The conclusions from this analysis are therefore rather limited.

In order to account for the other confounders such as sex, attribution, duration of time lived at the same place and to estimate whether there might be a dose-response relationship, we performed logistic regressions. This was done on all 26 variables excluding fever. Only the results of the models with a significant dose-response relation between the symptom and exposure are presented. As expected from the latter analysis, nervosity and inner restlessness, difficulties in falling asleep, difficulties in maintaining sleep as well as joint and limb pains showed a significant relationship between exposure and symptom. To our astonishment frequent coughing and sputum were also associated with the exposure to electromagnetic fields (see Table

Symptom	Zone A (%)	Zone B (%)	Zone C (%)	P-value
Nervosity, restlessness (<45)	12/55(21.8)	15/61 (24.6)	8/85 (9.4)	0.034
... (>46)	14/50(28.0)	7/58 (12.1)	4/94 (4.3)	<0.001
Disturbances in maintaining sleep (<45)	7/55 (12.7)	4/61 (6.6)	4/86 (4.7)	0.194
... (>46)	27/50 (54.0)	18/58 (31.0)	12/94 (12.8)	<0.001
Limb pain (<45)	1/55 (1.8)	3/61 (4.9)	1/86 (1.2)	0.329
... (>46)	14/50 (28.0)	5/58 (8.5)	5/94 (5.3)	<0.001
Disturbances in falling asleep (<45)	8/55 (14.5)	6/61 (9.8)	3/86 (3.5)	0.062
... (>46)	16/50 (32.0)	15/58 (25.9)	9/94 (9.6)	0.002
Joint pain (<45)	5/55 (9.1)	2/61 (3.3)	4/86 (6.7)	0.353
... (>46)	19/50 (38.0)	10/58 (17.2)	14/94 (14.9)	0.003
Psychovegetative index (<45)	1/54 (1.9)	1/60 (1.7)	1/84 (1.2)	0.947
... (>46)	12/50 (24.0)	5/55 (9.1)	5/90 (5.6)	0.004
Disturbances of concentration (<45)	1/55 (1.8)	2/61 (3.3)	2/86 (2.3)	0.874
... (>46)	7/50 (14.0)	1/57 (1.8)	3/94 (3.2)	0.009
General weakness, tiredness (<45)	10/54 (18.5)	9/61 (14.8)	3/86 (3.5)	0.011
... (>46)	13/50 (26.0)	7/58 (12.1)	8/94 (8.5)	0.014
Constipation (<45)	2/55 (3.6)	5/61 (8.2)	2/86 (2.3)	0.222
...(>46)	6/50 (12.0)	3/58 (5.2)	1/94 (1.1)	0.016
Diarrhora (<45)	1/55 (1.8)	1/61 (1.6)	2/86 (2.3)	0.952
... (>46)	6/50 (12.0)	3/58 (5.2)	1/94 (1.1)	0.016
Stomach trouble (<45)	3/55 (5.5)	2/61 (3.3)	4/86 (4.7)	0.845
... (>46)	7/50 (14.0)	5/58 (8.6)	3/94 (3.2)	0.057
Lower back pain (<45)	5/55 (9.1)	9/61 (14.8)	11/86 (12.8)	0.644
... (>46)	15/50 (30.0)	12/58 (20.7)	14/94 (14.9)	0.100

Table 5.15: *Complaints by Zone and age-groups*

Symptom	Zone A (%)	Zone B (%)	Zone C (%)	P-value
Feelings of excitement on body(<45)	3/55 (5.5)	3/61 (4.9)	0.85 (0.0)	0.034
... (>46)	5/50 (10.0)	4/58 (6.9)	2/94 (2.1)	0.102
Irregular heartbeat (<45)	2/22 (3.7)	0/61 (0.0)	0/86 (0.0)	0.067
... (>46)	0/50 (0.0)	0/58 (0.0)	3/93 (3.2)	0.170
Vertigo (<45)	2/55 (3.6)	4/61 (6.6)	3/86 (3.5)	0.635
... (>46)	7/50 (14.0)	4/58 (6.9)	5/94 (5.3)	0.175
Cough and sputum(<45)	2/55 (3.6)	4/61 (6.6)	2/85 (2.4)	0.435
... (>46)	6/50 (12.0)	3/58 (5.2)	4/94 (4.3)	0.177
Pounding heart at slight effort(<45)	1/55 (1.8)	2/61 (3.3)	0/86 (0.0)	0.261
... (>46)	7/50 (14.0)	3/57 (5.3)	6/94 (6.4)	0.185
Difficulty in breathing at slight effort (<45)	6/50 (12.0)	2/58 (3.5)	7/94(7.5)	0.239
... (>46)	1/55 (1.8)	1/61 (1.6)	1/86 (1.2)	0.945
Neck and shoulder pain (<45)	5/55 (9.1)	7/61 (11.5)	4/86 (4.7)	0.298
... (>46)	13/50 (26.0)	11/58 (19.0)	14/94 (14.9)	0.267
Sudden sweating (<45)	2/55 (3.6)	2/61 (3.3)	2/86 (2.3)	0.891
... (>46)	7/50 (14.0)	6/58 (10.3)	7/94 (7.4)	0.452
Back pain (<45)	4/55 (7.3)	7/61 (11.5)	8/86 (9.3)	0.740
... (>46)	4/50 (8.0)	5/58 (8.6)	4/93 (4.3)	0.506
Fast heart beat (<45)	1/55 (1.8)	0/61 (0.0)	2/86 /2.3)	0.502
... (>46)	1/50 (2.0)	0/58 (0.0)	2/93 (2.2)	0.537
unspecific gastroint. dist. (<45)	2/55 (3.6)	3/61 (4.9)	6/86 (7.0)	0.679
... (>46)	1/50 (2.0)	0/58 (0.0)	2/94 (2.1)	0.541
Headache (<45)	7/55 (12.7)	13/60 (21.7)	8/86 (9.3)	0.100
... (>46)	8/50 (16.0)	6/57 (10.5)	11/92 (12.0)	0.676
Palpitation and fast Heart beat (<45)	2/55 (3.7)	1/61 (1.7)	2/86 (2.3)	0.782
... (>46)	5/50 (10.0)	7/58 (12.1)	8/93 (8.6)	0.787
Palpitations (<45)	2/22 (3.7)	0/61 (0.0)	0(86 (0.0)	0.067
... (>46)	2/50 (4.0)	2/58 (3.4)	4/93 (4.3)	0.967
Fever (<45)	0/55 (0.0)	0/61(0.0)	0/86 (0.0)	n.a.
... (>46)	0/50 (0.0)	0/57 (0.0)	0/94 (0.0)	n.a.

Table 5.16: *Complaints by Zone and age-groups*

5.17).

Symptoms	OR	95% Confidence Intervals
Nervosity	2.77	1.62; 4.74
Diff. in falling asleep	3.35	1.86; 6.03
Diff. in maintaining sleep	3.19	1.84; 5.52
Joint pain	2.46	1.37; 4.43
Limb pain	2.51	1.15; 5.50
Cough and sputum	2.80	1.18; 6.64

Table 5.17: *Odd's ratios for an increase in 24-hour average exposure from 1 to 10 mA/m adjusted for age, sex, attribution and duration of time lived at the same place*

In order to understand the meaning of the odd's ratios calculated in Table 5.17, we here present its calculation. Let us consider two populations, aged 45, all men, all with the same opinion on environment and its influence on health, having lived the same time at their home, one exposed by x mA/m and one unexposed with x_0 mA/m: the odd's ratio for a symptom, e.g. difficulties in maintaining sleep, is calculated by

$$OR = e^{\beta \cdot (\log_{10} x - \log_{10} x_0)}.$$

Example 4 *The slope parameter β for the dose-response between difficulties in maintaining sleep and exposure is* 1.16 *with* $se = 0.30$. *Consider a baseline exposure of* $x_0 = 0.076$ *mA/m (this is the exposure in Zone C), then the OR can be expressed as a function of the exposure x by*

$$OR = e^{1.16 \cdot (\log_{10} x - \log_{10} 0.076)}.$$

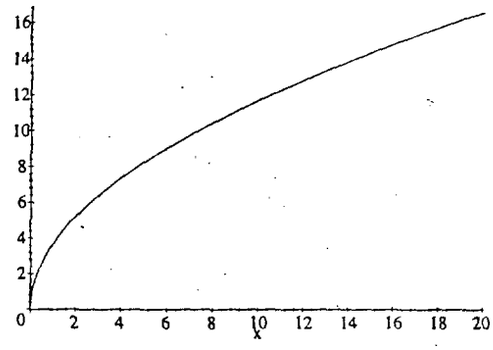


Figure 5.1: x corresponds to exposure in mA/m. y corresponds to the OR. For convenience, we fixed x_0 at 1 *mA/m and calculated the odd's ratio for a exposed population of* 10 *mA/m. The 95% confidence limits are obtained by*

$$OR = e^{(\beta \pm 1.96 \cdot se)},$$

since $\log_{10} 10 - \log_{10} 1 = 1$.

In order to estimate the sensitivity of our models we repeated the same logistic regressions with the exclusion of Zone C. Nervosity and inner restlessness, difficulties in falling asleep and limb pain lost their association with the magnetic field component, either due to a reduction of the regression estimate β or due to an increase of its standard error se. Difficulties in maintaining sleep, joint pain as well as cough and sputum remained associated in a rather stable fashion (see Table 5.18).

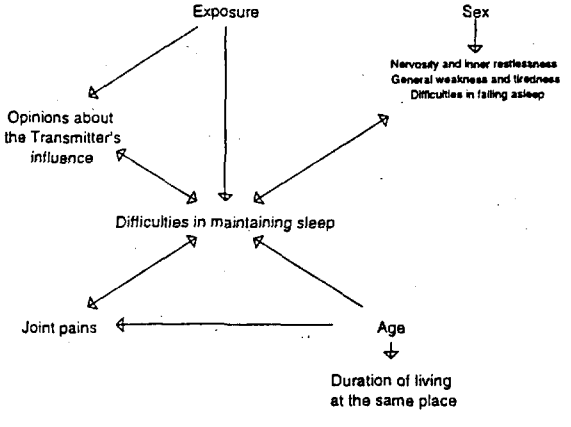
Symptoms	OR	95% Confidence Intervals
Nervosity	1.67	0.61 ; 4.52
Diff. in falling asleep	2.03	0.69 ; 5.98
Diff. in maintaining sleep	3.19	1.04 ; 9.75
Joint pain	6.62	1.85 ;23.60
Limb pain	2.08	0.52 ; 8.34
Cough and sputum	5.70	1.08 ;30.14

Table 5.18: *Odd's ratios for an increase in 24h-average exposure from 1 to 10 mA/m adjusted for age, sex, attribution and time of living at the same place after exclusion of Zone C*

Whereas age and sex were of importance in accordance with the symptom, none of the other confounders reached the level of significance in the logistic regression models.

Graphical Model:

In the following graphical model variables which are connected represent a statistically significant dependence at the level of 5%.



The variables 'Nervosity and inner restlessness', 'General weakness and tiredness' and 'Difficulties in falling asleep' are strongly related and therefore collapsed to one variable, which could be called "chronic fatigue syndrome". This syndrome is associated with sex and difficulties in maintaining sleep. It seems evident that chronic insomnia provokes such a syndrome. Chronic difficulties in maintaining sleep are related to joint pains, age, opinions on the Transmitter's influence as well as the H-field exposure. The relationship between age and insomnia is known as well as the relationship to chronic joint pains. What is, however, astonishing is that 'difficulties in maintaining sleep' remain associated with the electromagnetic field component even after taking into consideration all the other parameters, especially the opinions on the transmitters influence. This is, however, not a proof that insomnia is caused by electromagnetic fields, since the purpose of graphical modelling is to detect structures in data sets and not to prove relationships.

5.3.4 Personality test (FPI-R)

Out of 404 distributed questionnaires, 205 (50%) were sent back. Out of these, 14 could not be further evaluated, for the following reasons:

1. .Two questionnaires were filled in by persons who did not live inside any of the Zones.
2. Eight questionnaires could not be related to a persons after the questionnaire having had been sent back.
3. In 4 questionnaires more than 7 questions were not answered (5% of the items).

The percentage of analyzed questionnaires decreases by Zones (see Table 5.19). There were no significant differences between Zones with regard to age, sex and education in this sample. Therefore, the results could be compared between Zones.

Zone	N-Study	N FPI-R	%
A	105	62	59.0
B	119	63	52.9
C	180	66	36.7
Total	404	191	47.3

Table 5.19: *Answer quotas FPI-R*

The purpose of the personality testing was to find out whether the different frequencies of health complaints between the three Zones might be associated with a specific personality characteristics. We were especially interested in finding out whether hypochondriacal persons were more frequent in Zones A and B. This was tested by means of the item 'health worries'.

There were only two scales which showed a difference between Zones: 'Body complaints' and 'Being emotional' (Kruskal-Wallis rank sum test). The persons under survey in Zone A had a higher scale median for both of these items than the participants of Zones B and C. The median scale for health worries was lower in Zone A than in Zone B and C, but this difference did not reach the level of statistical significance (see Table 5.20).

FPI-R-Scales	Zone A	Zone B	Zone C	$p - value$
Satisfaction with life	9	9	9	ns.
Social orientation	9	9	10	ns.
Performance orientation	9	9	9.5	ns.
Having inhibitions	9	9	9.5	ns.
Being oversensitive	8	7	7	ns.
Aggresiveness	5	6	5	ns.
Ability to take stress	9	9	9	ns.
Body complaints	6	5	5	<0.05
Health worries	8	10	10	ns.
Openness	8	9	9	ns.
Being extrovert	10	10	10	ns.
Being emotional	9	8	8	<0.05

Table 5.20: *Freiburg Personality test by Zones. Kruskal-Wallis, p-values*

5.4 Discussion and Conclusion

The purpose of the present study was to answer the question:

> Are ill health and health complaints of the population who live in the neighbourhood of the Transmitter more frequent than in an unexposed control population?

Serious diseases and ill health such as cancer, cardiovascular disease without hypertension, diabetes mellitus, glaucoma, cataract, psychiatric disorders were not found to be more frequent in the unexposed control population in Zone C. Due to the sample size of n=404, however, the conclusion remained limited, since it could not be excluded with certainty that a real risk which could be related to the Transmitter's electromagnetic field was present (Type II error).

There was some evidence that hypertension might be more frequent in the exposed population than in the unexposed one. This suspicion, however, could not be confirmed in a further study (see Chapter 9).

There is a consistent evidence, that insomnia and joint paints were more frequent in the exposed population than in the controls. No other health

complaints showed such a stable association. Either their association lost its significance if Zone C was excluded (e.g. nervosity, limb pain etc.), or they did not show significantly different proportions between Zones (e.g. cough and sputum). Insomnias and joint pains showed a dose-response relationship even after correction for age, sex, attribution to the potential hazard of the Transmitter and period of time lived at the same home. Graphical modelling suggests that a corner stone between psychovegetative disorders and the Transmitter's field are insomnias, especially difficulties in maintaining sleep.

The personality test revealed that persons in Zone A who sent back the test had a higher median score of 'body complaints' and 'being emotional' than participants living in Zones B and C. The median score of 'health worries' showed no significant difference between the three Zones. Therefore, the higher frequency of health complaints in Zone A could not be explained by an increased frequency of persons who especially worried about their health. The conclusions of the personality testing were, unfortunately, based only on a participation proportion of 50% of the health survey population.

Conclusion:

Insomnias and joint paints, especially in the elderly, were more frequently reported in Zone A than in Zones B and C. They showed a dose-response relationship in the logistic regression and they were not related to a health-worrying personality. Further studies are of need to establish a biophysical mechanism.

Chapter 6

Sleep disorders in the surroundings of the Shortwave Transmitter Schwarzenburg

6.1 Introduction

The health interview survey in 1992 suggested an association between sleep disorders and the Transmitter's electromagnetic field. In this Chapter a more sophisticated analysis of this symptom is presented.

Sleeping disorders are quite common. Between 9 and 31% of the adult population complain frequently and chronically about quality and amount of their sleep [Schwartz et al. (1987), Nino Murcia (1992), Borbély (1984)]. From 3 to 11% of adults use sedative-hypnotic drugs and the percentage increases with age [Schwartz et al. (1987), Rosekind (1990), Borbély (1984)].

In medicine we distinguish:

1. Insomnia: disorders of initiating and maintaining sleep.

2. Hypersomnia: disorders of excessive somnolence.

3. Disorders of the sleep-wake schedule

4. Parasomnia: a number of undesirable behavioral and psychologic events that occur in association with sleep or specific sleep stages, e.g. sleep-walking, sleep terror, dream anxiety attacks.

Our interest was in insomnias and disorders of the sleep-wake schedule.