Health Effects of Microwave Radio Exposures

Paul Dart MD FCA

The current FCC Limits for Microwave RF Exposure were published in 1999.

These guidelines are only designed to protect the public against the thermal effects of microwave RF.

The FCC has explicitly stated that they do not make any regulations or assurances whatsoever regarding the "nonthermal" biological effects of lower level microwave RF exposures (other physiologic effect besides heat damage).

Many statements from industry spokesmen state that "not enough is known" about these exposures to identify risk, or that there is "insufficient" or "incomplete" evidence regarding such risks, or that there is "no scientific consensus" on this risk.

This implies that there isn't much scientific information on this subject. But actually, there is a great deal of research documenting adverse biological effects from low level RF exposures.

Acute Symptoms from RF Exposure:

"EHS"

In this presentation, we're going to take a look at the current scientific evidence for adverse biological effects of RF exposures.

First, we'll look at the evidence that RF exposures can produce **acute symptoms** in many individuals, a problem called **Electrohypersensitivity Syndrome or "EHS"**.

Then we'll look at the evidence that RF exposures **alter hormone physiology** and **increase oxidative stress** in living systems.

Then we'll review the evidence that such alterations in physiology can **damage DNA**, increase the incidence of some forms of **cancer**, and decrease **fertility** in animals and in human beings.

U.S. Embassy, Moscow (1953-1978)

Acute symptoms provoked by microwave radiation were first described by Russian medical researchers in the 1950's. They described a constellation of symptoms including headache, ocular dysfunction, fatigue, dizziness, sleep disorders, dermatographism, cardiovascular abnormalities, depression, irritability, and memory impairment.

In the years **between 1953 and 1978** the Russian government harrassed the U.S. Embassy in Moscow by targeting it with radiation from a microwave transmitter positioned on the roof of a nearby building.

Exposed embassy staff experienced a statistically significant excess of several problems, including: depression, irritability, difficulty in concentrating, memory loss, ear problems, skin problems, vascular problems, and other health problems. Symptom incidence increased significantly with accrued years of exposure.

Exposure levels inside the building were in the order of **2 to 28 μW/cm² (FCC Guidelines: 600 μW/cm²)**

U.S. Embassy, Moscow (1953-1978)

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO.	2.	3. Recipient's Accession No. PB288163
4. Title and Subtitle: Evaluation of Health Status of Foreign Service and other Employees from Selected Eastern European Posts			5. Report Date: July 31, 1978 6.
7. Author(s): Abraham M. Lilienfeld, M.D. Principal Investigator			8. Performing Organization Rept. No.
9. Performing Organization Name and Address: Department of Epidemiology School of Hygiene and Public Health The Johns Hopkins University			10. Project/Task/Work Unit No. 11. Contract(C) or Grant(G) No. (C) 6025 619073 (G)
12. Sponsoring Organization Name and Address: Medical Director Office of Medical Services Department of State Washington, D C			13. Type of Report & Period Covered: Final 1953 - 1976 14.

15. Supplementary Notes: Released publicly November 20 simultaneously by Department of State and The Johns Hopkins University.

16. Abstract (Limit: 200 words)

This is a biostatistical study of 1827 Department of State employees and their dependents at the Moscow Embassy and 2561 employees and their dependents from other Eastern European Embassies. Health records, health questionnaires and death certificates were the basic information sources. The study is the impact of the Moscow environment including microwave exposure on the health status and mortality of the employees. It was concluded that personnel working at the American Embassy in Moscow from 1953 to 1976 suffered no ill effects from the microwaves beamed at the Chancery.

Concern about health effects among Embassy personnel led to a detailed study by A.M. Lilienfeld, an epidemiologist at Johns Hopkins University. The abnormalities found in this study were an embarrassment to the U.S. government, since the levels of exposure experienced by embassy staff inside the building were in the order of **2 to 28 microwatts/cm2**, a level dramatically below the described U.S. safety standards for microwave exposure. It appears that the conclusions of the study were altered to soft-pedal any abnormal findings.

Lilienfeld AM LGM, Cauthen J, Tonascia S, Tonascia J. Evaluation of health status of foreign service and other employees from selected eastern European embassies. *Foreign Service Health Status Study, Final Report; Contract No. 6025-619037 (NTIS publication P8-288 163/9)* (1979); 1-447.

Liakouris AG. Radiofrequency (RF) Sickness in the Lilienfeld Study: An Effect of Modulated Microwaves? Archives of Environmental Health (1998); 53(3):236-238.

Goldsmith JR. Where the trail leads. Ethical problems arising when the trail of professional work leads to evidence of a cover-up of serious risk and mis-representation of scientific judgement concerning human exposures to radar. *Eubios Journal of Asian and International Bioethics* (1995b); 5(4):92-94.

Cherry N. Evidence of Health Effects of Electromagnetic Radiation, To the Australian Senate Inquiry into Electromagnetic Radiation (2000): 1-84. *http://www.neil- cherry.com/documents 90_m1_EMR_Australian_Senate_Evidence_8-9-2000.pdf*

Norway (1998)

From:
Mild, K.H., Oftedal, G., Sandstrom, M., Wilen, J., Tynes, T., Haugsdal, B. and Hauger E., 1998: "Comparison of symptoms by users of analogue and digital mobile phones - A Swedish- Norwegian epidemiological study". National Institute for Working Life, 1998:23, Umea, Sweden, 84pp.

Norway (1998)

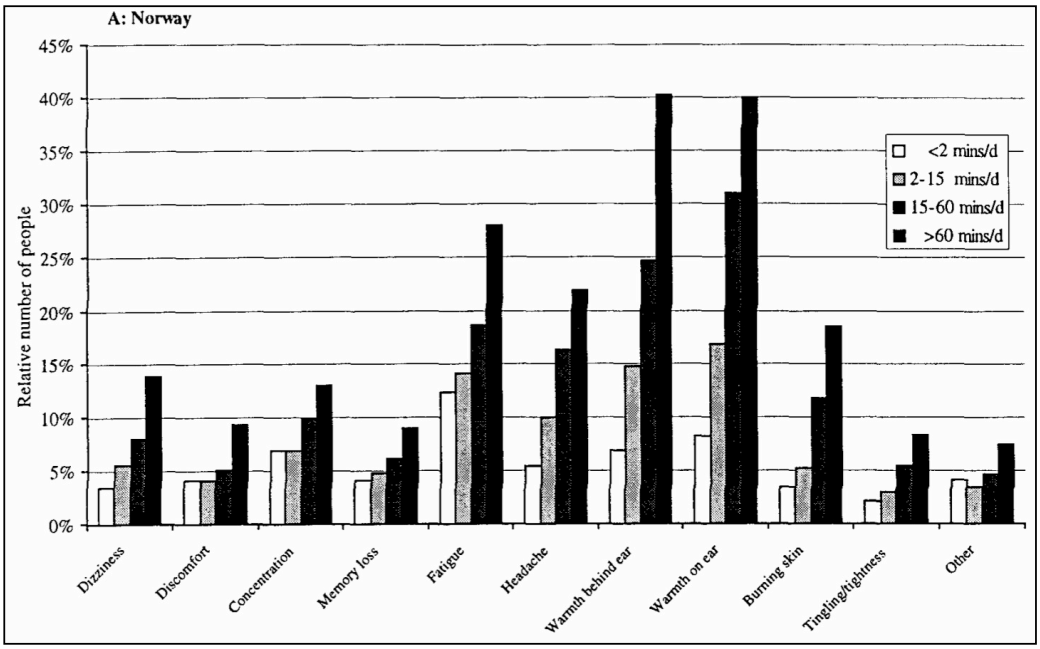
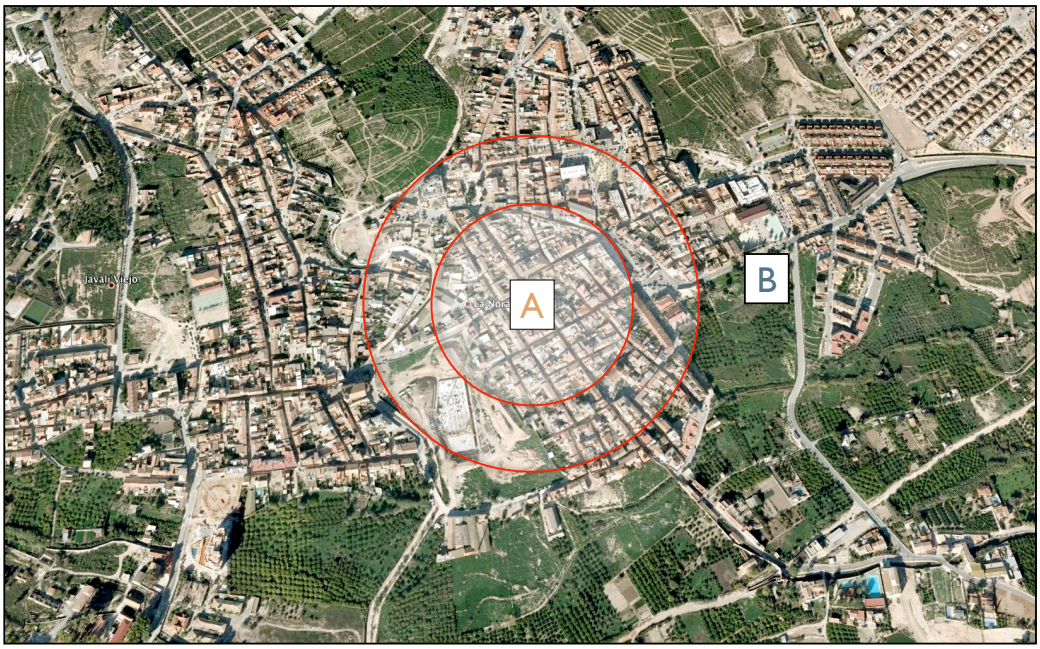


Figure 11: Prevalence of symptoms for Norwegian mobile phone users, mainly analogue, with various categories of length of calling time per day, from Mild et al. (1998).

In:
Cherry N. EMF/EMR Reduces Melatonin in Animals and People. (2002):1-14. *http://www.neilcherry.com/documents.php*
From:
Mild, K.H., Oftedal, G., Sandstrom, M., Wilen, J., Tynes, T., Haugsdal, B. and Hauger E., 1998: "Comparison of symptoms by users of analogue and digital mobile phones - A Swedish- Norwegian epidemiological study". National Institute for Working Life, 1998:23, Umea, Sweden, 84pp.

La Ñora, Spain (2001)



Town of 1900 inhabitants, with GSM cell phone tower.

Questionnaire distributed, 5% of inhabitants responded. The questionnaire was composed of 25 different items mainly concerning health information about the respondents.

The respondents scored and marked from 0 to 3 the presence of the suffered health dysfunction: 0 never, 1 sometimes, 2 often, 3 very often.

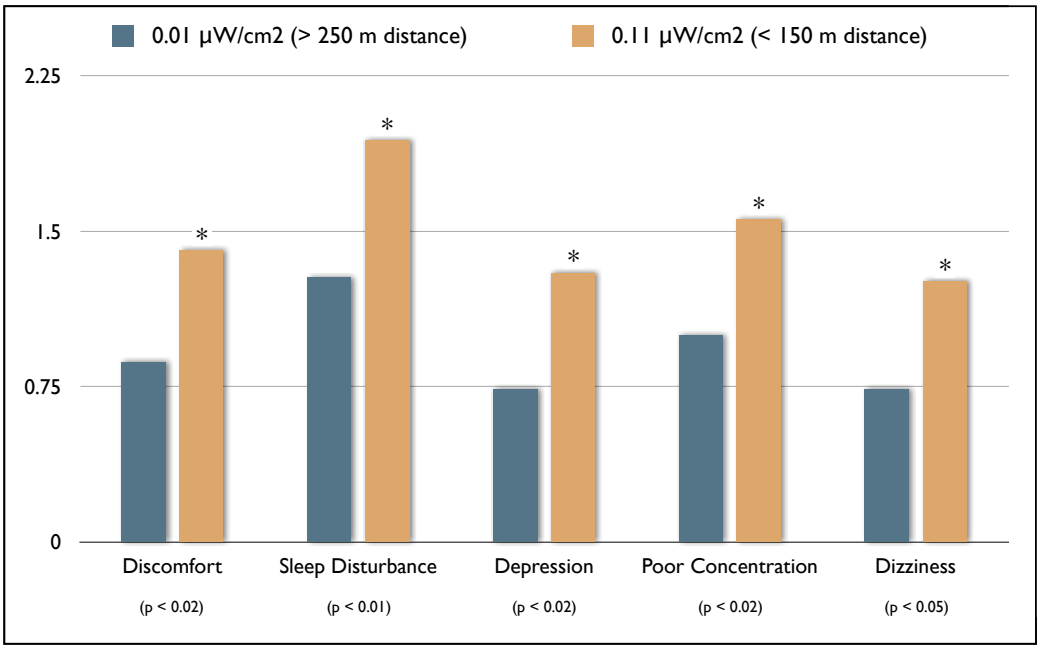
Power density of signal in bedrooms of respondents was measured.

Area A (< 150 meters from tower) = average power density 0.11 μW/cm^2.

Area B (> 250 meters from tower) = average power density 0.01 μW/cm^2.

Navarro E, Segura J, Portolés M, Gómez-Perretta C. The Microwave Syndrome: A Preliminary Study in Spain. Electromagn Biol Med (2003); 22(2-3):161-169.

La Ñora, Spain (2001)



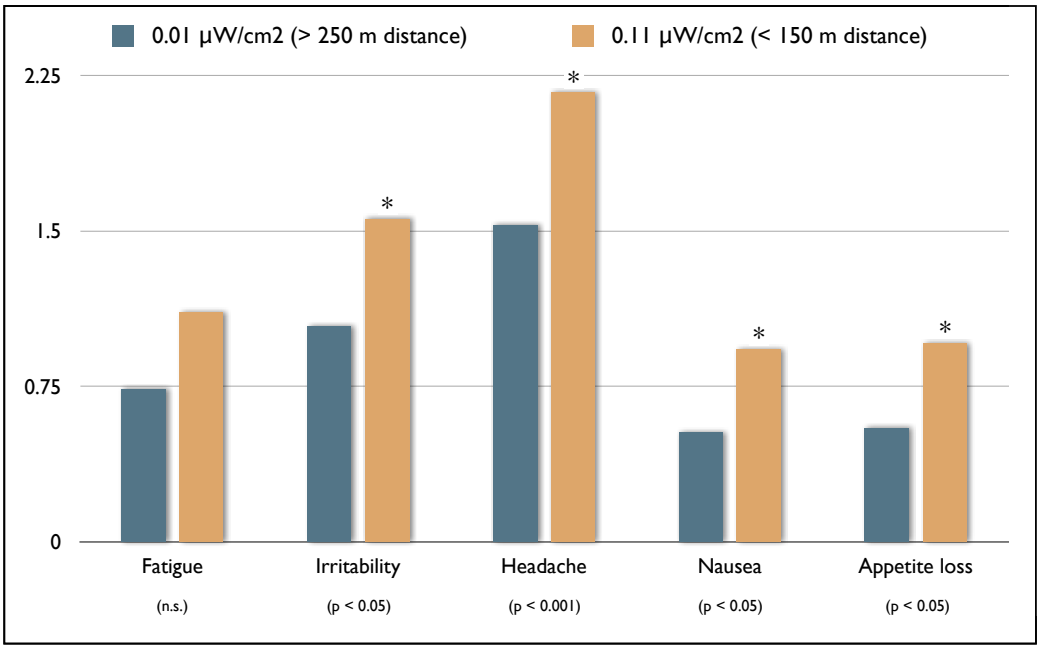
Symptom score (0 – 3) vs Average Bedroom Exposure Levels to Microwave RF

FCC Guidelines: **600 - 1000 μW/cm^2**

Navarro E, Segura J, Portolés M, Gómez-Perretta C. The Microwave Syndrome: A Preliminary Study in Spain. Electromagn Biol Med (2003); 22(2-3):161-169.

Abstract

A health survey was carried out in Murcia, Spain, in the vicinity of a Cellular Phone Base Station working in DCS-1800 MHz. This survey contained health items related to " microwave sickness " or "RF syndrome." The microwave power density was measured at the respondents' homes. Statistical analysis showed significant correlation between the declared severity of the symptoms and the measured power density. The separation of respondents into two different exposure groups also showed an increase of the declared severity in the group with the higher exposure.



Symptom score (0 – 3) vs Average Bedroom Exposure Levels to Microwave RF

Based on the data of this study the advice would be to strive for levels not higher than 0.02 V/m for the sum total, which is equal to a power density of 0.0001 µW/cm2 or 1 µW/m2, which is the indoor exposure value for GSM base stations proposed on empirical evidence by the Public Health Office of the Government of Salzburg in 2002.

Oberfeld G, Navarro E, Portoles M, Maestu C, Gomez-Perretta C. The Microwave Syndrome -- Further Aspects of a Spanish Study. (2004):1-8. *http://www.powerwatch.org.uk/pdfs/20040809_kos.pdf*

France (2002)

Questionnaire re multiple symptoms that have been described for “microwave syndrome”.

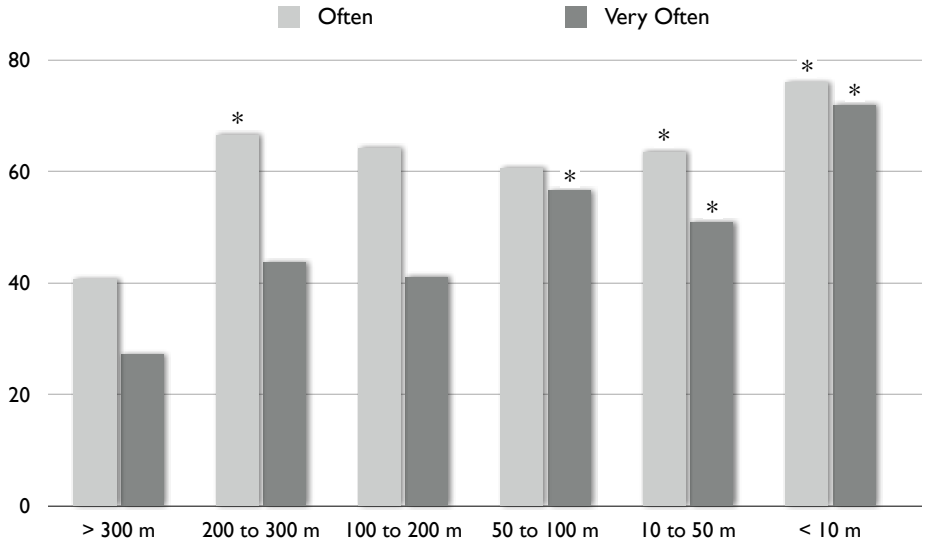
n = 530

Evaluated incidence of symptoms as a function of residential proximity in meters to a cell phone tower.

Santini R, Santini P, Danze JM, Le Ruz P, Seigne M. [Investigation on the health of people living near mobile telephone relay stations: I/Incidence according to distance and sex]. *Pathol Biol (Paris)* (2002); 50(6):369-373.

Santini R SP, Le Ruz P, Danze J, Seigne M. Survey Study of People Living in the Vicinity of Cellular Phone Base Stations. *Electromagnetic Biology and Medicine* (2003); 22(1):41-49.

Fatigue



* p < 0.05 in comparison to residence > 300 meters or not exposed.

X axis = responses grouped by residential proximity to cell phone tower (in meters).

Y axis = percentage in exposure category answering “Often” or “Very Often” to a symptom query, in reference to total number of respondents living at that distance who answered “Never” to that symptom query.

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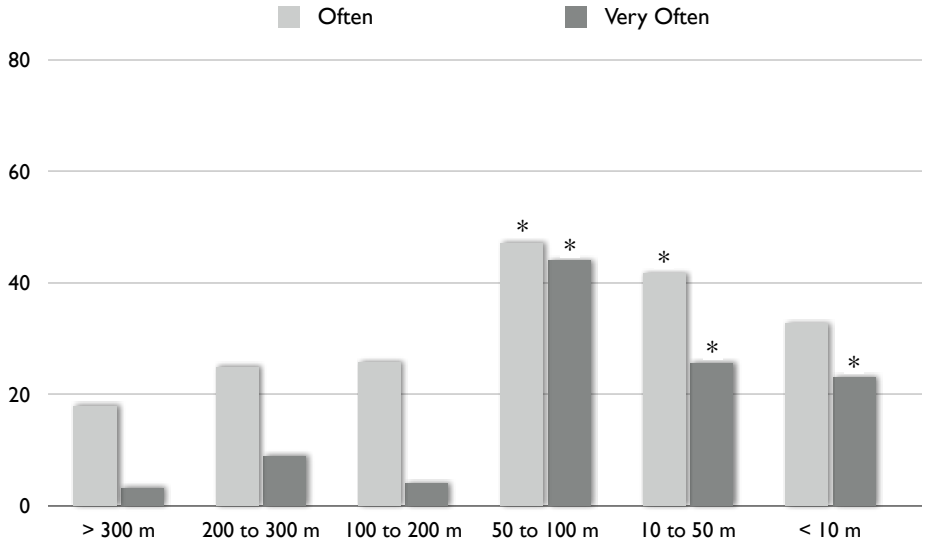
Irritability



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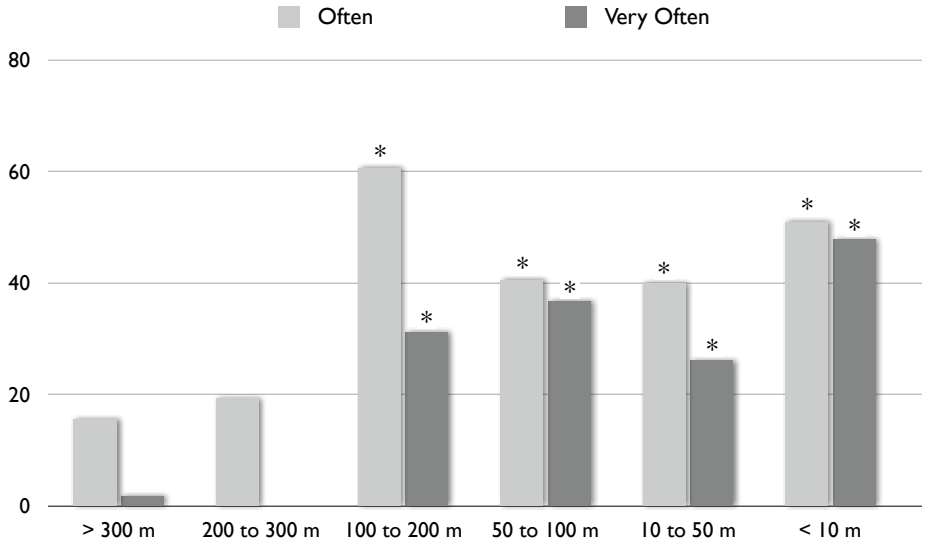
Headache



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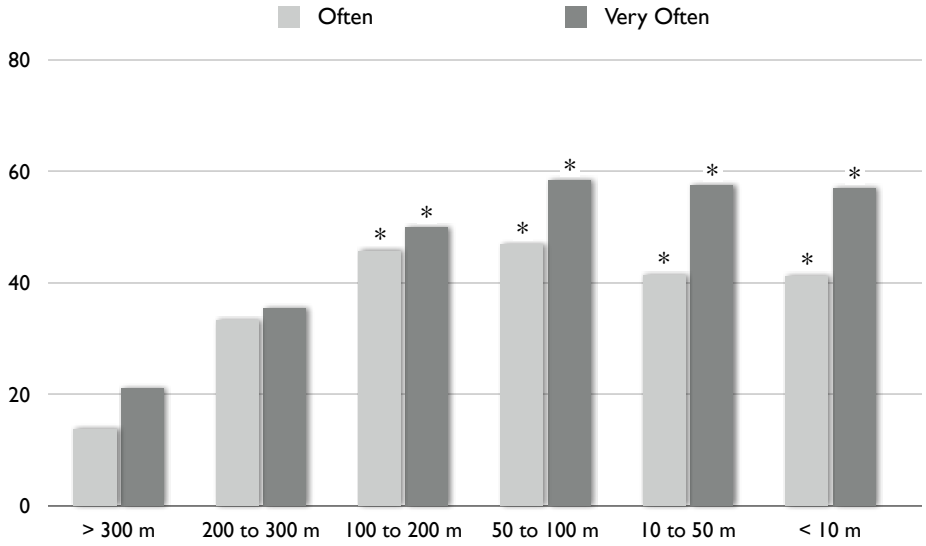
Sleep Disruption



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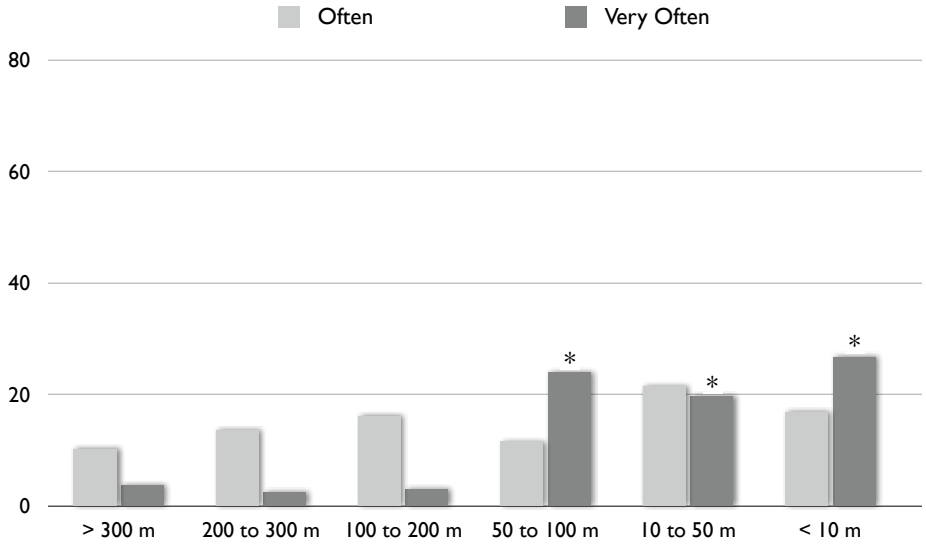
Depression



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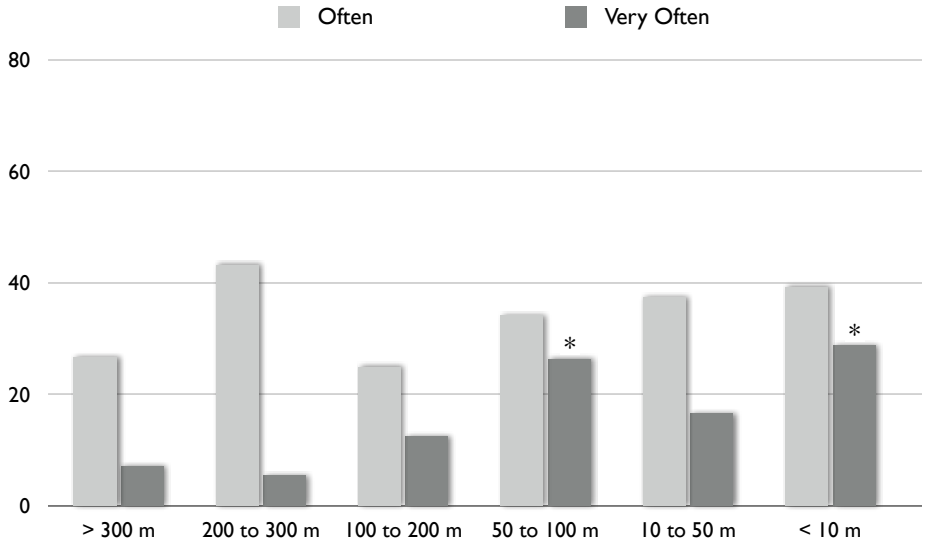
Difficulty in Concentration



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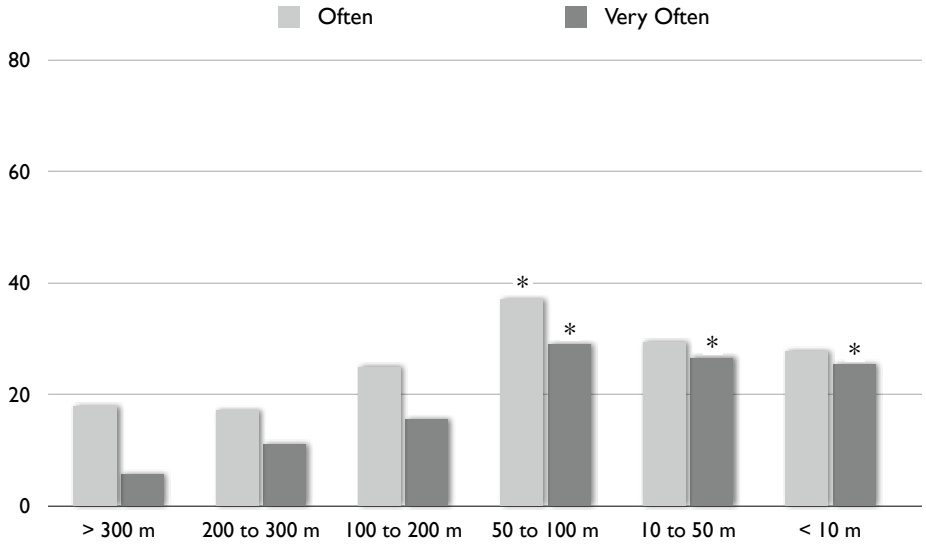
Memory Loss



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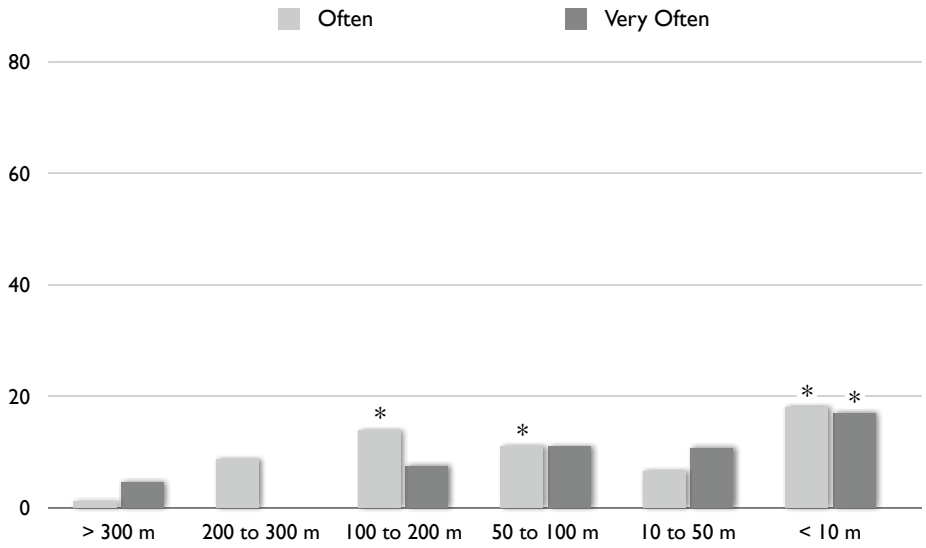
Skin Problems



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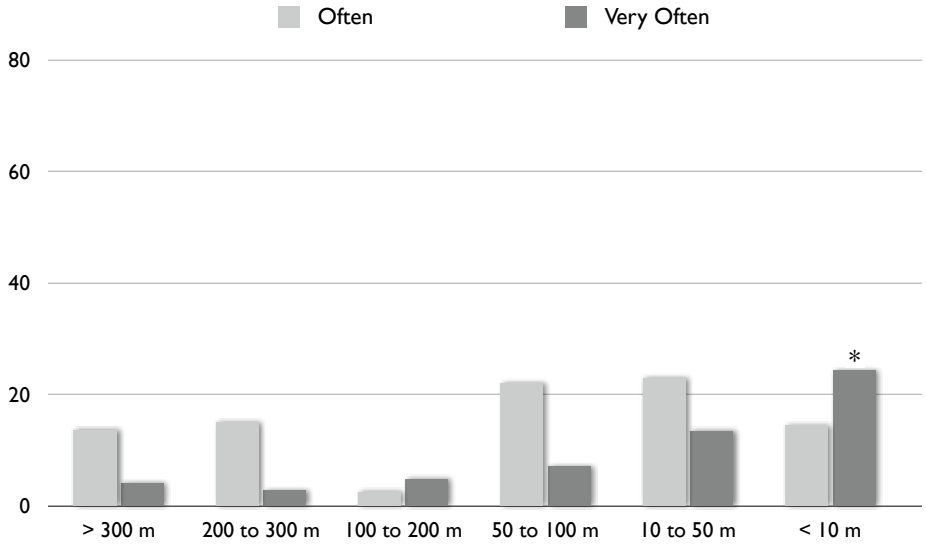
Visual Disruption



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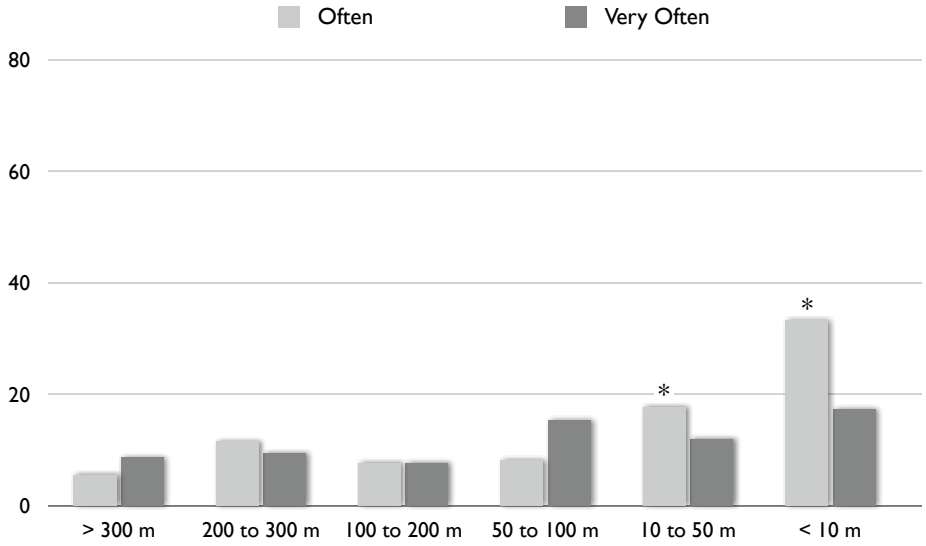
Hearing Disruption



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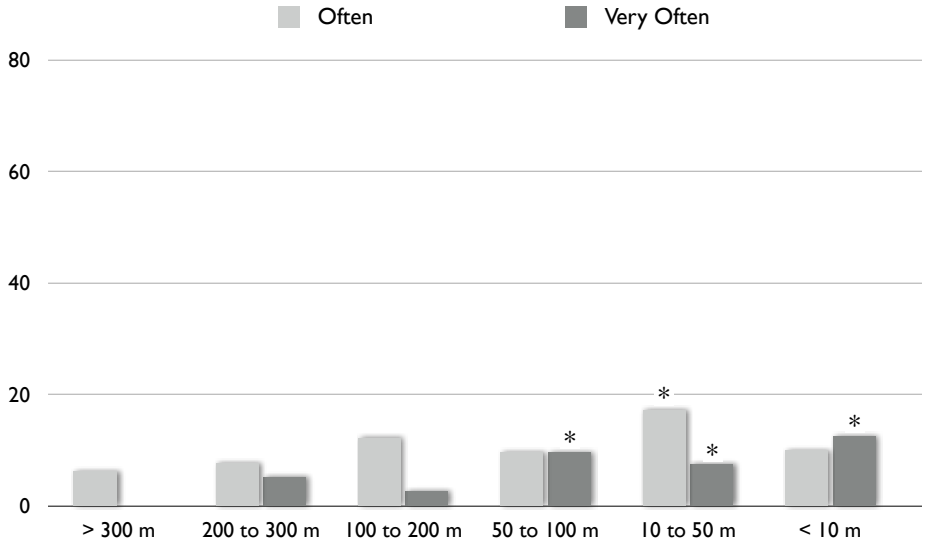
Dizziness



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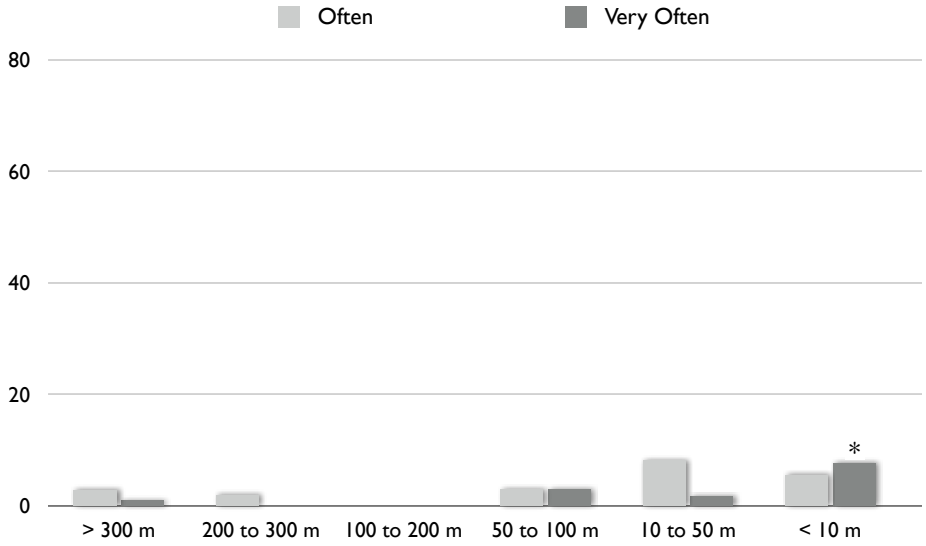
Movement Difficulties



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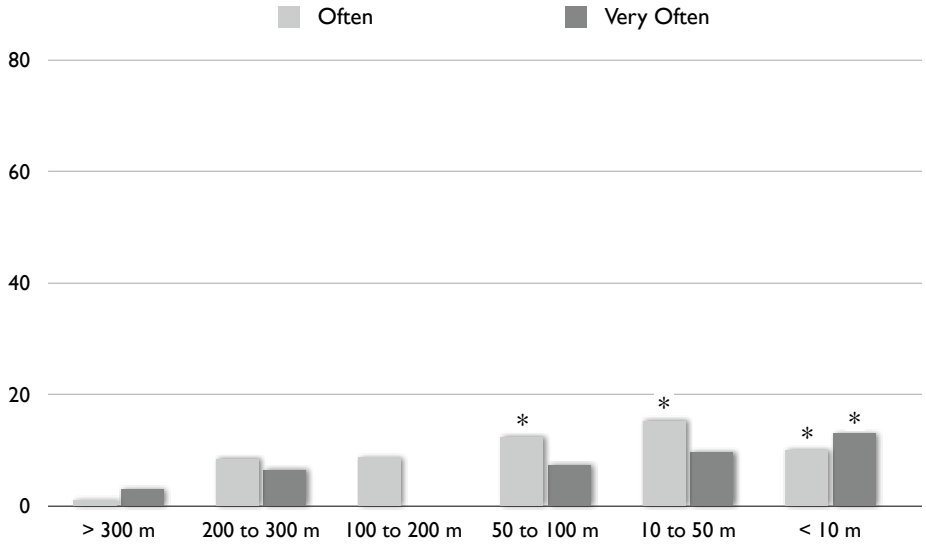
Cardiovascular Problems



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Elderly people are more vulnerable

Table 3. Influence of age on the percentages of complaints

	≤ 20 years		21–40 years		41–60 years		>60 years	
	Distances of subjects from antennas (in meters)							
Symptoms	≤ 300	>300	≤ 300	>300	≤ 300	>300	≤ 300	>300
Fatigue	56.7	62.5	82.4*	25	81.4*	57.8	73.3*	40
Irritability	16.2	11.1	46.2	18.2	50.5	35.3	52.1*	21
Headaches	42.4	26.3	57.6*	18.2	52*	13,3	49.5*	10
Nausea	2	0	12.9	0	9.9	0	15.6	15.7
Loss of appetite	13.3	8.8	12.7	0	11.8	0	15.9	15
Sleep disturbances	26.1	14.8	53*	12,5	73.9	52.6	68.5*	44.4
Depressive tendencies	10.2	5.7	14	5.8	36	20	41.7	27.7
Feeling of discomfort	4.4	2.9	26.3	6	41.6	16.6	45*	19
Difficulties in concentration	30.3	40	42.1	18.7	45.8	36.8	53.3*	20
Memory loss	7.5	8	21.8	6.6	43	40	64	36.8
Skin problems	16.6	9.3	24.2	6.6	18.3	0	20.4	5.2
Visual disturbances	16.3	12.5	14.7	12.5	26.6	26.3	36.8	17.6
Hearing disturbances	9.4	5.1	15.4	0	29.8	21.7	43.8	31.5
Dizziness	6.2	5.2	3.2	6.6	15.4	4.5	39.3*	9.5
Movement difficulties	0	2.3	0	0	3.5	4	21.4	10.5
Cardiovascular problems	0	2.3	5.1	0	19.2*	0	36.4	15

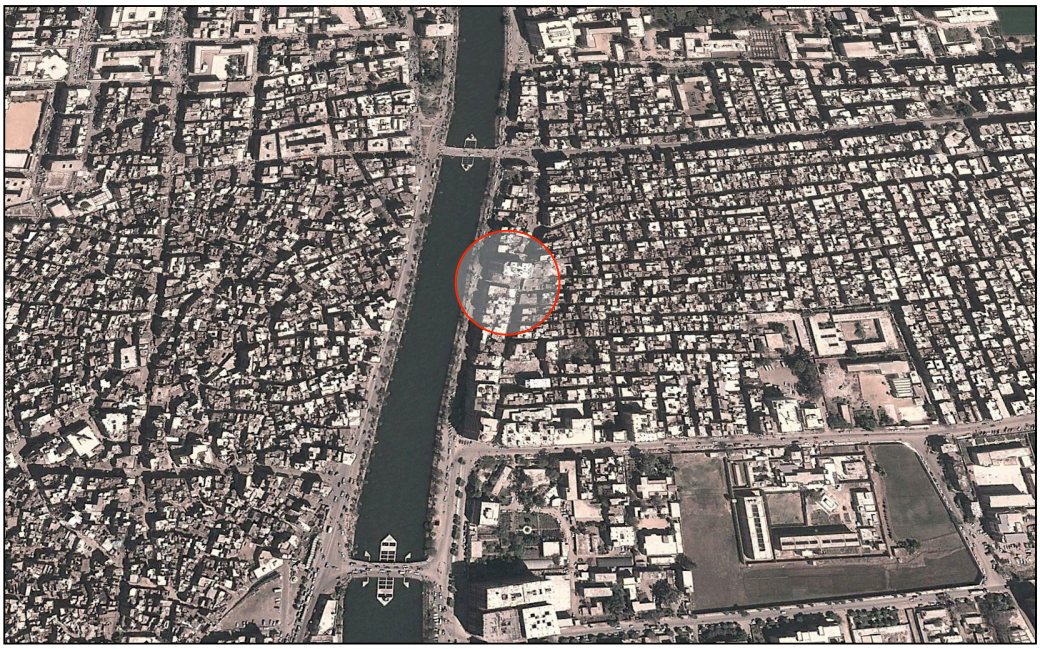
for 16 Non Specific Health Symptoms experienced by 530 people (270 men + 260 women) in relation to their distances from cellular phone base stations (≤ 300 m vs. >300 m [reference group]).
* = $P < 0.05$ for levels of complaints 2 + 3 pooled.

Influence of age on the percentage of complaints

Santini R, Santini P, Danze JM, Le Ruz P, Seigne M. [Investigation on the health of people living near mobile telephone relay stations: I/Incidence according to distance and sex]. *Pathol Biol (Paris)* (2002); 50(6):369-373.

Santini R SP, Le Ruz P, Danze J, Seigne M. Survey Study of People Living in the Vicinity of Cellular Phone Base Stations. *Electromagnetic Biology and Medicine* (2003); 22(1):41-49.

Shebeen El-Kom, Egypt (2003)



Study of 85 inhabitants living near the first cell phone tower in the city (tower operational since 1998).

Abdel-Rassoul G, El-Fateh OA, Salem MA et al. Neurobehavioral effects among inhabitants around mobile phone base stations. Neurotoxicology (2007); 28(2): 434-440.

BACKGROUND: There is a general concern on the possible hazardous health effects of exposure to radiofrequency electromagnetic radiations (RFR) emitted from mobile phone base station antennas on the human nervous system. AIM: To identify the possible neurobehavioral deficits among inhabitants living nearby mobile phone base stations. METHODS: A cross-sectional study was conducted on (85) inhabitants living nearby the first mobile phone station antenna in Menoufiya governorate, Egypt, 37 are living in a building under the station antenna while 48 opposite the station. A control group (80) participants were matched with the exposed for age, sex, occupation and educational level. All participants completed a structured questionnaire containing: personal, educational and medical histories; general and neurological examinations; neurobehavioral test battery (NBTB) [involving tests for visuomotor speed, problem solving, attention and memory]; in addition to Eysenck personality questionnaire (EPQ). RESULTS: The prevalence of neuropsychiatric complaints as headache (23.5%), memory changes (28.2%), dizziness (18.8%), tremors (9.4%), depressive symptoms (21.7%), and sleep disturbance (23.5%) were significantly higher among exposed inhabitants than controls: (10%), (5%), (5%), (0%), (8.8%) and (10%), respectively (P<0.05). The NBTB indicated that the exposed inhabitants exhibited a significantly lower performance than controls in one of the tests of attention and short-term auditory memory [Paced Auditory Serial Addition Test (PASAT)]. Also, the inhabitants opposite the station exhibited a lower performance in the problem solving test (block design) than those under the station. All inhabitants exhibited a better performance in the two tests of visuomotor speed (Digit symbol and Trailmaking B) and one test of attention (Trailmaking A) than controls. The last available measures of RFR emitted from the first mobile phone base station antennas in Menoufiya governorate were less than the allowable standard level. CONCLUSIONS AND RECOMMENDATIONS: 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. So, revision of standard guidelines for public exposure to RER from mobile phone base station antennas and using of NBTB for regular assessment and early detection of biological effects among inhabitants around the stations are recommended.

Shebeen El-Kom, Egypt (2003)

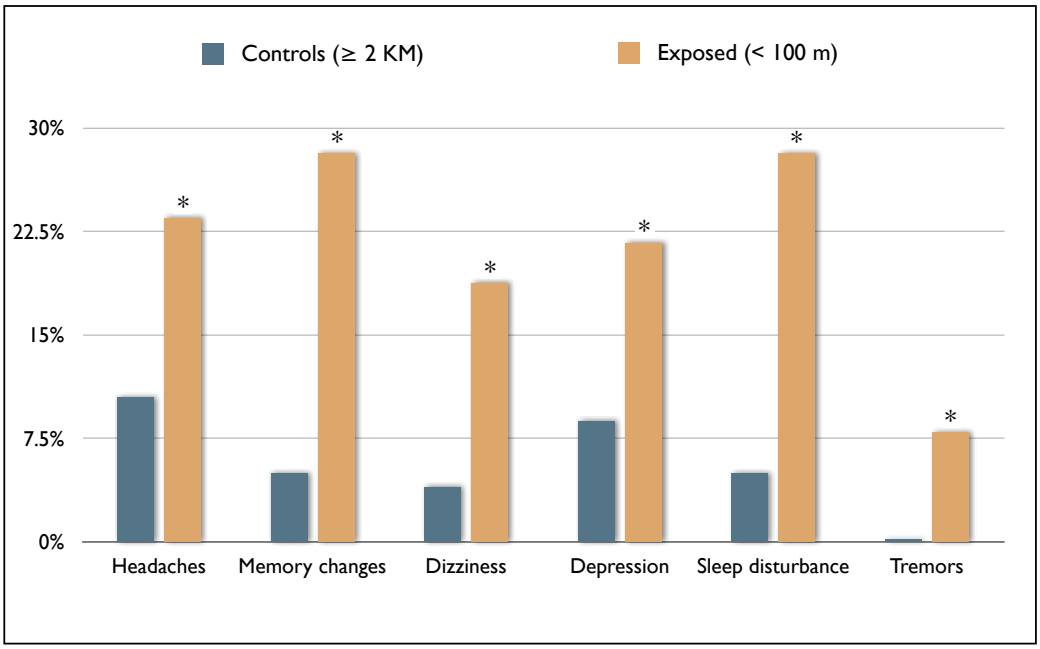
37 subjects lived in the building under the transmitters.

48 others worked in the building across the street.

A control group of 80 individuals worked in a building 2 kilometers away from the towers.

Controls were matched for age, sex, occupation, education level, and mobile phone use.

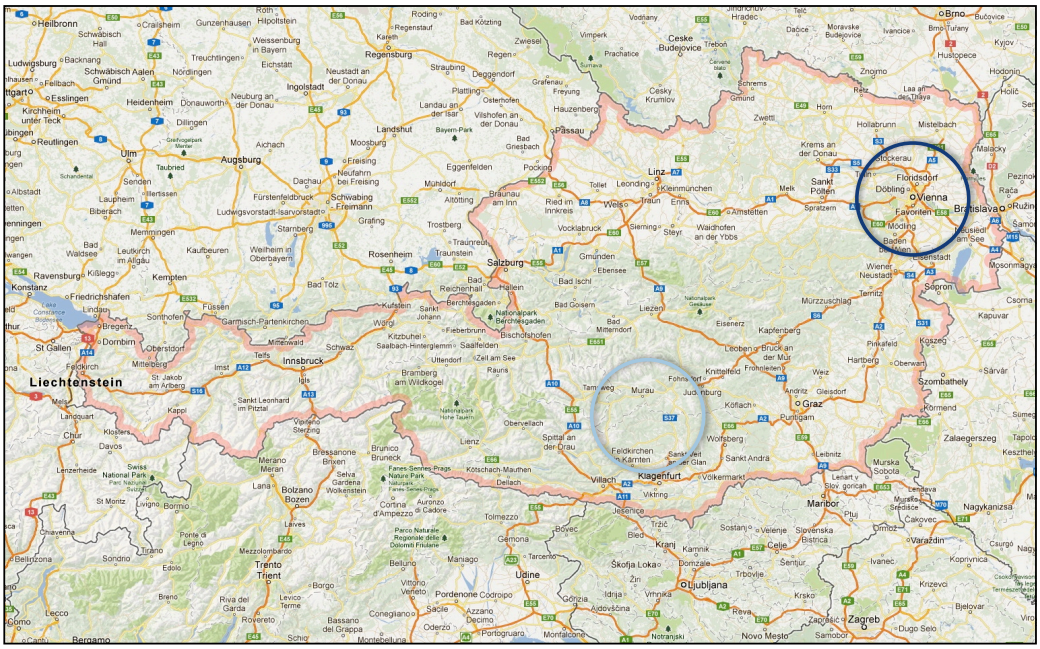
Shebeen El-Kom, Egypt (2003)



* = statistically significant at this sample size ($p < 0.05$ or better)

Abdel-Rassoul G, El-Fateh OA, Salem MA et al. Neurobehavioral effects among inhabitants around mobile phone base stations. Neurotoxicology (2007); 28(2): 434-440.

Vienna and Carinthia, Austria (2004)



Study of health effects around 10 cell phone towers ("base stations") in urban and rural Austria.

Criteria:

Towers operational for >2 years.

No local controversy.

No other towers nearby (when possible).

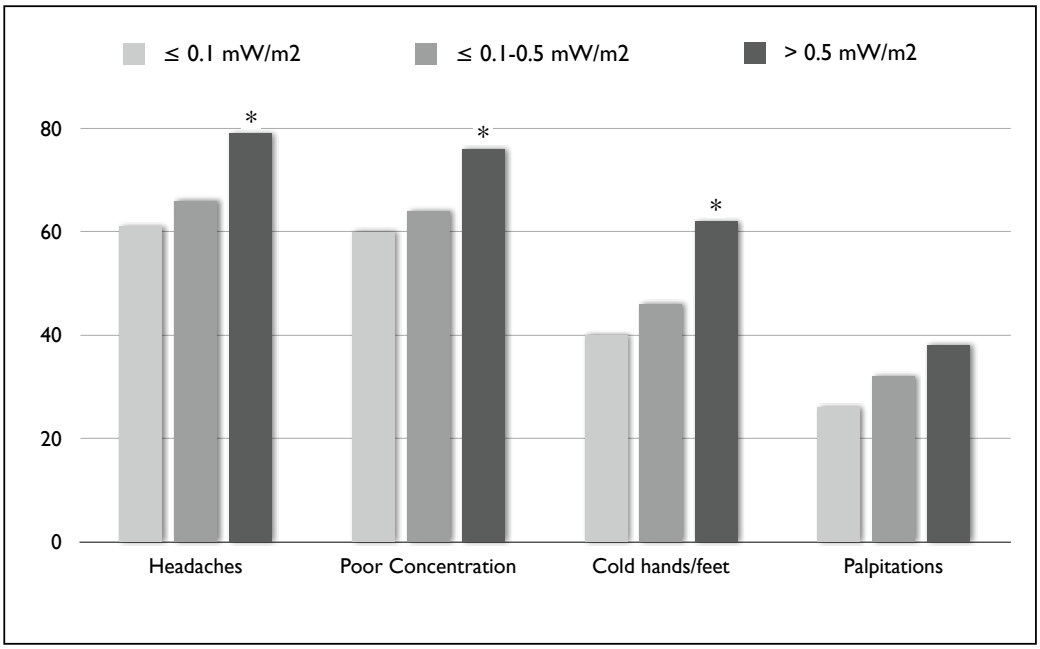
900 MHz transmission.

Random selection of households within the study areas.

Performance tests, symptom questionnaires, exposure measurements in the subject's bedroom.

Hutter HP, Moshammer H, Wallner P, Kundi M. Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations. *Occup Environ Med* (2006); 63(5):307-313.

Austria (2004)



Percentage of subjects reporting symptoms, stratified by RF exposure levels as measured in subject's bedroom.

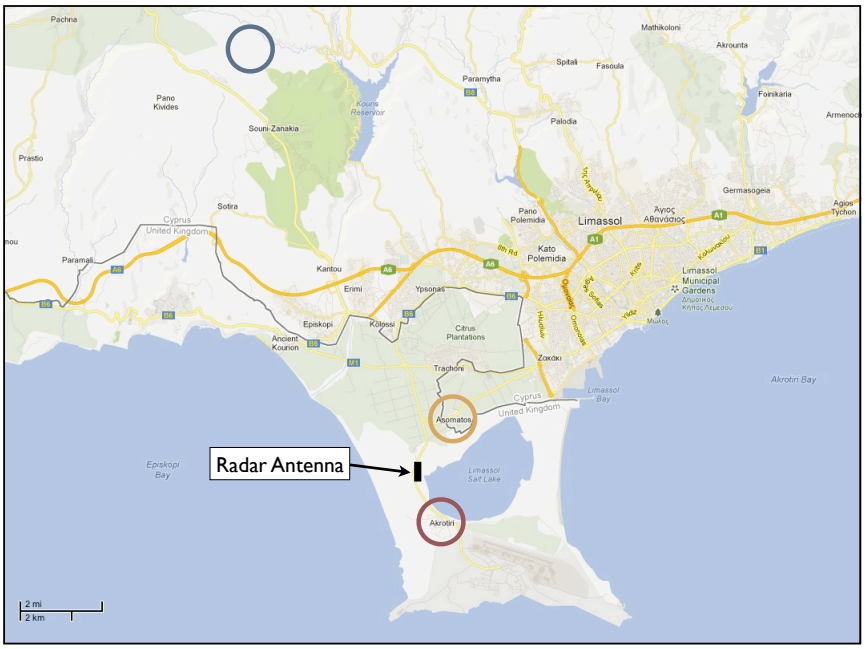
* = statistically significant for this sample size.

FCC Guidelines: 6000 mW/m^2

Hutter HP, Moshammer H, Wallner P, Kundi M. Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations. Occup Environ Med (2006); 63(5):307-313.

BACKGROUND: The erection of mobile telephone base stations in inhabited areas has raised concerns about possible health effects caused by emitted microwaves.
METHODS: In a cross-sectional study of randomly selected inhabitants living in urban and rural areas for more than one year near to 10 selected base stations, 365 subjects were investigated. Several cognitive tests were performed, and wellbeing and sleep quality were assessed. Field strength of high-frequency electromagnetic fields (HF-EMF) was measured in the bedrooms of 336 households.
RESULTS: Total HF-EMF and exposure related to mobile telecommunication were far below recommended levels (max. 4.1 mW/m2). Distance from antennae was 24-600 m in the rural area and 20-250 m in the urban area. Average power density was slightly higher in the rural area (0.05 mW/m2) than in the urban area (0.02 mW/m2). Despite the influence of confounding variables, including fear of adverse effects from exposure to HF-EMF from the base station, there was a significant relation of some symptoms to measured power density; this was highest for headaches. Perceptual speed increased, while accuracy decreased insignificantly with increasing exposure levels. There was no significant effect on sleep quality. CONCLUSION: Despite very low exposure to HF-EMF, effects on wellbeing and performance cannot be ruled out, as shown by recently obtained experimental results; however, mechanisms of action at these low levels are unknown.

Akrotiri, Cyprus (2005)

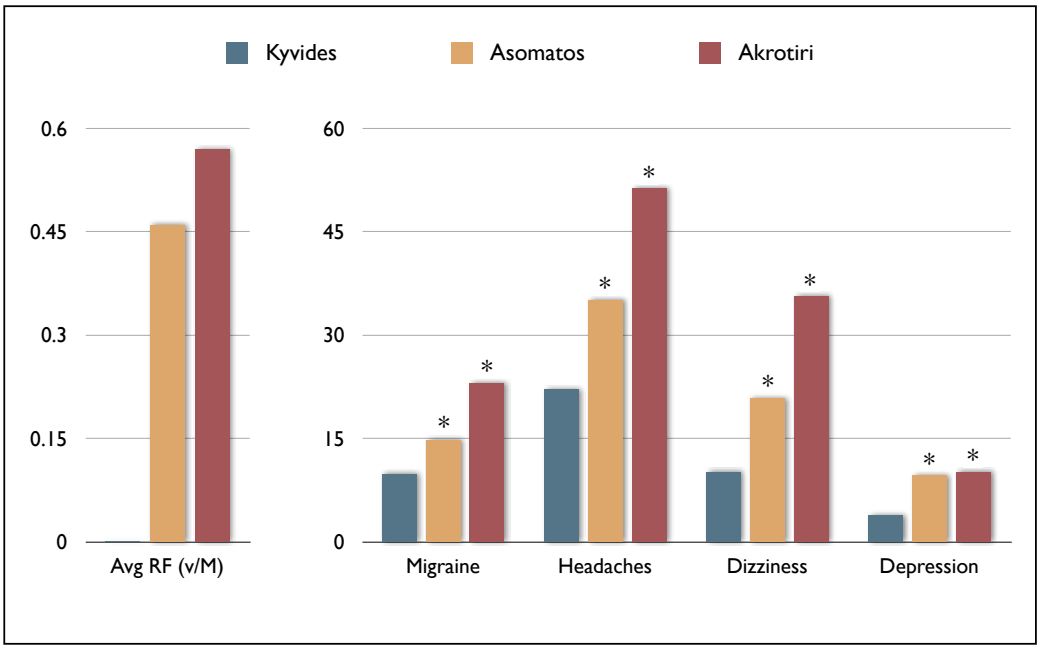


Evaluation of health concerns near a military radar antenna:

Measurement of average RF levels in two nearby communities:
Akrotiri [red circle]
Asomatos [yellow circle]
And as a control, in another village > 20 km distant [blue circle]
Akrotiri also had a cell phone tower.

Preece AW, Georgiou AG, Dunn EJ, Farrow SC. Health response of two communities to military antennae in Cyprus. Occup Environ Med (2007); 64(6):402-408.

Akrotiri, Cyprus (2005)



On left, average RF readings in the three communities (in v/M).

On the right, percentages of four reported symptoms were significantly higher in the towns with higher RF exposures.

Average power densities:
Akrotiri: 0.57 v/m = 0.863 µW/cm²
Asomatos: 0.46 v/m = 0.561 µW/cm²
Pano Kyvides: 0.001 v/m = 0.000001 µW/cm²

FCC Guidelines: 600–1000 µW/cm²

Preece AW, Georgiou AG, Dunn EJ, Farrow SC. Health response of two communities to military antennae in Cyprus. Occup Environ Med (2007); 64(6):402-408.

Selbitz, Bavaria (2009)

General health survey sent to 1080 residents of the village of Selbitz, Bavaria (population 4644), with 251 responses (23% return).

Two cell tower transmitters in the center of town.

Exposure areas determined by concentric circles of 100 to 400 meters radius.

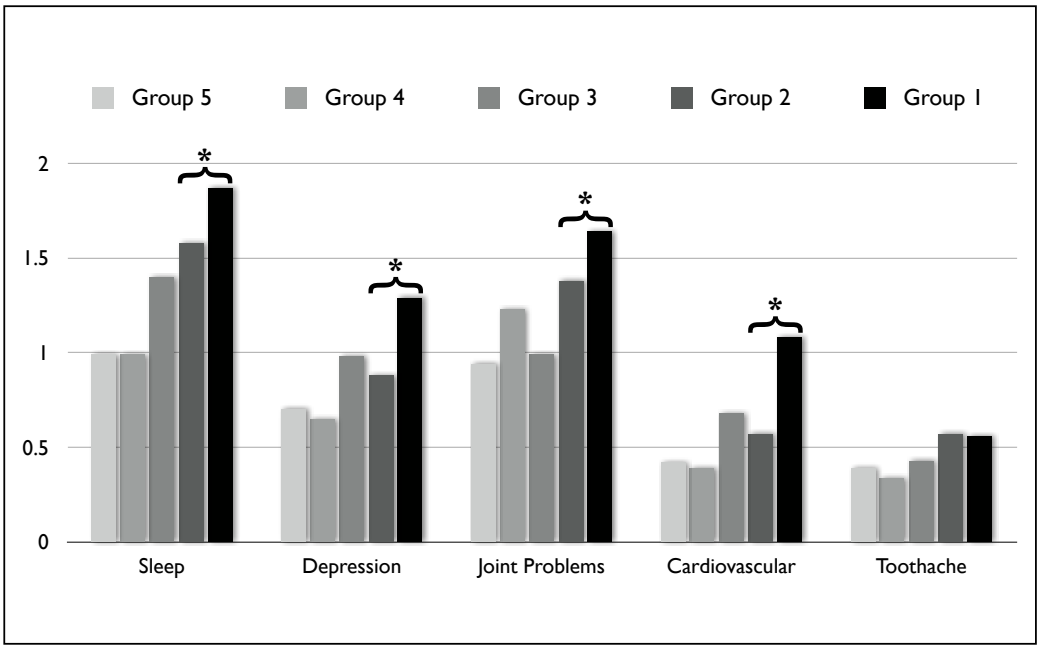
Field measurements stratified exposures into two regions:

Groups 1 and 2 (mean exposure 1.17 V/m)

Groups 3 and 4 (mean exposure 0.70 V/m)

Eger H, Jahn M. Specific Health Symptoms and Cell Phone Radiation in Selbitz (Bavaria, Germany) -- Evidence of a Dose-Response Relationship. *umwelt-medizin-gesellschaft* (2010); 23:1-20.

Selbitz, Bavaria (2009)



Some sample data from the study. Symptoms scored on 0 – 5 scale.

*** = statistically significant (Groups 1 + 2 compared to Groups 3 + 4).**

14 of 19 symptom categories showed statistically significant elevations in groups 1 and 2 as compared to groups 3 and 4.

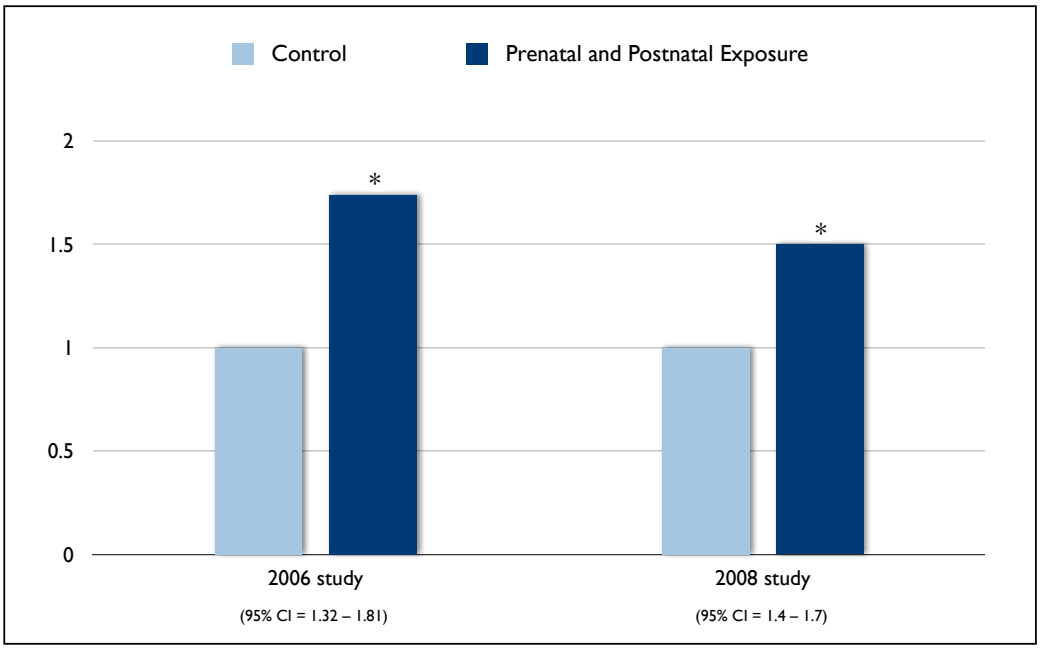
Eger H, Jahn M. Specific Health Symptoms and Cell Phone Radiation in Selbitz (Bavaria, Germany) -- Evidence of a Dose-Response Relationship. *umwelt-medizin-gesellschaft* (2010); 23:1-20.

Danish Birth Cohort Studies

Several studies done on large numbers of young children in the Danish National Birth Cohort.
Evaluating health status of children at age 7.

Significant changes found in three areas:
Behavioral problems.
Headaches.
Hearing Loss.

Cell Phone Exposure and Behavioral Problems in Young Children



Association of prenatal and postnatal cell phone exposure and behavioral problems in young children, evaluated at age 7.

Two studies with the Danish National Birth Cohort:

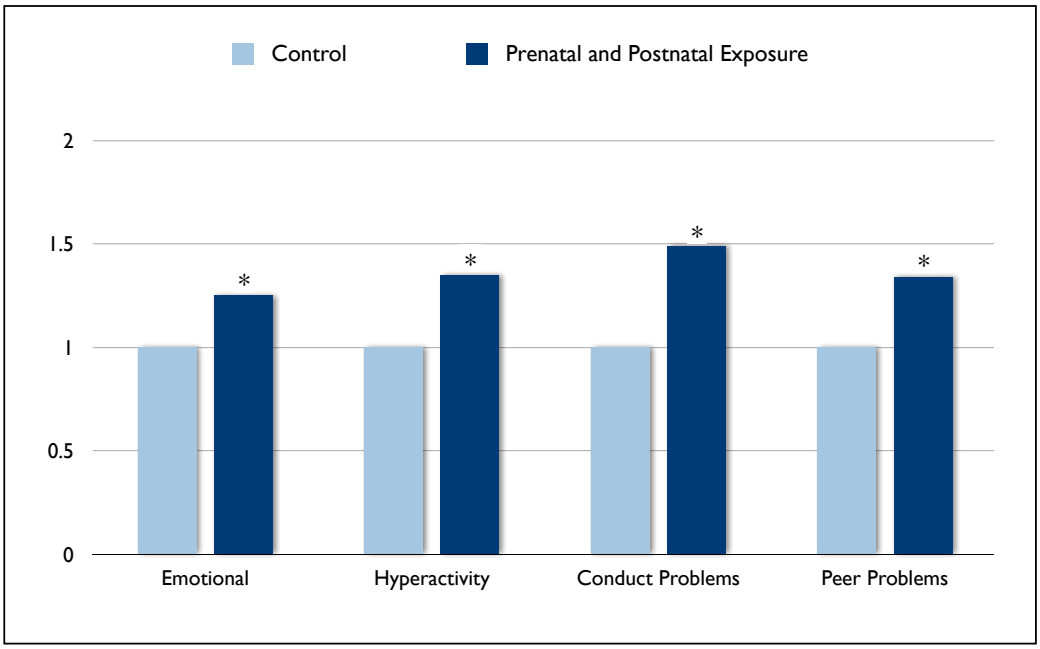
Study 1 – (2006 data, n = 13,159) OR=1.80 (95% CL=1.45–2.23)

Divan HA, Kheifets L, Obel C, Olsen J. Prenatal and postnatal exposure to cell phone use and behavioral problems in children. *Epidemiology* (2008); 19(4): 523-529.

Study 2 – (2008 data, n = 28,745) OR=1.5 (95% CL=1.4–1.7)

Divan HA, Kheifets L, Obel C, Olsen J. Cell phone use and behavioural problems in young children. *J Epidemiol Community Health* (2010); 66:524-529

Cell Phone Exposure and Behavioral Problems in Young Children

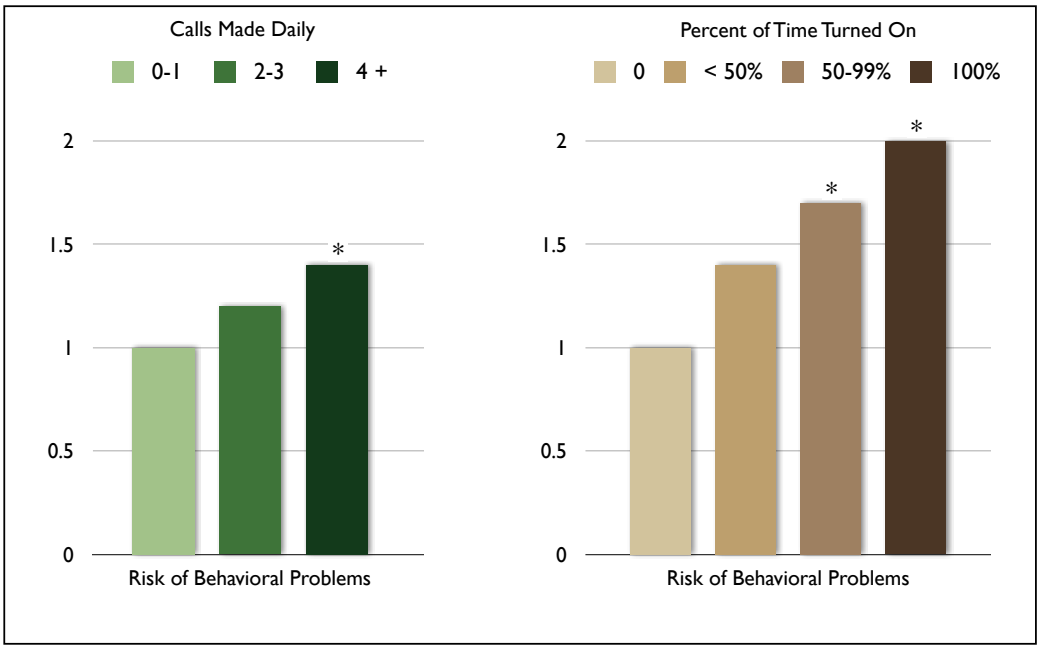


Association of prenatal and postnatal cell phone exposure and behavioral problems in young children, evaluated at age 7.

Study 1 – 2006 (n = 13,159)

Divan HA, Kheifets L, Obel C, Olsen J. Prenatal and postnatal exposure to cell phone use and behavioral problems in children. *Epidemiology* (2008); 19(4): 523-529.

Behavior Problems Stratified by Cell Phone Exposure Level



Association of prenatal and postnatal cell phone exposure and behavioral problems in young children, evaluated at age 7.

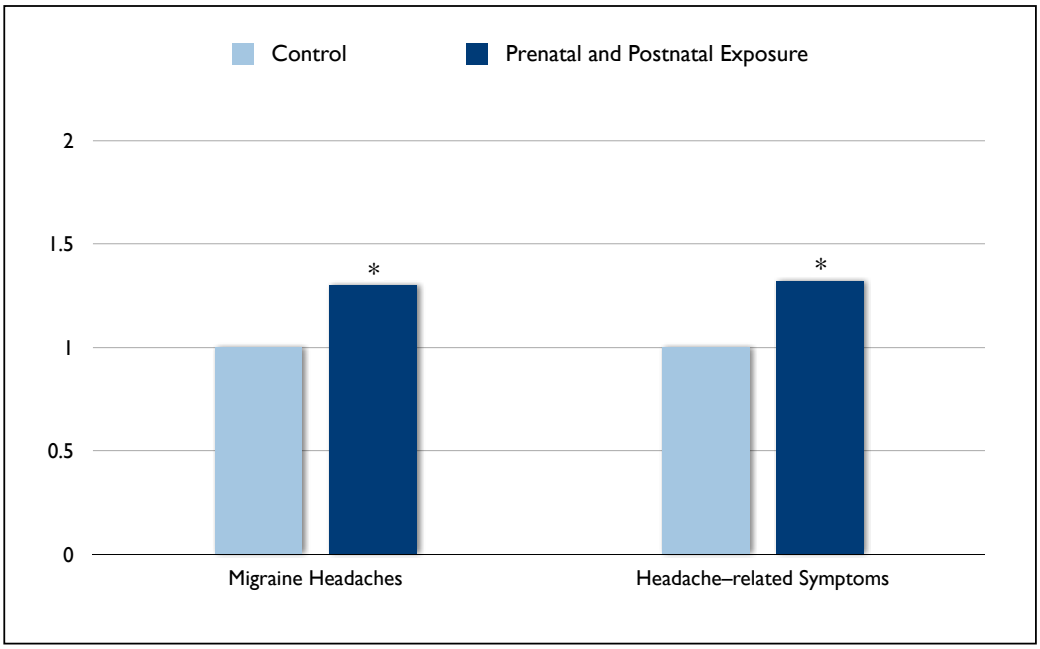
Danish National Birth Cohort:

Study 2 – 2008 cohort (n = 28,745)

1 = no increased risk

Divan HA, Kheifets L, Obel C, Olsen J. Cell phone use and behavioural problems in young children. *J Epidemiol Community Health* (2010); 66:524-529

Cell Phone Exposure and Headaches in Young Children

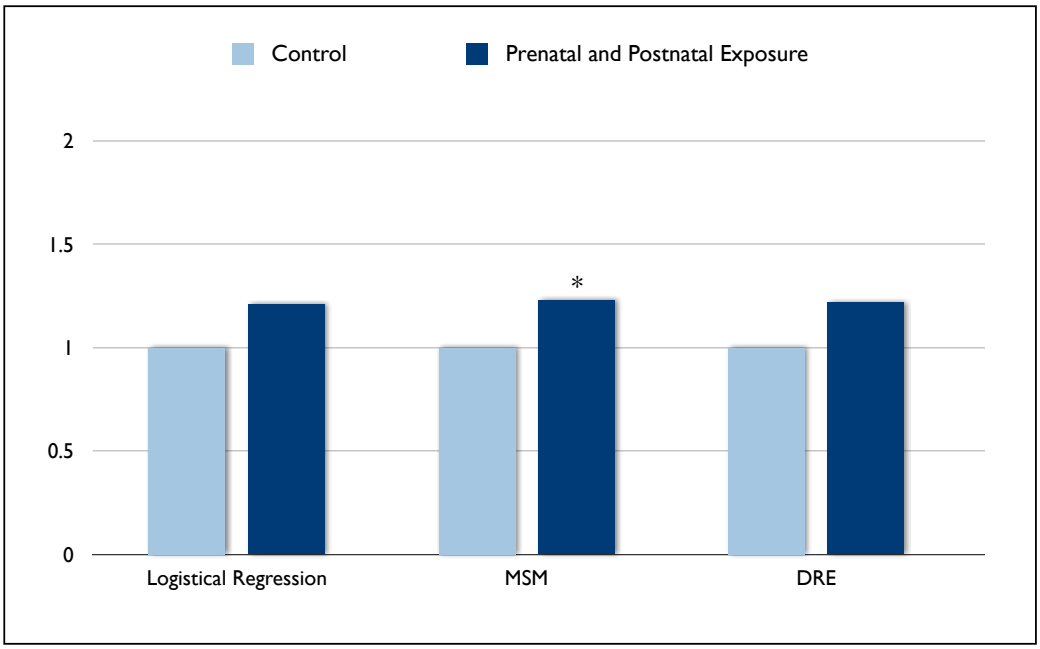


Association of postnatal cell phone exposure and headaches in young children, evaluated at age 7.
52,680 children in the Danish National Birth Cohort:

Results—Our analyses included data from 52,680 children. Children with cell phone exposure had higher odds of migraines and headache-related symptoms than children with no exposure. The odds ratio for migraines was 1.30 (95% confidence interval: 1.01–1.68) and for headache-related symptoms was 1.32 (95% confidence interval: 1.23–1.40) for children with both prenatal and postnatal exposure.

Sudan M, Kheifets L, Arah O, Olsen J, Zeltzer L. Prenatal and Postnatal Cell Phone Exposures and Headaches in Children. *Open Pediatr Med Journal* (2012); 6 (2012):46-52.

Cell Phone Use and Hearing Loss in Young Children

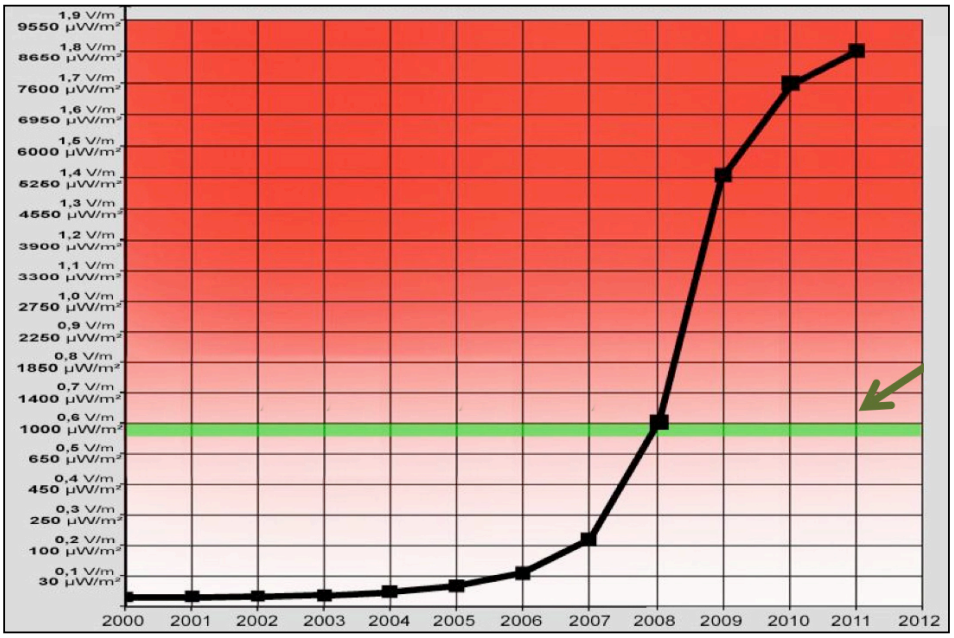


Association of postnatal cell phone exposure and headaches in young children, evaluated at age 7.
52,680 children in the Danish National Birth Cohort:
Three forms of statistical analysis showed this trend.

Results: Our analyses included data from 52 680 children. We observed weak associations between cell phone use and hearing loss at age 7, with odds ratios and 95% confidence intervals from the traditional logistic regression, MSM and DRE models being 1.21 [95% confidence interval [CI] 0.99, 1.46], 1.23 [95% CI 1.01, 1.49] and 1.22 [95% CI 1.00, 1.49], respectively.

Sudan M, Kheifets L, Arah OA, Olsen J. Cell phone exposures and hearing loss in children in the Danish National Birth Cohort. *Paediatr Perinat Epidemiol* (2013); 27(3):247-257.

Exposure to Microwave RF has Increased Dramatically.

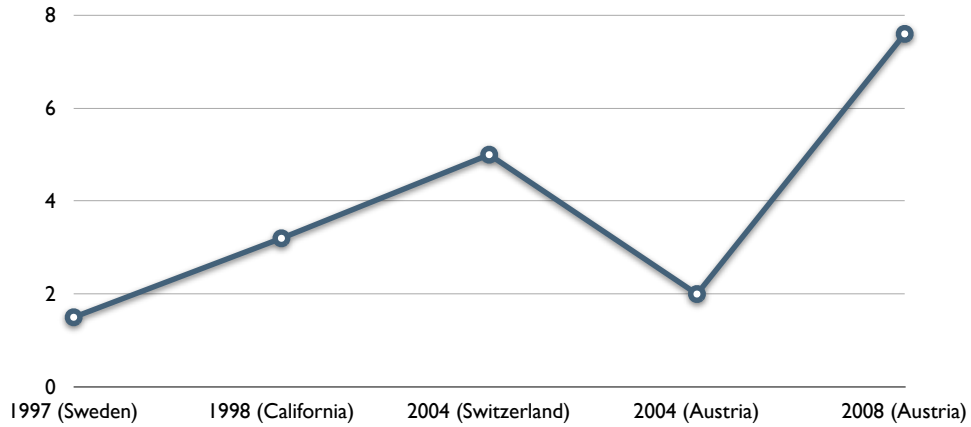


Measurement of average levels of microwave RF signal (900 MHz – 2.5 GHz in urban areas in France, 2000–2012.

The green line is at 0.1 microwatt/cm2 = 1000 microwatts per meter squared ~ 0.6 V/m, which many researchers in Europe suggest as an appropriate limit for exposure to the public.

http://www.next-up.org

Incidence of self-identified electrohypersensitivity (%)



In the previous studies, we saw that some symptoms are more common with higher exposure to microwave RF transmissions.

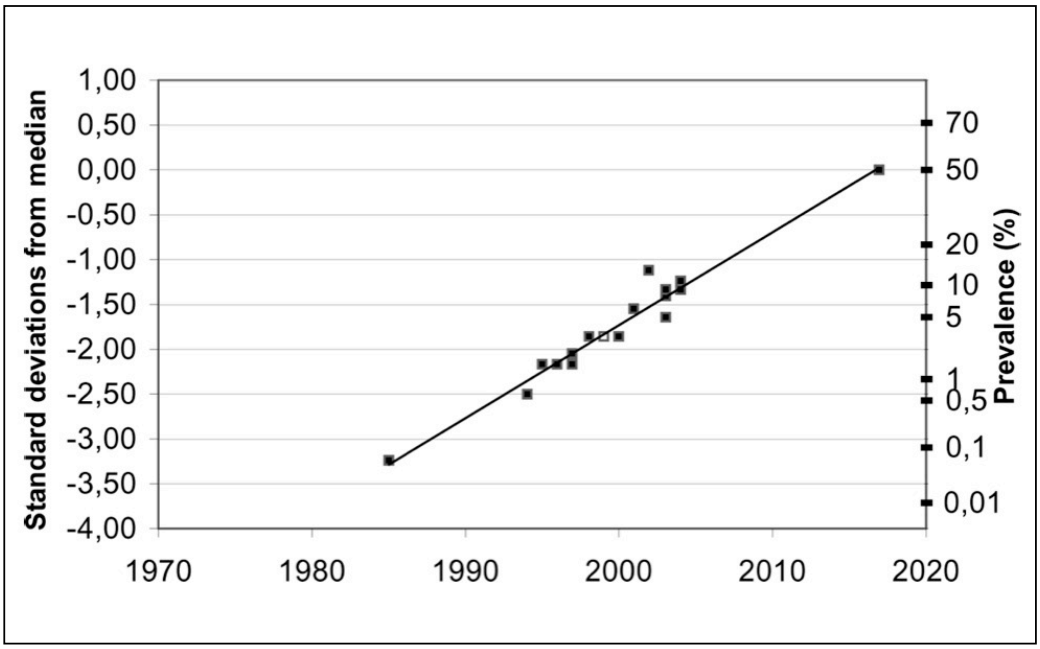
The people who had those symptoms may or may not have been aware that RF was a factor.

But some people with symptoms triggered by microwave RF exposures are aware that this is happening to them.

If these symptoms are sufficiently debilitating, the affected individual may consider themselves to be “electrohypersensitive”.

The above graph shows the percentage of the population that self-identified as having “EHS” in surveys done in various countries over the last two decades.

The prevalence of self-reported EHS is increasing.



The prevalence (%) of people around the world who consider themselves to be electrosensitive, as reported in various research studies from 1997 to 2008, plotted over time in a normal distribution graph.

The endpoint at 50% is an extrapolated value.

Hallberg O, Oberfeld G. Letter to the editor: will we all become electrosensitive? Electromagn Biol Med (2006); 25(3): 189-191.

Stockholm County, Sweden, 1997: 1.5% of the population reported being hypersentive to electrical or magnetic fields. (Hillert et al., 2002)

California, 1998: 3.2% of the adult population reported being sensitive to sources of EMF. (Levallois et al., 2002)

Switzerland, 2004: 5% of the population had symptoms attributable to EHS. (Schreier et al., 2006)

Austria, 2004: 2% of the population was estimated to have electrohypersensitivity.

Austria, 2008: 29.3% with some adverse response, 2.1% reported intense disturbance, and 3.5% had experienced enough difficulty that they had consulted a physician about the problem. (Schrottner and Leitgeb, 2008)

Alterations in Hormone Physiology

Rimbach, Bavaria (2004 - 2005)

In spring of 2004 a GSM cell tower was installed near Rimbach, Bavaria (population ~ 2000).

Prior to activation of the antenna, the town residents were asked to participate in a mass screening.

Urine levels of the stress hormones adrenaline, noradrenaline, dopamine, and phenylethylamine were measured in January/February 2004, and again in July 2004, January 2005, and July 2005.

A medical history and symptom questionnaire was also administered.

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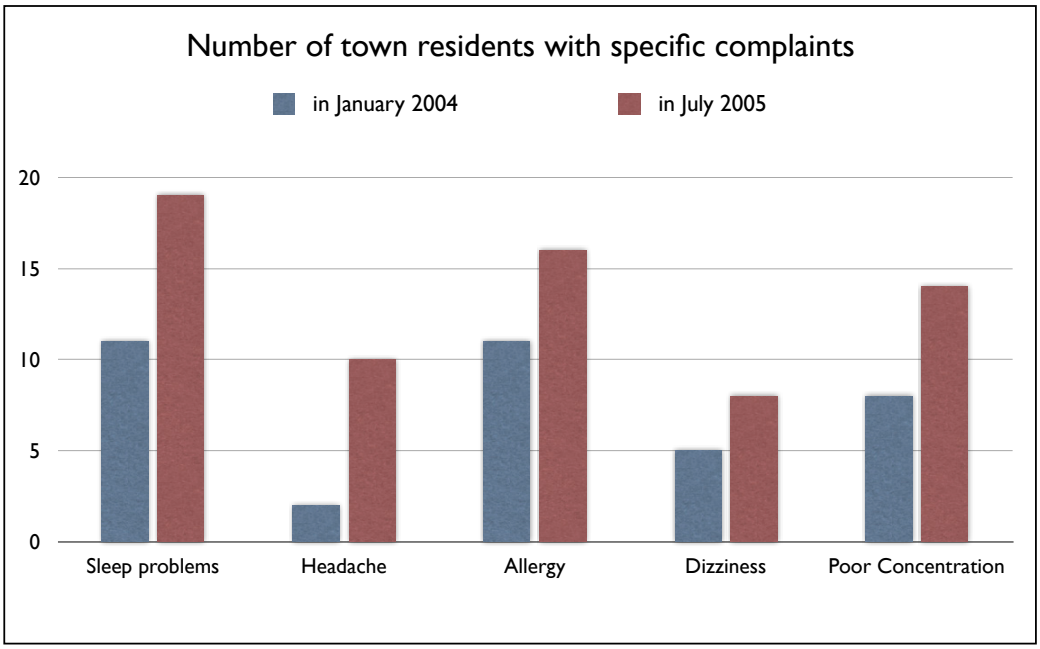
Buchner K EH. Changes of Clinically Important Neurotransmitters under the Influence of Modulated RF Fields--A Long-term Study under Real-life Conditions. *Umwelt-Medizin-Gesellschaft* (2011); 24(1):44-57.

Rimbach, Bavaria (2004 - 2005)

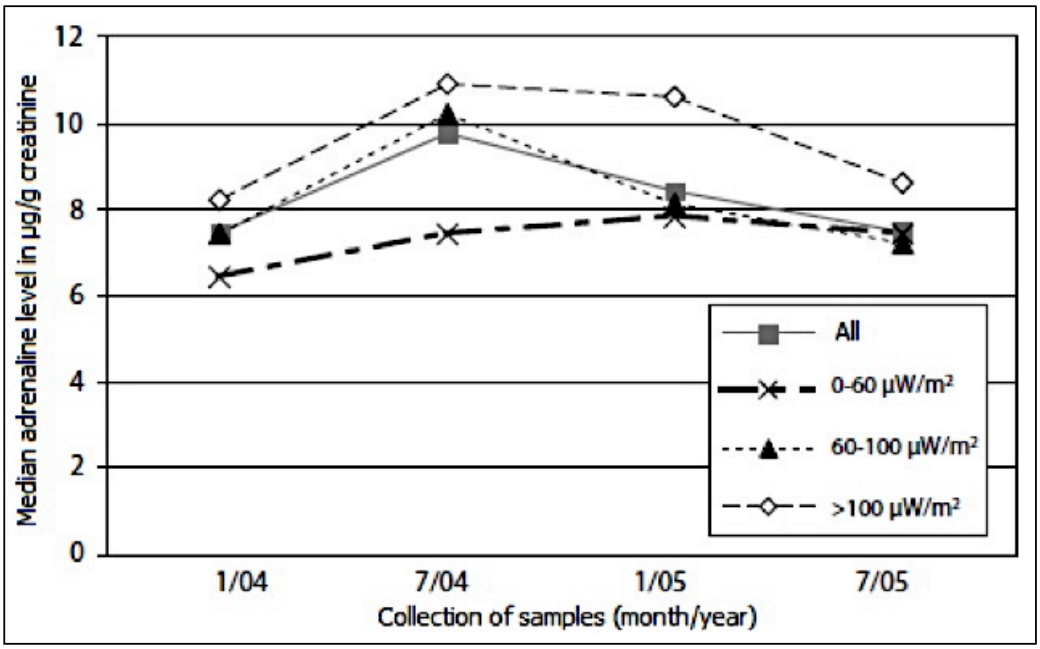


Here we see some symptom scores before tower activation (blue) and after a year of tower transmission (red)
Some health complaints increased over the course of the study.

Buchner K EH. Changes of Clinically Important Neurotransmitters under the Influence of Modulated RF Fields--A Long-term Study under Real-life Conditions. *Umwelt-Medizin-Gesellschaft* (2011); 24(1):44-57.

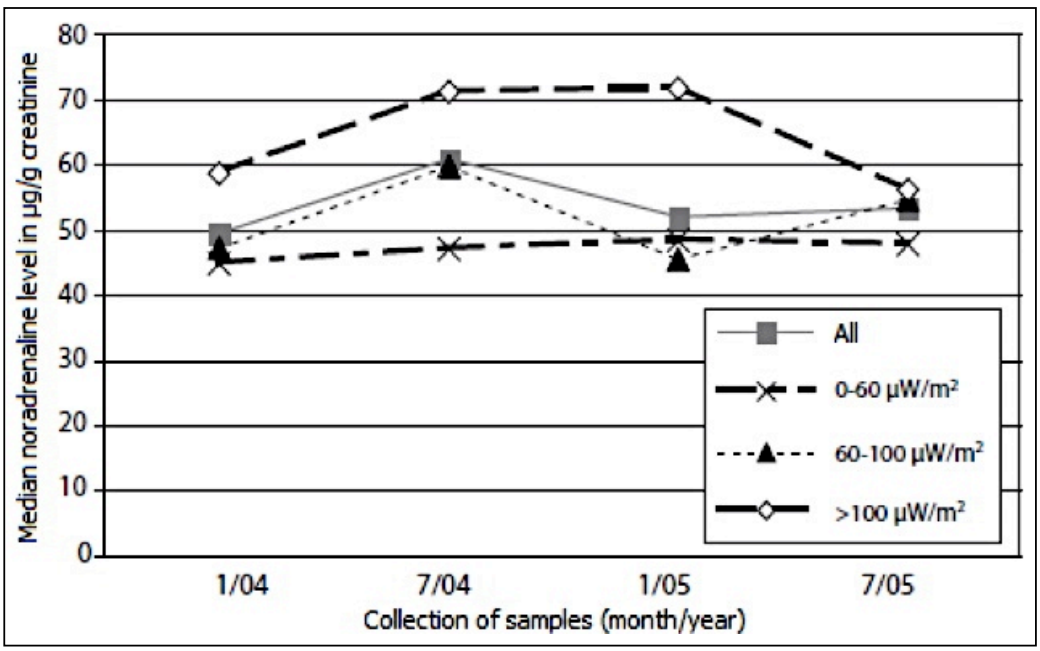
Abstract: This follow-up of 60 participants over one and a half years shows a significant effect on the adrenergic sys- tem after the installation of a new cell phone base station in the village of Rimbach (Bavaria). After the activation of the GSM base station, the levels of the stress hormones adrenaline and noradrenaline increased significantly during the first six months; the levels of the precursor dopamine decreased substantially. The initial levels were not restored even after one and a half years. As an indicator of the dysregulated chronic imbalance of the stress system, the phenylethylamine (PEA) levels dropped significantly until the end of the study period. The effects showed a dose-response relationship and occurred well below current limits for technical RF radiation exposures. Chronic dysregulation of the catecholamine system has great relevance for health and is well known to damage human health in the long run.

Adrenaline levels



Results were stratified by in-home exposure levels (mW/m^2) in three cohorts.
Hormone levels graphed for each exposure cohort.
Levels of the stress hormone adrenaline rose after the transmitter became active.
In the highest exposure cohort adrenaline levels never returned to pre-exposure baseline.

Fig. 3: Median adrenaline levels for all participating citizens of Rimbach whose cell phone base station exposure was above 100 µW/m2, between 60 and 100 µW/m2, or up to 60 µW/m2. The power density levels refer to peak values of the GSM radiation exposure in front of a given residence.



Noradrenaline levels also rose after the transmitter became active.
They never returned to pre-exposure baseline.

Fig. 7: Median noradrenaline levels in all participating citizens of Rimbach as a function of GSM power density levels (peak values)

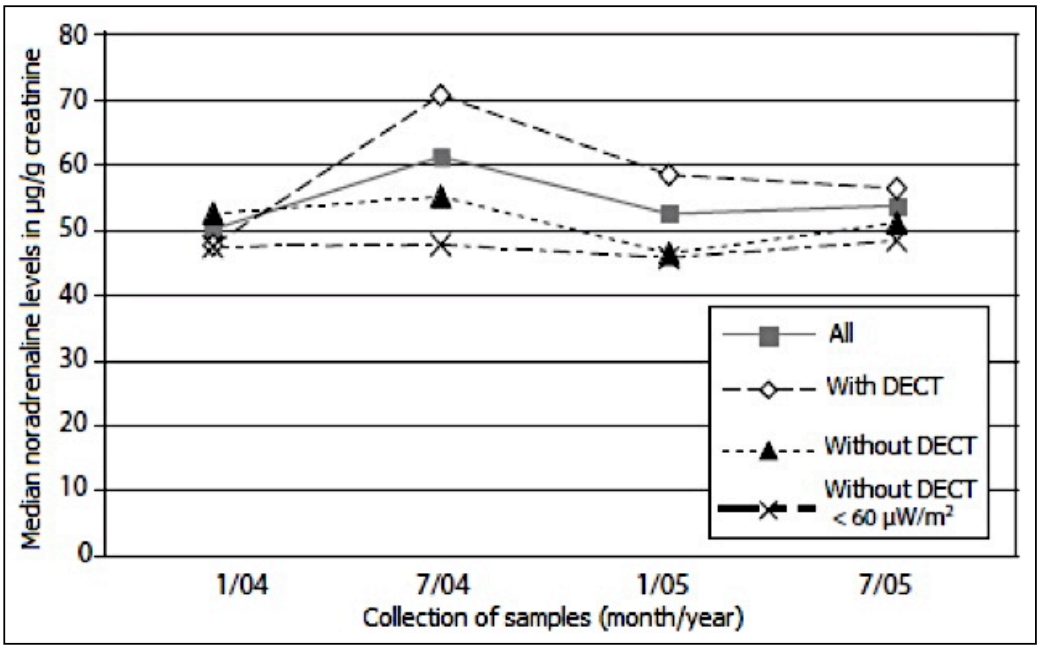
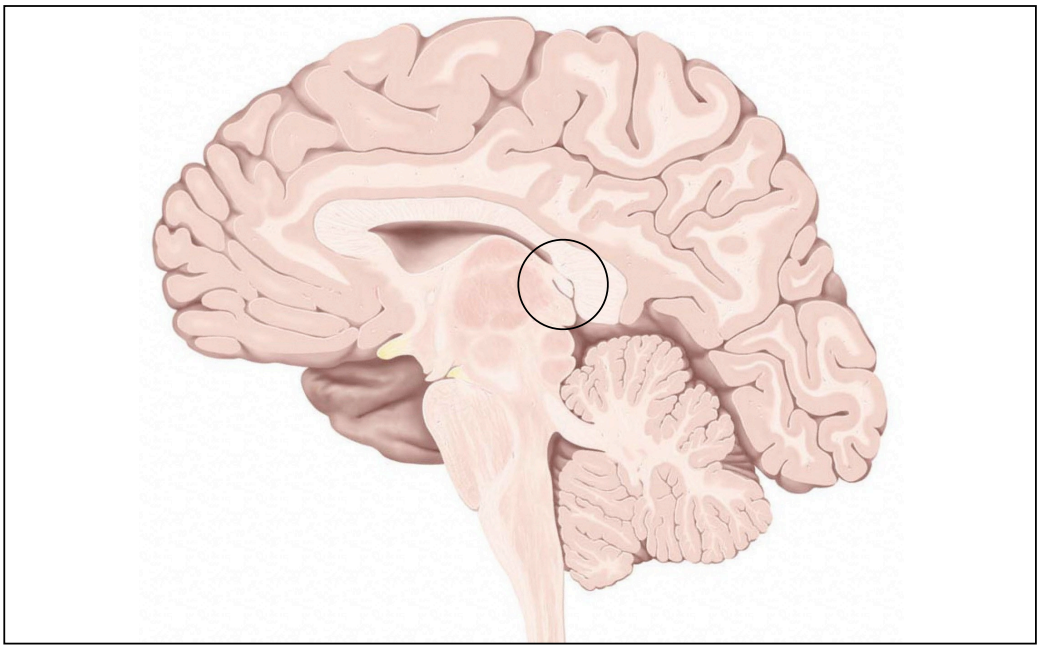


Fig. 8: Median noradrenaline values for subjects who had a DECT phone or other wireless devices at home, for those without indoor wireless devices, as well as for subjects without indoor wireless devices and with a GSM radiation exposure up to 60 µW/m2 (peak value measured in front of residence)

Buchner K EH. Changes of Clinically Important Neurotransmitters under the Influence of Modulated RF Fields--A Long-term Study under Real-life Conditions. Umwelt-Medizin-Gesellschaft (2011); 24(1):44-57.

Abstract: This follow-up of 60 participants over one and a half years shows a significant effect on the adrenergic sys- tem after the installation of a new cell phone base station in the village of Rimbach (Bavaria). After the activation of the GSM base station, the levels of the stress hormones adrenaline and noradrenaline increased significantly during the first six months; the levels of the precursor dopamine decreased substantially. The initial levels were not restored even after one and a half years. As an indicator of the dysregulated chronic imbalance of the stress system, the phenylethylamine (PEA) levels dropped significantly until the end of the study period. The effects showed a dose-response relationship and occurred well below current limits for technical RF radiation exposures. Chronic dysregulation of the catecholamine system has great relevance for health and is well known to damage human health in the long run.

Melatonin

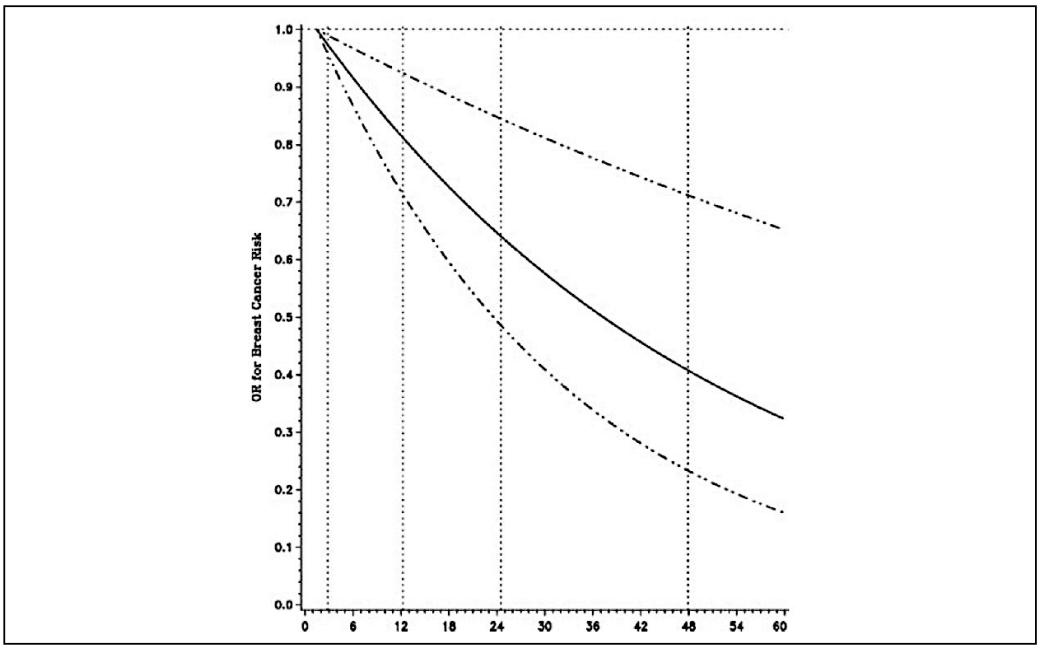


The pineal gland secretes melatonin. Ambient light suppresses melatonin secretion. So melatonin secretion is high during the night-time hours, peaking shortly after midnight. **Higher melatonin levels are part of what makes us feel "sleepy" at night.**

Exposure to light during the night-time hours will lead to a rapid suppression of melatonin secretion by the pineal gland, and this can cause disruption of sleep and derangement of the circadium rhythm.

Melatonin is one of the most potent anti-oxidant molecules in the human body, and acts to reduce reactive oxidative processes in the body. Melatonin can quench the damaging free radical activity produced by inflammation. The presence of elevated melatonin at night is therefore a key factor in the healing and rejuvenating functions that we associate with "a good night's sleep".

Melatonin lowers risk of breast cancer.



[Figure 1. Smoothing spline plot for **aMT6s level (ng/mg creatinine)** in relation to **breast cancer risk** among postmenopausal women. 95% CIs are indicated by dotted lines.]

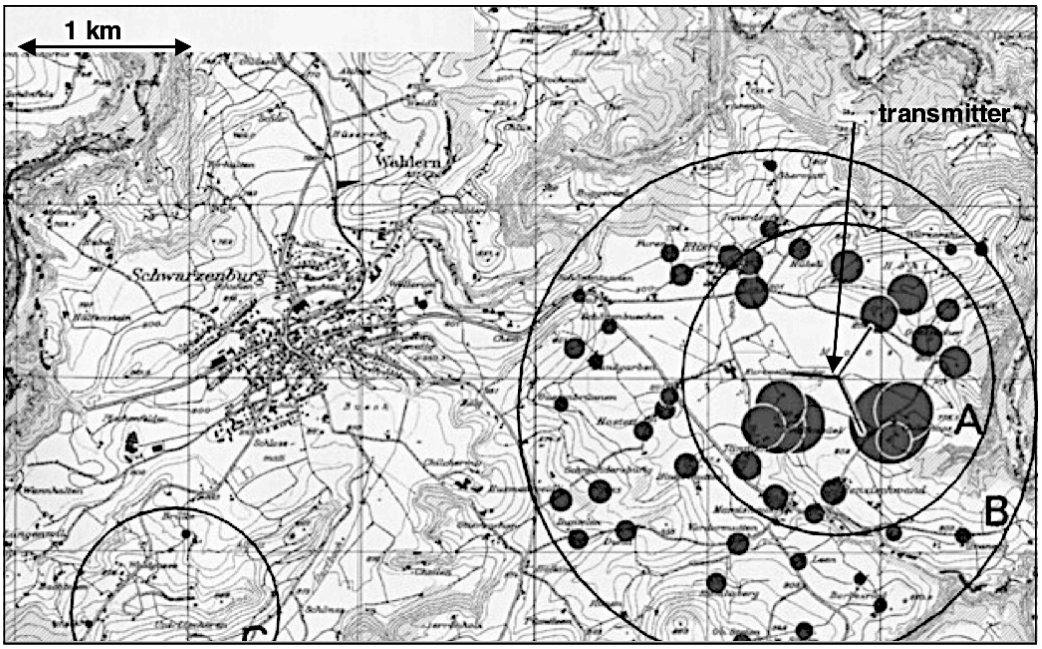
Melatonin is also protective against the growth of cancer cells, and disruption of the circadian melatonin cycle has been shown to lead to increased tumor growth in a variety of cancer types.

Women who have lower levels of nocturnal melatonin are at greater risk for developing breast cancer.

In 2007 the International Agency for Research on Cancer declared night shift work to be a probable carcinogen due to increased breast cancer risk..

Schernhammer ES, Hankinson SE. Urinary melatonin levels and postmenopausal breast cancer risk in the Nurses' Health Study cohort. Cancer Epidemiol Biomarkers Prev (2009); 18(1):74-79.

Schwarzenburg Short Wave Radio Broadcast Tower – 1998



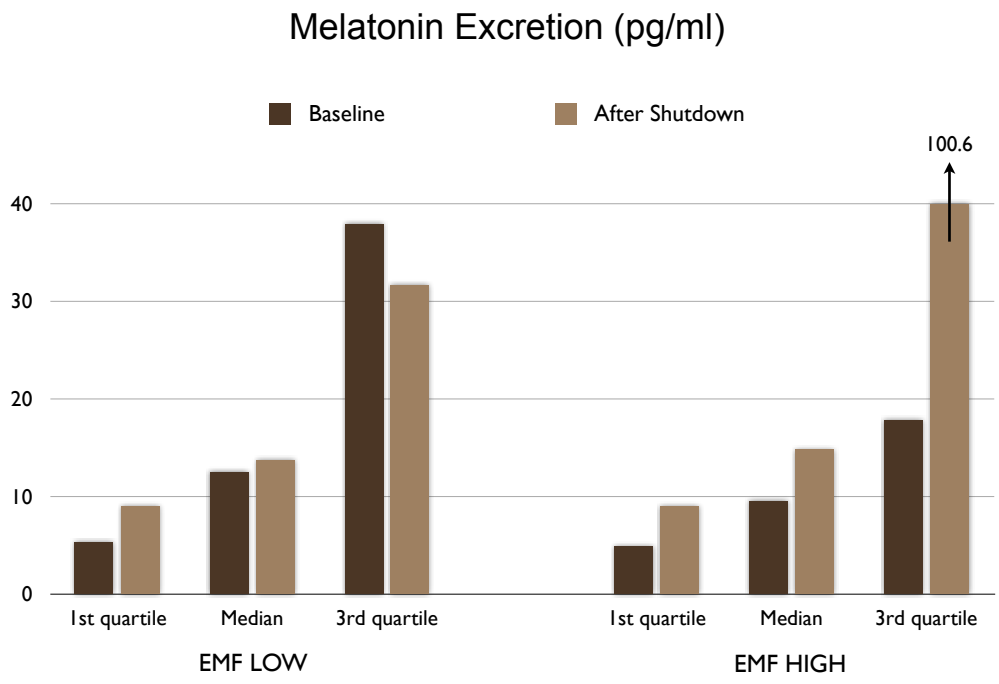
RF exposure can also lower melatonin levels.

Schwarzenburg experiment: Decommissioning the Swiss national short-wave radio transmitter of Schwarzenburg, about 20 km south of the Swiss Capital city of Berne, transmitting since 1939. It operated at frequencies of 3 to 30 MHz, with a maximum power of two times 150 kW.

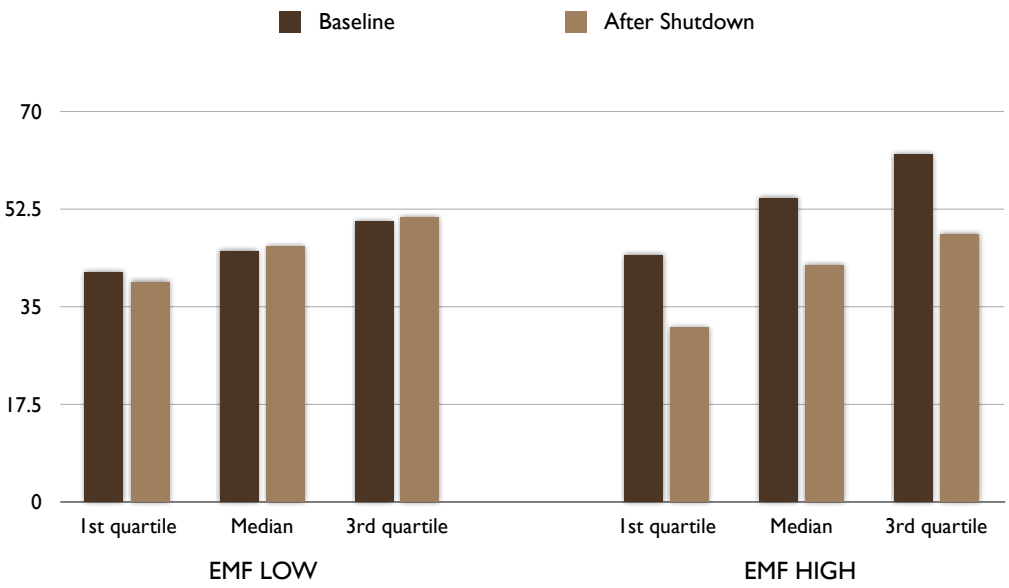
Figure 1. Map of the Schwarzenburg area showing the location of the transmitter, the H-field measurement points and the location of the zones A, B, C and R. The diameters of the circles around the measurement points indicate the 24 hour average magnetic field strengths, as measured between August 1992 and August 1993. (Reproduced with approval from swisstopo (BA046633.))

Abelin T, Altpeter E, Roosli M. Sleep Disturbances in the Vicinity of the Short-Wave Broadcast Transmitter Schwarzenburg. Somnologie (2005); 9:203-209.

Altpeter ES, Roosli M, Battaglia M, Pfluger D, Minder CE, Abelin T. Effect of short-wave (6-22 MHz) magnetic fields on sleep quality and melatonin cycle in humans: the Schwarzenburg shut-down study. Bioelectromagnetics (2006); 27(2):142-150.



Altpeter ES, Roosli M, Battaglia M, Pfluger D, Minder CE, Abelin T. Effect of short-wave (6-22 MHz) magnetic fields on sleep quality and melatonin cycle in humans: the Schwarzenburg shut-down study. Bioelectromagnetics (2006); 27(2):142-150.



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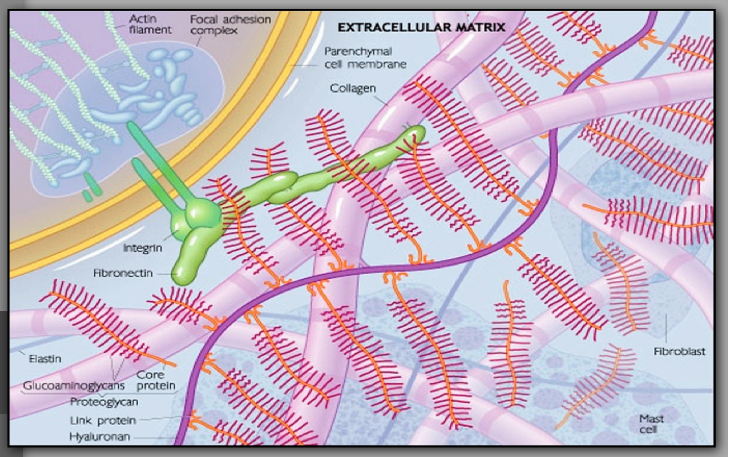
Microwave RF Interacts with Molecular Structures



(Original art by Raychel Ciemma, Springfield, Oregon, for Paul Lee DO FAAO's book Interface, used with permission.)

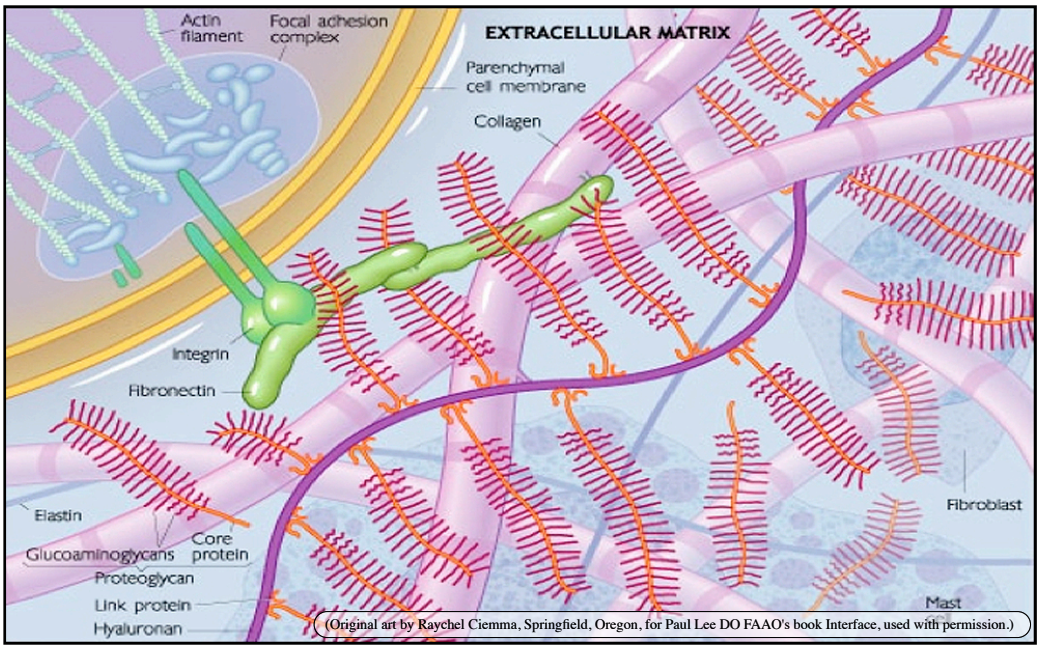
The molecules in our bodies vary in size and in total electric charge.

These molecular structures of our body can resonate with fluctuating electromagnetic fields.

Any charged particle has a resonant frequency.

This frequency varies depending on the total mass and charge of the particle.

Molecules resonate in fluctuating electromagnetic fields.



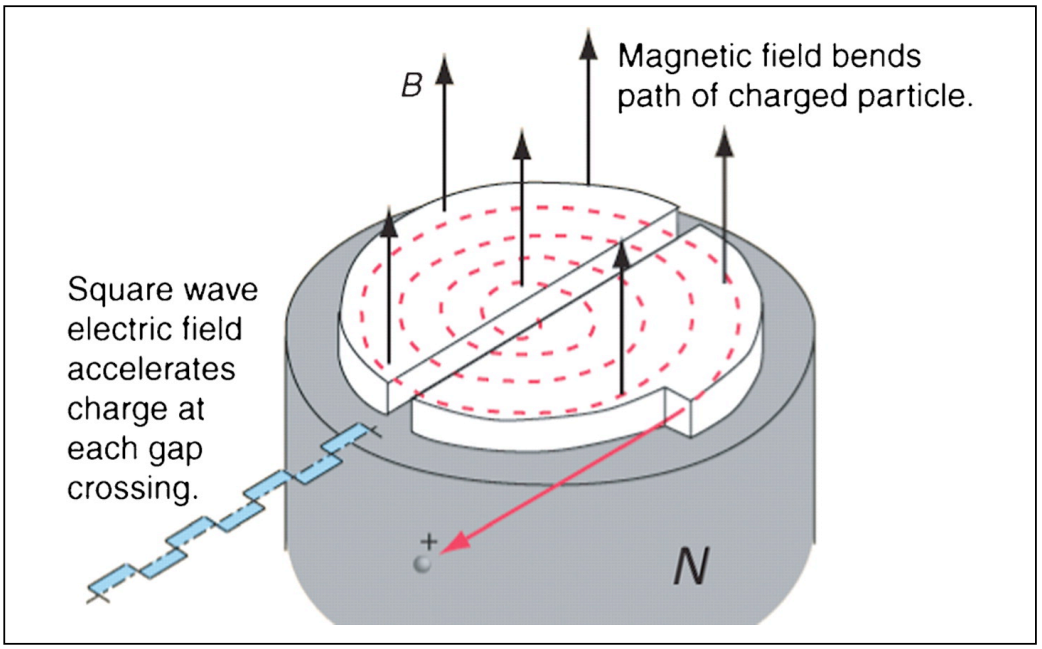
The molecules in our bodies vary in size and total electric charge.

These molecular structures of our body resonate with fluctuating electromagnetic fields.

Resonance Frequency

When you push something at its resonant frequency,
a small force can produce a lot of motion.

Resonance Frequency

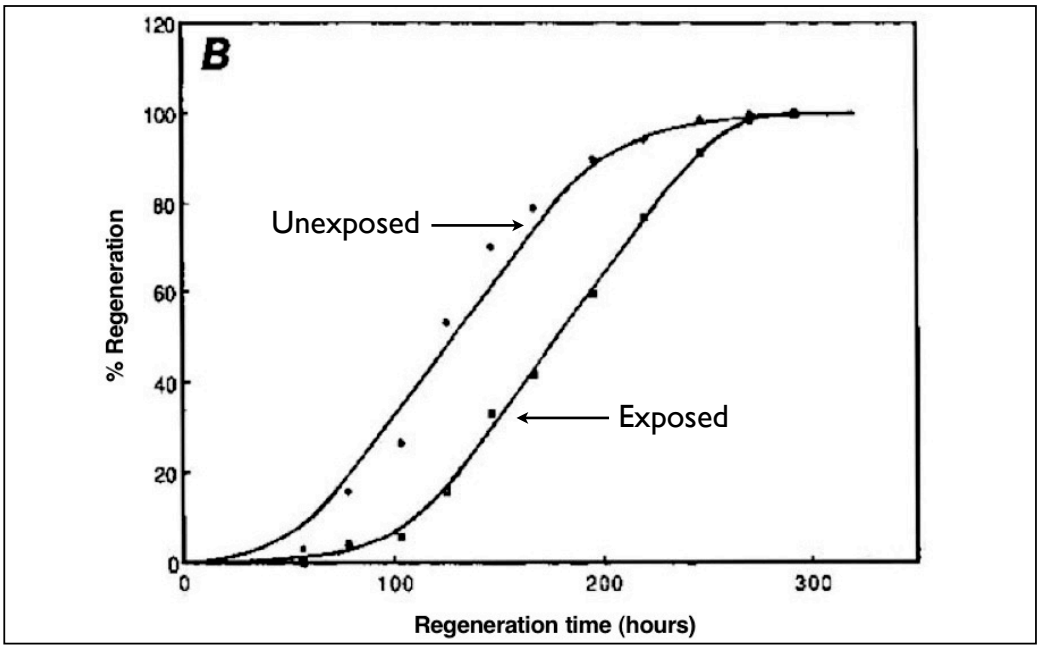


Placing the particle in an electromagnetic field that fluctuates at the resonant frequency will amplify the motion of the particle.

This is how a cyclotron works, and the frequency is often referred to as the “Ion Cyclotron Resonance” or ICR frequency.

Magnetic fields that fluctuate at the resonant frequency of an ion like calcium, or of a specific enzyme, can have dramatic effects on biochemical processes in the body.

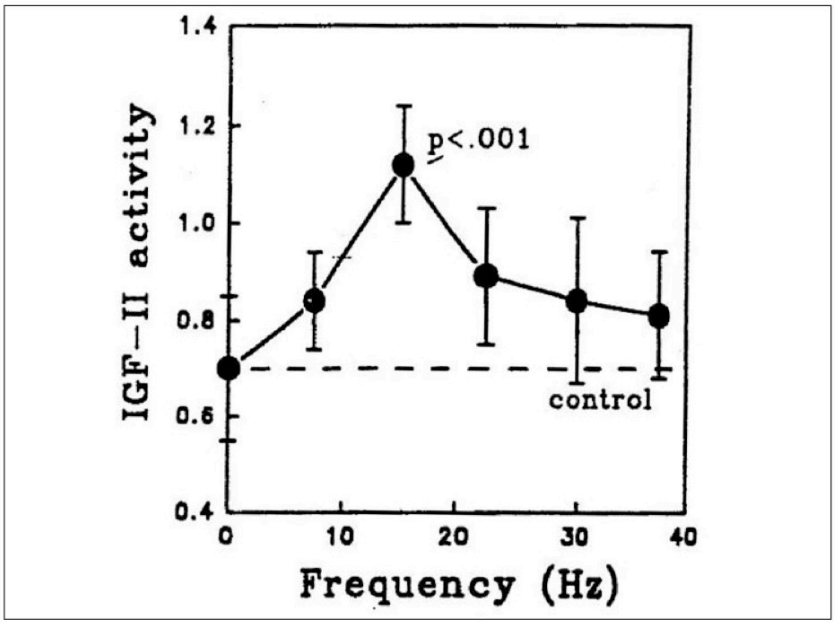
Resonance Effect



Planaria exposed to a magnetic field fluctuating at the calcium ion's ICR frequency take far longer (48 hours) to regenerate than those that are not exposed.

Liboff A. Weak low-frequency electromagnetic fields are biologically interactive. In: Giuliani L, Soffritti M, eds. Non-Thermal Effects and Mechanisms of Interaction Between Electromagnetic Fields and Living Matter -- An ICEMS Monograph. Fidenza, Italy: Mattioli, (2010): 51-61. *http://www.ramazzini.it/ricerca/publications.asp*

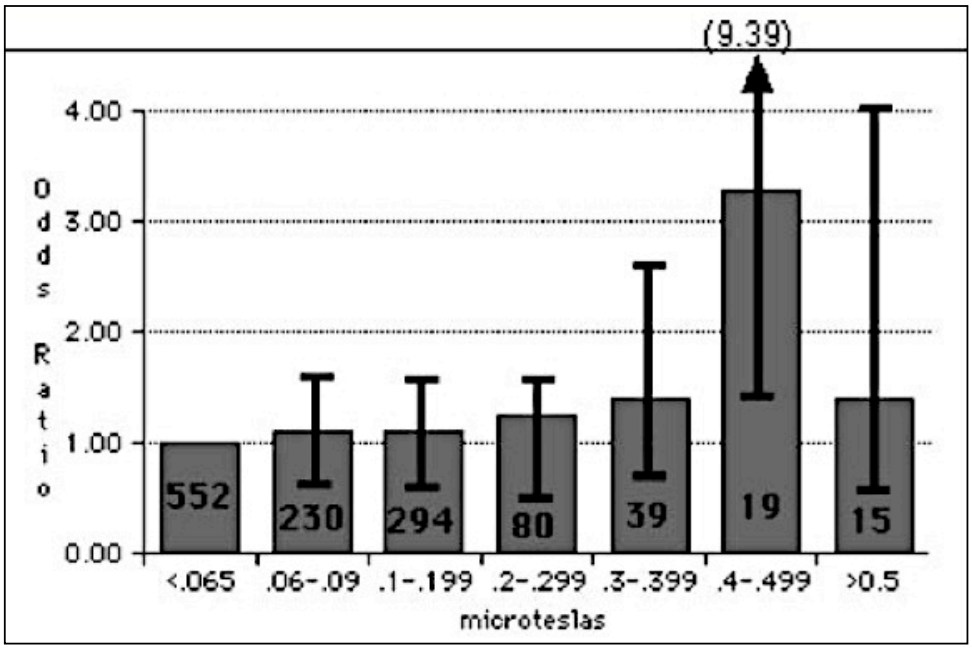
"frequency window"



Some effects of fluctuating EMF occur at specific frequencies, called "frequency windows".
The peak in IGF-II expression for human osteosarcoma bone cells exposed to combined magnetic fields occurs when the field is tuned to the calcium ion's ICR frequency

Liboff A. Weak low-frequency electromagnetic fields are biologically interactive. In: Giuliani L, Soffritti M, eds. Non-Thermal Effects and Mechanisms of Interaction Between Electromagnetic Fields and Living Matter -- An ICEMS Monograph. Fidenza, Italy: Mattioli, (2010): 51-61. *http://www.ramazzini.it/ricerca/publications.asp*

“power window”



At a given frequency, some power levels may have a different effect than others. This is a “power window”

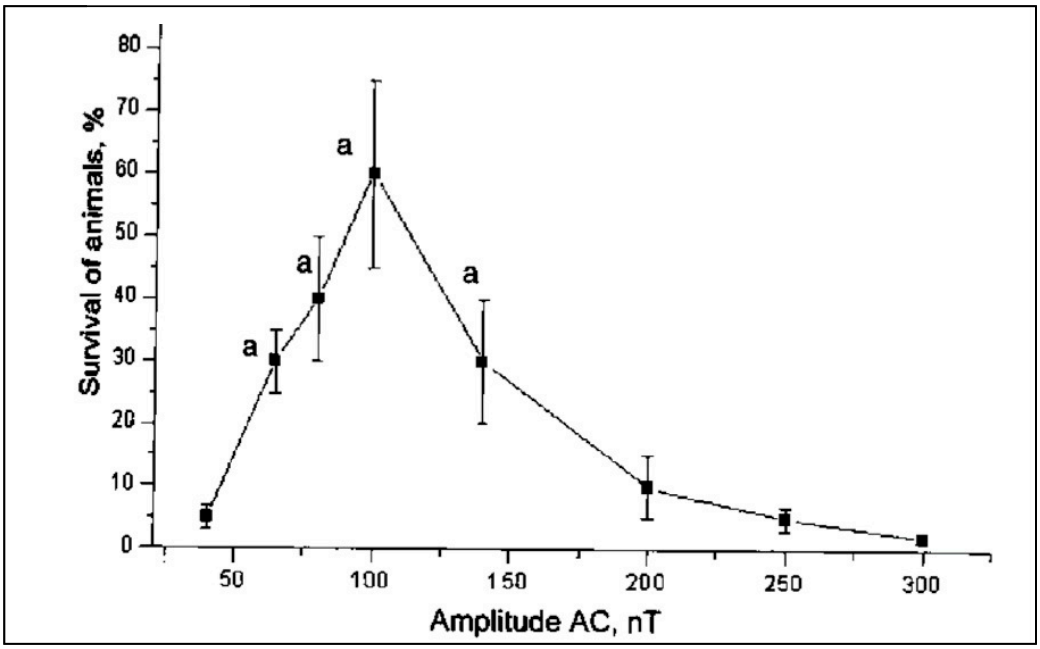
In this illustration, the odds ratio for childhood onset of Acute Lymphoblastic Leukemia is significantly higher if they are exposed to 60 cycle magnetic fields at a magnitude of 0.4 to 0.499 microtesla.

Lower and higher field magnitudes do not show the same effect.

Liboff A. Weak low-frequency electromagnetic fields are biologically interactive. In: Giuliani L, Soffritti M, eds. Non-Thermal Effects and Mechanisms of Interaction Between Electromagnetic Fields and Living Matter -- An ICEMS Monograph. Fidenza, Italy: Mattioli, (2010): 51-61. *http://www.ramazzini.it/ricerca/publications.asp*

Fig. 1. Odds ratios for childhood ALL, determined by Linet et al 6, as a function of residential magnetic field. The large ratios seen for fields between .4 and .499 μT, although having many less participants, are nevertheless statistically significant

“power window”



Mice with Ascites Ehrlich carcinoma 33,

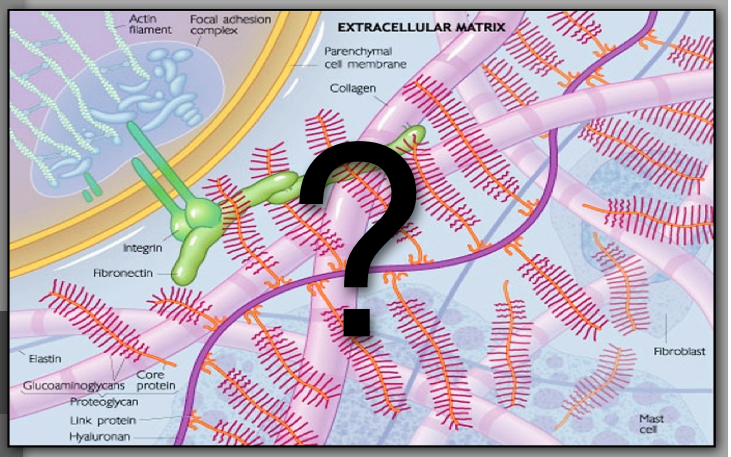
exposed to a fluctuating EM field tuned to the ICR frequency for aspartic acid and glutamic acid ions.

Survival varies with the AMPLITUDE (magnitude) of the field.

Liboff A. Weak low-frequency electromagnetic fields are biologically interactive. In: Giuliani L, Soffritti M, eds. Non-Thermal Effects and Mechanisms of Interaction Between Electromagnetic Fields and Living Matter -- An ICEMS Monograph. Fidenza, Italy: Mattioli, (2010): 51-61. *http://www.ramazzini.it/ricerca/publications.asp*

Fig. 5. Survival curve for mice infected with Ascites Ehrlich carcinoma33, under ICR conditions corresponding to mean tuning (4.4 Hz) for aspartic acid and glutamic acid ions. In contrast to Fig. 2 where the frequency is varied, a resonance (or window) peak is observed as the AC magnetic field intensity is varied

What does this mean?



(Original art by Raychel Ciemma, Springfield, Oregon, for Paul Lee DO FAAO's book Interface, used with permission.)

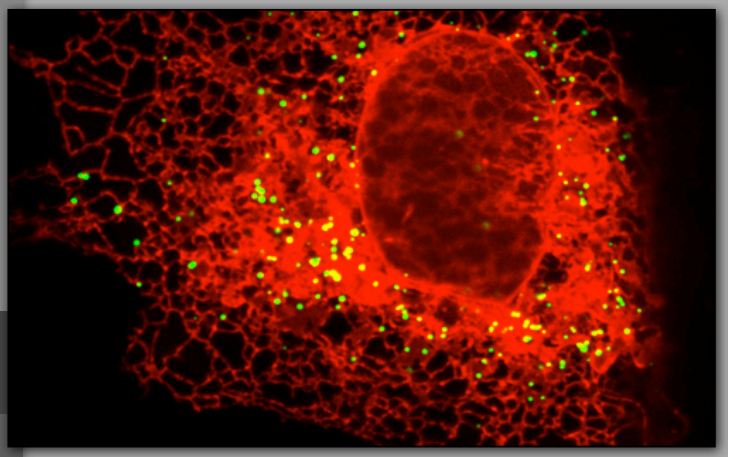
There are thousands of enzymes and other molecules in the human body.

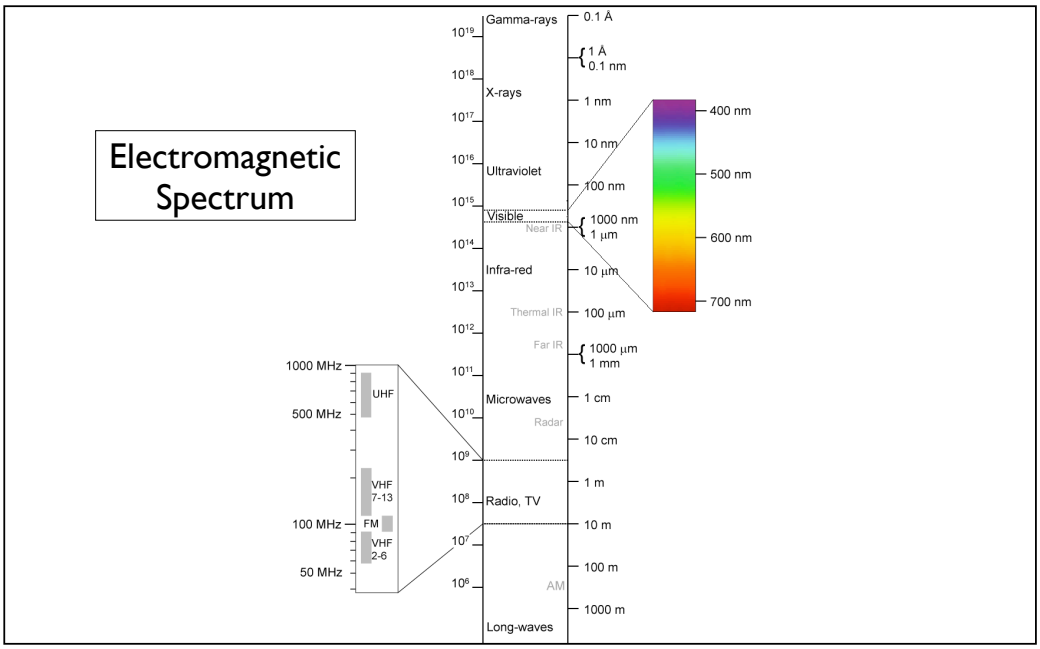
Each has its own mass, charge, and resonant frequency.

This means that different electromagnetic frequencies will resonate with different molecules.

Which means that the biological effects of EMF on molecular physiology are probably much more complex than is generally assumed to be the case.

Microwave RF Produces Oxidative Stress in Cells





Ionizing radiation from the high energy end of the electromagnetic spectrum can directly break DNA molecular bonds, causing mutations.

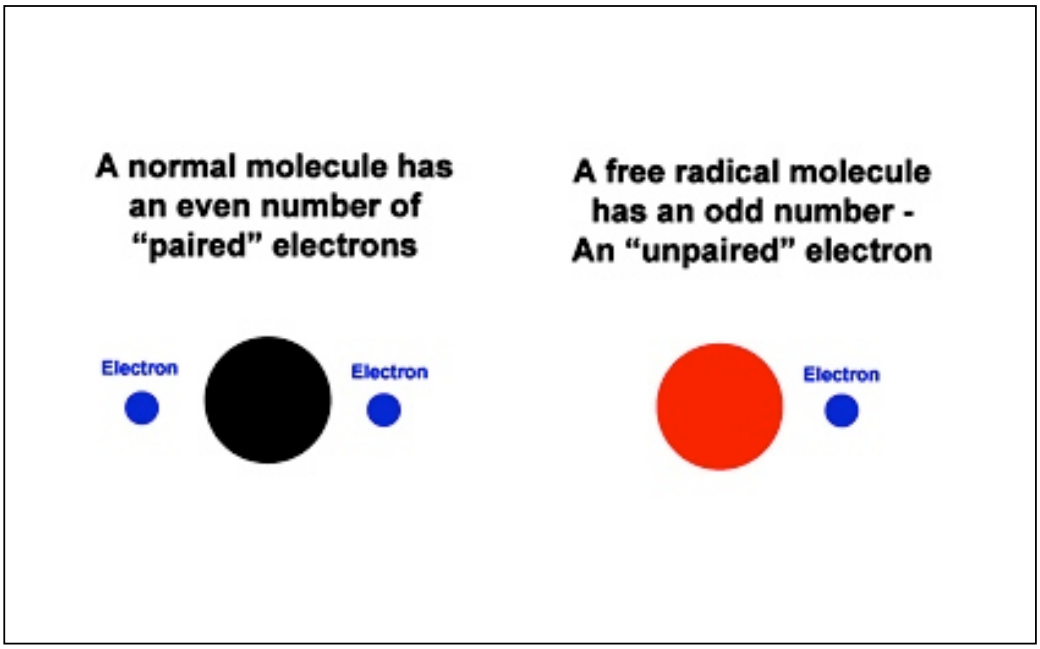
But photons of microwave RF do not have enough energy to directly break covalent molecular bonds.

Industry advocates often make the statement that since RF cannot break molecular bonds, there is no way that it can cause cancer.

Such statements sound like good physics. But they reflect a poor understanding of biology.

Tobacco can cause cancer. Genital warts can cause cancer. Asbestos can cause cancer. There are many ways to cause cancer besides ionizing radiation.

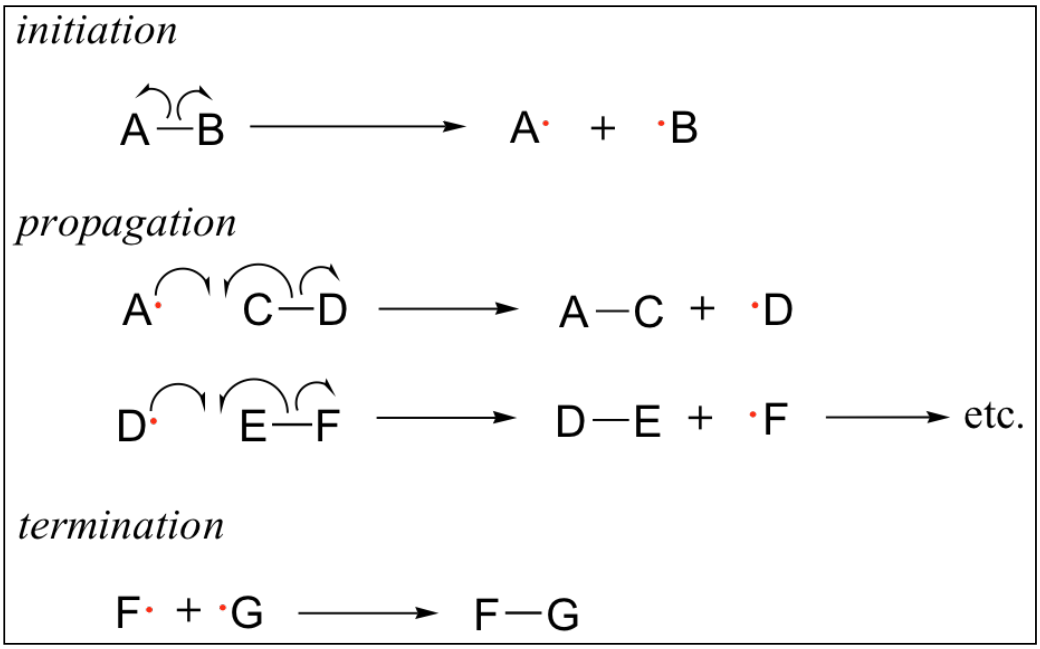
Free Radicals



Free radicals are oxidizing agents.

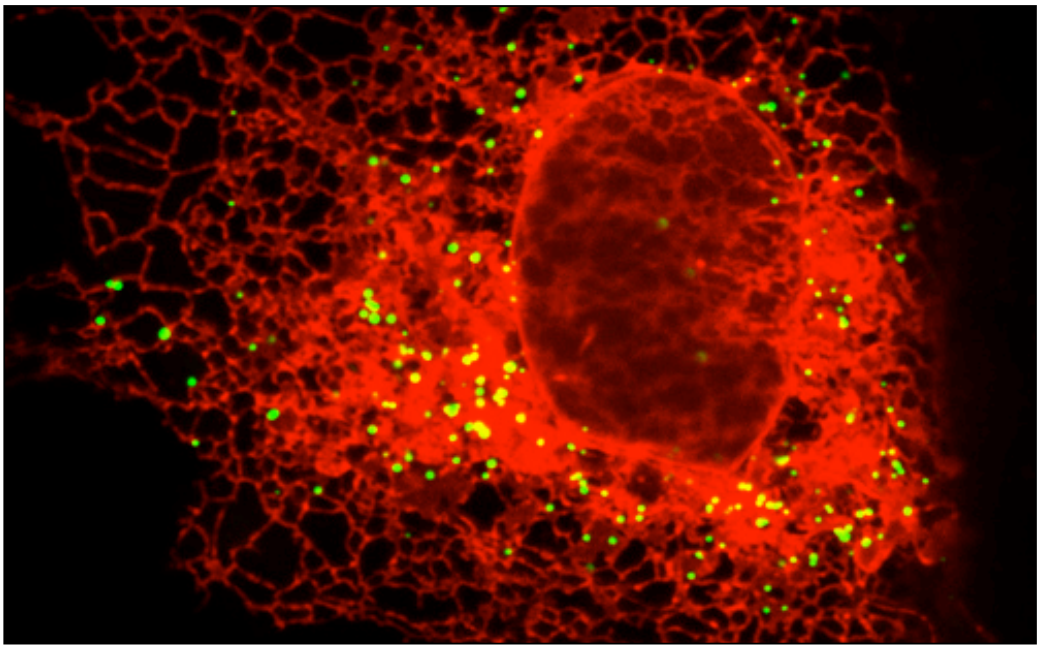
They take electrons from other atoms or molecules, which can break molecular bonds.

Life cycle of a free radical.



Precursor molecule (AB) splits to form two free radicals.

Free radicals then can produce chain reactions, causing oxidative damage.



Peroxizomes (yellow) in a cell – packages of free radicals stored in cells.

Cells are making free radicals all the time.

Our bodies release them in inflammation to combat bacteria, remove diseased tissue, etc.

The free radicals release by the inflammatory process can break covalent bonds and fragment macomolecules.

Review Article *J. Cell. Mol. Med. Vol XX, No X, 2013 pp. 1-9*

Guest Editor:

Electromagnetic fields act *via* activation of voltage-gated calcium channels to produce beneficial or adverse effects

Martin L. Pall *

Professor Emeritus of Biochemistry and Basic Medical Sciences, Washington State University, Portland, OR, USA

Received: January 8, 2013; Accepted: May 20, 2013

Abstract

The direct targets of extremely low and microwave frequency range electromagnetic fields (EMFs) in producing non-thermal effects have not been clearly established. However, studies in the literature, reviewed here, provide substantial support for such direct targets. Twenty-three studies have shown that voltage-gated calcium channels (VGCCs) produce these and other EMF effects, such that the L-type or other VGCC blockers block or greatly lower diverse EMF effects. Furthermore, the voltage-gated properties of these channels may provide biophysically

This recently published article reviews published evidence that EMF can produce physiologic effects by altering the function of voltage gated calcium channels in cell walls.

Pall ML. Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects. *J Cell Mol Med* (2013);

Table 1 EMF responses blocked or lowered by calcium channel blockers

Ref. no.	EMF type	Calcium channel	Cell type or organism	Response measured
2	Pulsed magnetic fields	L-type	Human lymphocytes	Cell proliferation; cytokine production
3	Static magnetic field (0.1 T)	L-type	Human polymorphonuclear leucocytes	Cell migration; degranulation
5	ELF	L-type	Rat chromaffin cells	Differentiation; catecholamine release
6	Electric field	L-type	Rat and mouse bone cells	Increased Ca^{2+}, phospholipase A2, PGE2
7	50 Hz	L-type	Mytilus (mussel) immunocytes	Reduced shape change, cytotoxicity
8	50 Hz	L-type	AtT20 D16V, mouse pituitary corticotrope-derived	Ca^{2+} increase; cell morphology, premature differentiation
9	50 Hz	L-type	Neural stem/progenitor cells	*In vitro* differentiation, neurogenesis
10	Static magnetic field	L-type	Rat	Reduction in oedema formation
11	NMR	L-type	Tumour cells	Synergistic effect of EMF on anti-tumour drug toxicity
12	Static magnetic field	L-type	Myelomonocytic U937 cells	Ca^{2+} influx into cells and anti-apoptotic effects
13	60 Hz	L-type	Mouse	Hyperalgesic response to exposure
14	Single nanosecond electric pulse	L-type	Bovine chromaffin cells	Very rapid increase in intracellular Ca^{2+}
15	Biphasic electric current	L-type	Human mesenchymal stromal cells	Osteoblast differentiation and cytokine production
16	DC & AC magnetic fields	L-type	β-cells of pancreas, patch clamped	Ca^{2+} flux into cells
17	50 Hz	L-type	Rat pituitary cells	Ca^{2+} flux into cells
18	50 Hz	L-type, N-type	Human neuroblastoma IMR32 and rat pituitary GH3 cells	Anti-apoptotic activity
19	Nanosecond pulse	L-type, N-type, P/Q-type	Bovine chromaffin cells	Ca^{2+} dynamics of cells
20	50 Hz	Not determined	Rat dorsal root ganglion cells	Firing frequency of cells
21	700–1100 MHz	N-type	Stem cell–derived neuronal cells	Ca^{2+} dynamics of cells
22	Very weak electrical fields	T-type	Sharks	Detection of very weak magnetic fields in the ocean
23	Short electric pulses	L-type	Human eye	Effect on electro-oculogram
24	Weak static magnetic field	L-type	Rabbit	Baroreflex sensitivity
25	Weak electric fields	T-type	Neutrophils	Electrical and ion dynamics
26	Static electric fields, 'capacitive'	L-type	Bovine articular chondrocytes	Agrican & type II collagen expression; calcineurin and other Ca^{2+}/calmodulin responses

EMF: electromagnetic field; ELF: extremely low frequency.

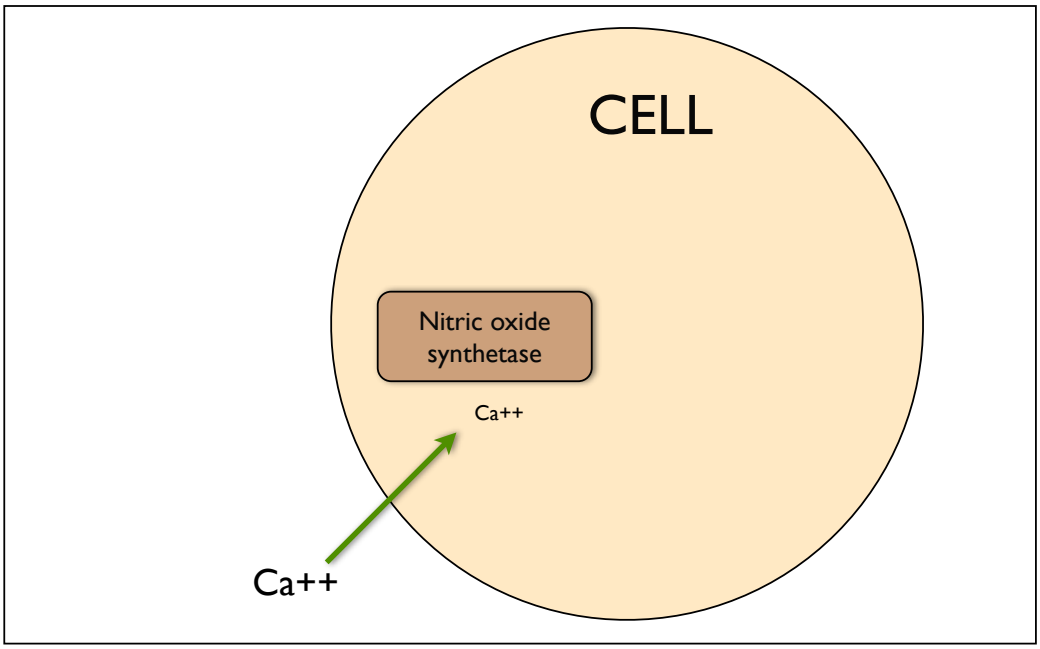
These are some of the 23 published studies documenting that EMF can increase flow through these calcium channels, producing biological effects.

In all these studies, the effects of EMF on increased cellular calcium levels could be blocked by calcium channel blocking drugs.

In all these studies, the effects of EMF on increased cellular calcium levels could be blocked by calcium channel blocking drugs.

Pall ML. Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects. *J Cell Mol Med* (2013);

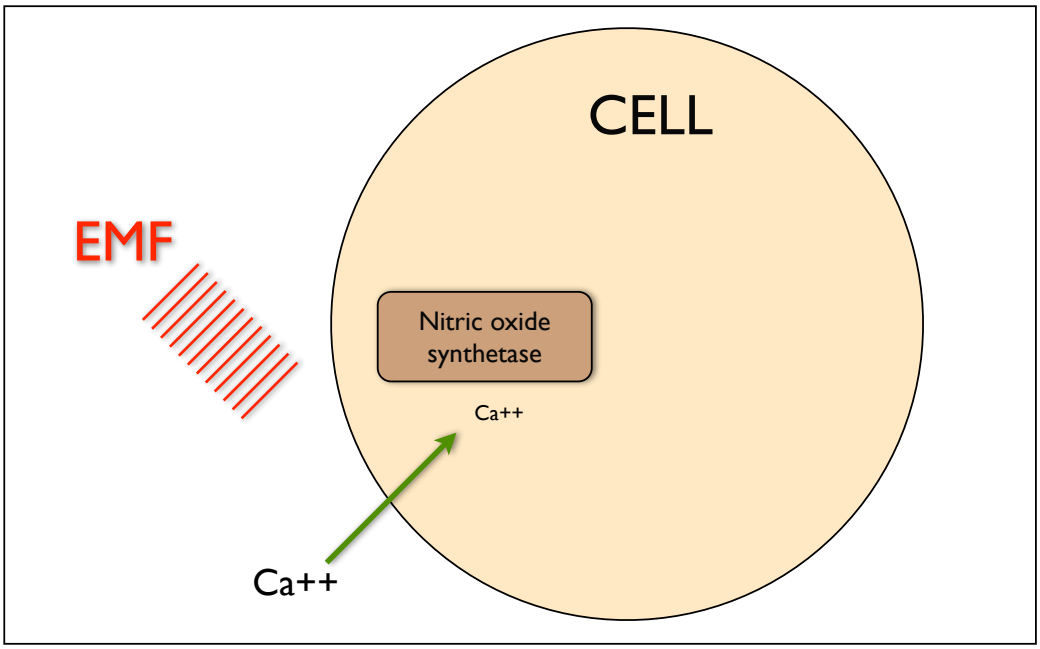
EMF Activation of VGCCs Increases Free Radical Production



Normally, Calcium concentrations are much higher outside of cells than inside them.
Influxes of calcium into cells act as chemical signals to alter cellular physiologic activity.
Here we have a diagram of a cell, with high levels of calcium outside, and lower levels of calcium inside.
The green arrow is a voltage-gated calcium channel, that can open to allow more calcium to enter the cell.
Inside the cell, we can see an enzyme (nitric oxide synthetase).

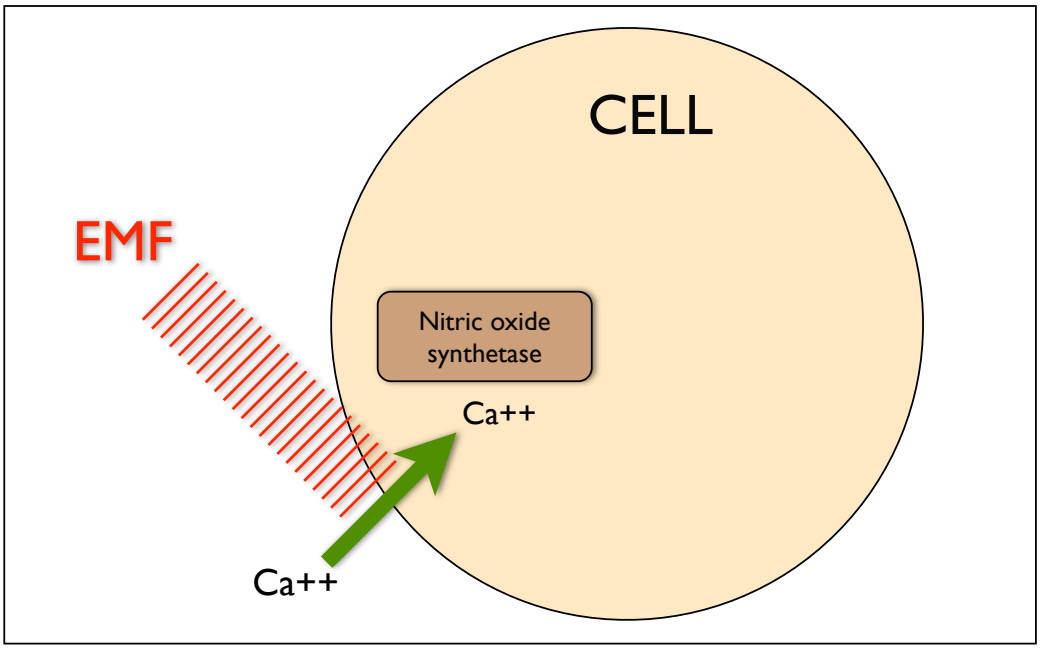
As discussed by Pall ML. Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects. *J Cell Mol Med* (2013);

EMF Activation of VGCCs Increases Free Radical Production



An electromagnetic field arrives at the cell wall.

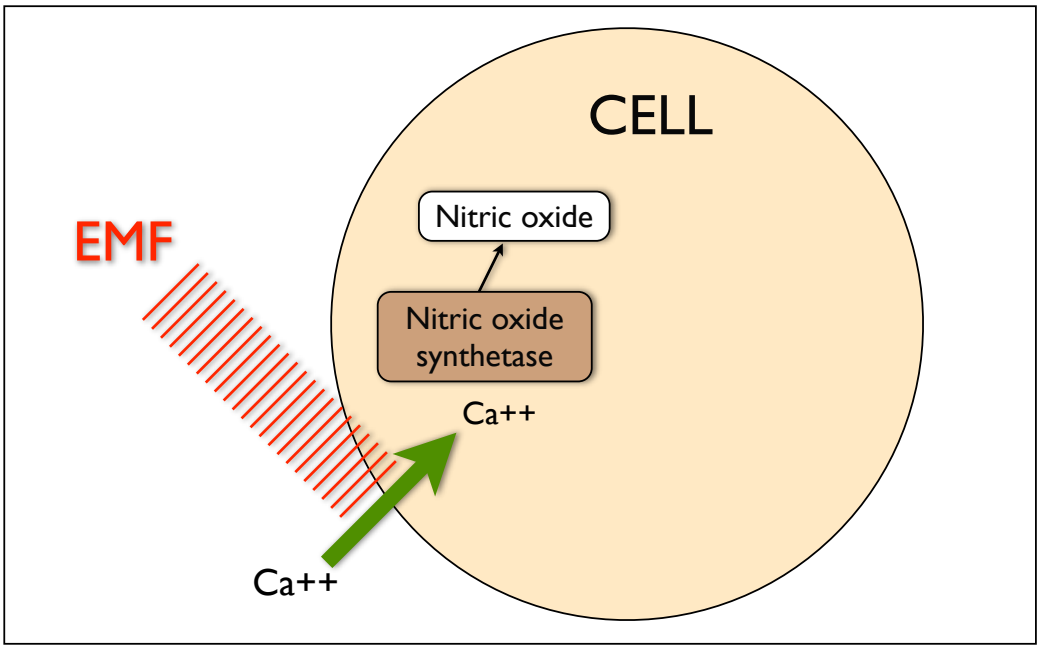
EMF Activation of VGCCs Increases Free Radical Production



The electromagnetic field stimulates opening of voltage-gated calcium channels (VGCCs) in the cell membrane.

This increases Ca++ entry into the cell.

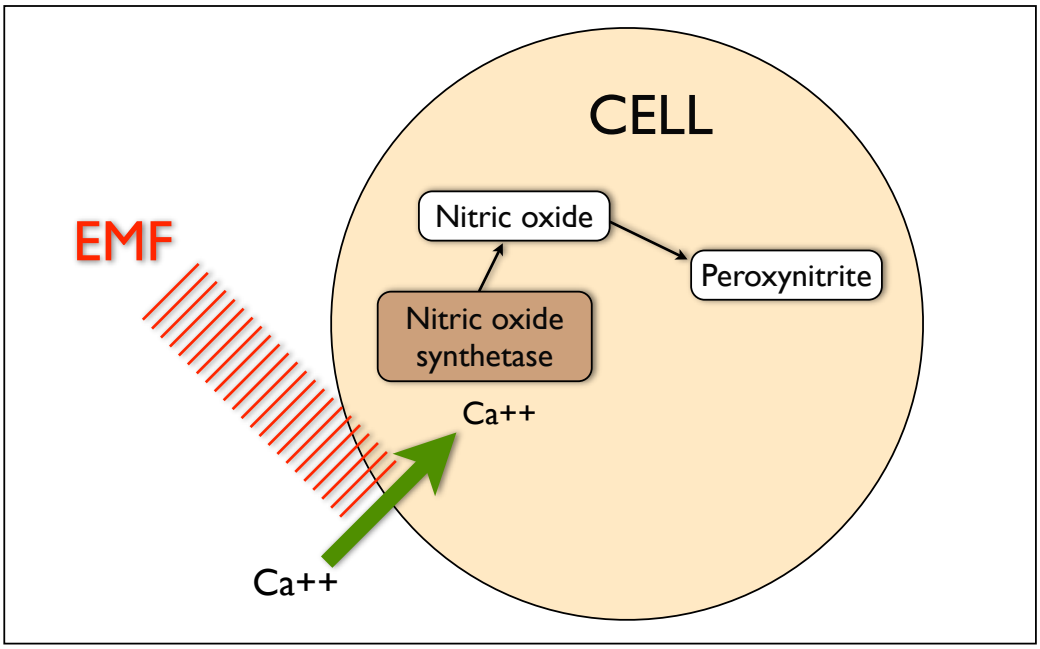
EMF Activation of VGCCs Increases Free Radical Production



Increased intracellular calcium levels stimulate the activity of nitric oxide synthetase,

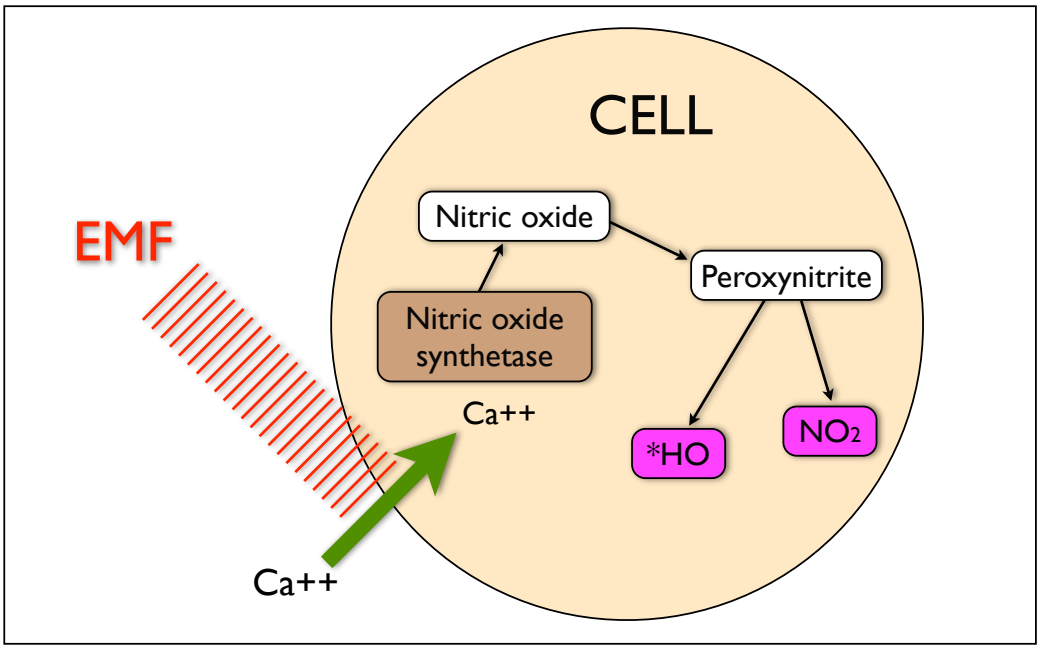
Which leads to increased production of nitric oxide in the cell.

EMF Activation of VGCCs Increases Free Radical Production



Increased nitric oxide leads to increase in peroxynitrite, a potent non-radical oxidant.

EMF Activation of VGCCs Increases Free Radical Production

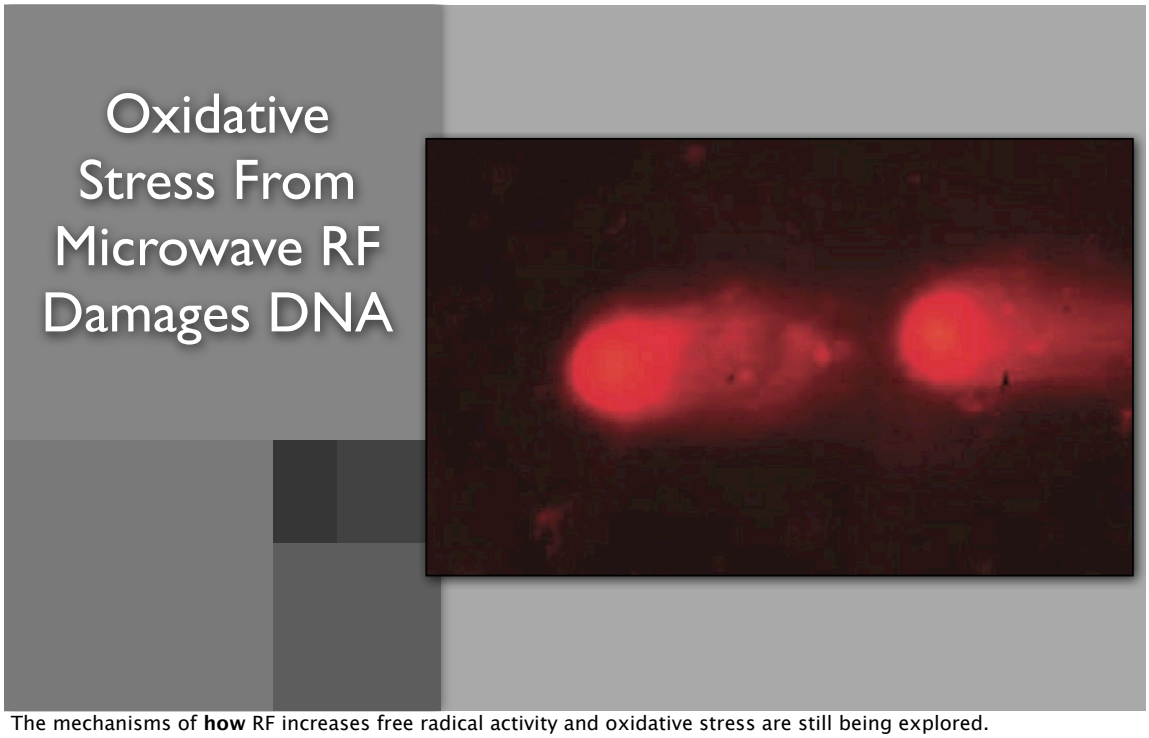


Peroxynitrite produces free radicals, including hydroxyl radical and NO_2.

This increase in free radicals then leads to inflammation, oxidant stress, and damage to cell structures, including DNA.

The EMF doesn't directly damage the cell. It just deranges cellular metabolism.

The free radicals that are produced by this change in metabolism are what causes the damage.

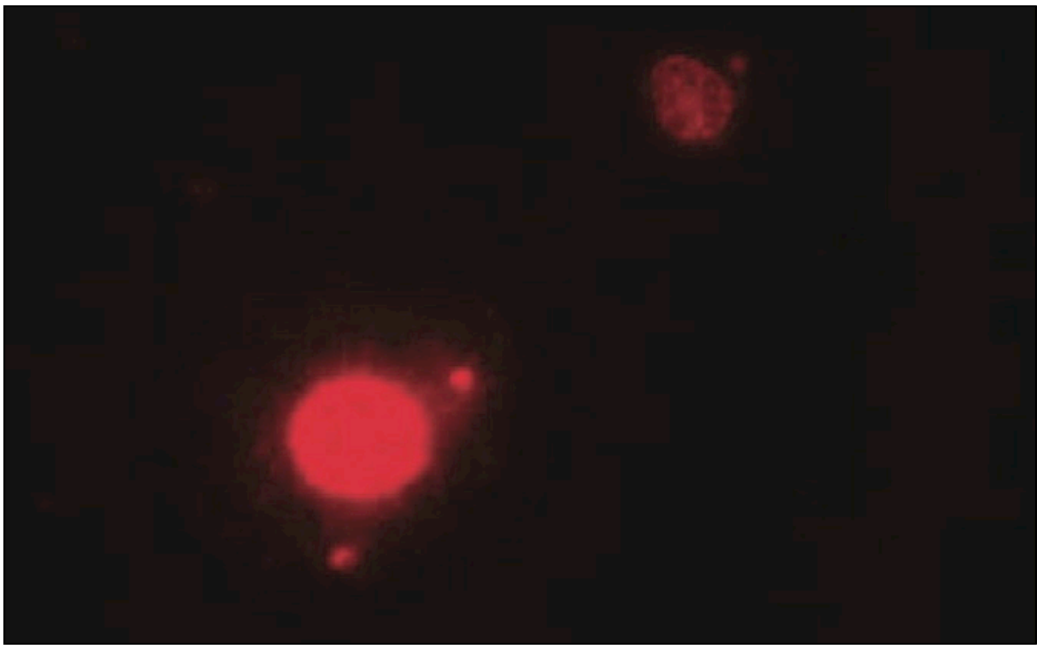


The mechanisms of **how** RF increases free radical activity and oxidative stress are still being explored.

But the fact that RF **does do this** has been CLEARLY ESTABLISHED by many research studies.

This increase in free radical levels can and does lead to DNA damage.

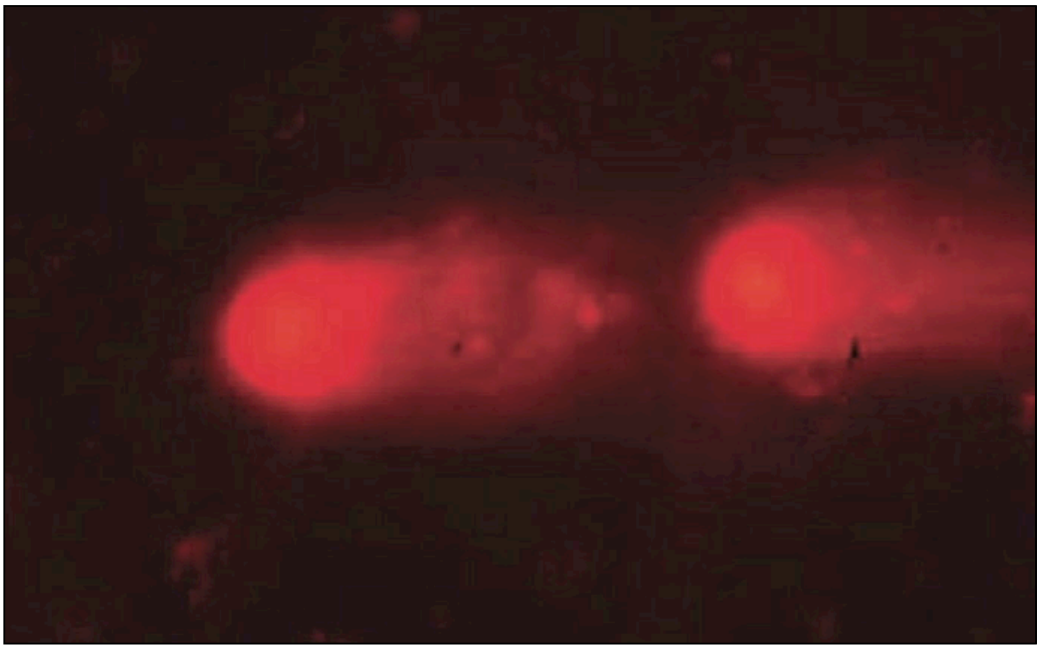
Comet assay: Unexposed control



The Comet assay is one way to measure DNA damage.
This is a study of DNA extracted from normal rat brain cells (unexposed controls).
Electrophoresis: DNA molecules of given mass and charge placed in a diffusion medium.
Preparation placed in a static electric field.
DNA molecules migrate towards a charged pole.
DNA molecules that are the same size, so they migrate at the same rate, will stay in a clump.

Kesari KK, Behari J, Kumar S. Mutagenic response of 2.45 GHz radiation exposure on rat brain. *Int J Radiat Biol* (2010a); 86(4):334-343.

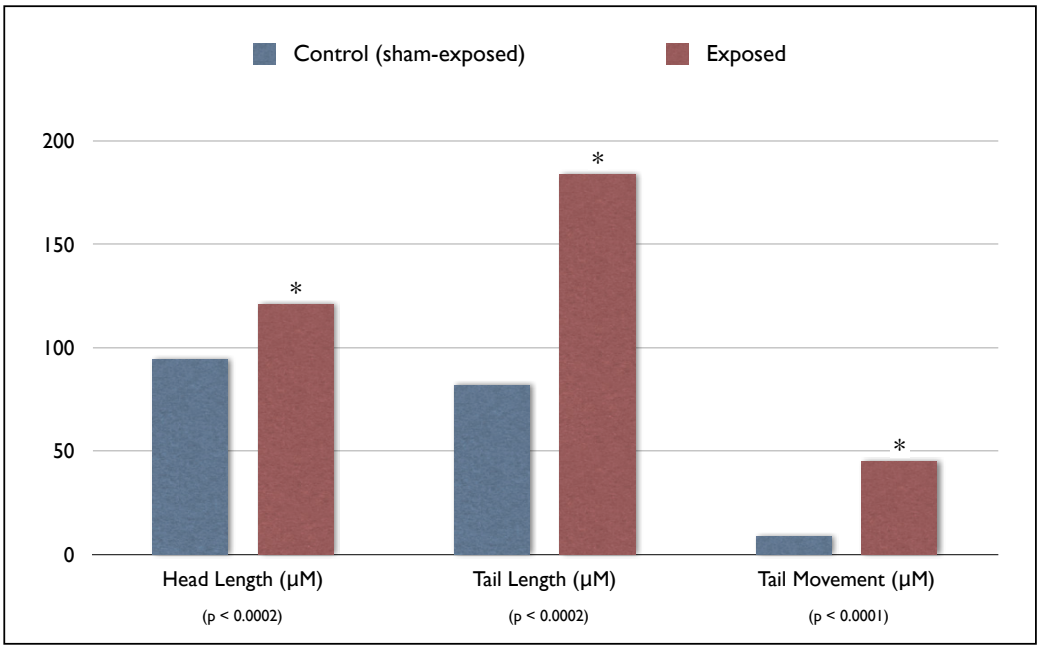
RF exposure: 2.45 GHz @ 0.34 mW/cm2, 2 hours per day x 35 days



DNA from brain cells of exposed rats. Here, some of the DNA molecules are broken.
The broken parts vary in mass and total charge, so they migrate through the gel at different rates
This leaves a "comet tail" of lighter fragments behind the main body of intact DNA.
The length of the tail can be measured.
This is a **very sensitive** assay for DNA damage.

Kesari KK, Behari J, Kumar S. Mutagenic response of 2.45 GHz radiation exposure on rat brain. *Int J Radiat Biol* (2010a); 86(4):334-343.

RF exposure: 2.45 GHz @ 0.34 mW/cm2, 2 hours per day x 35 days



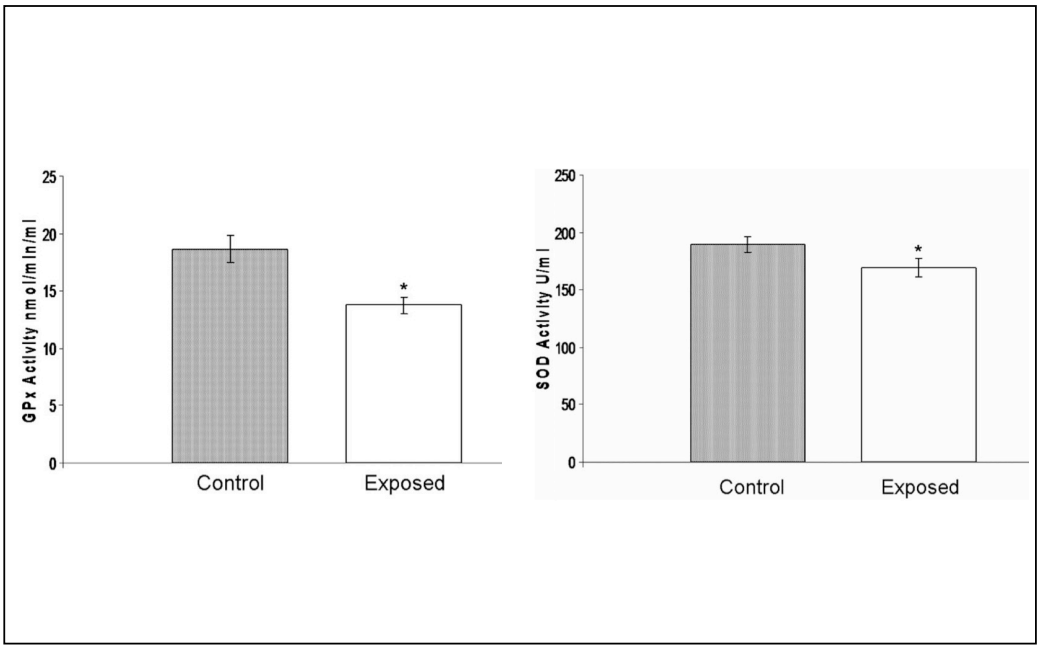
Comet Assay: **Measure of DNA fragmentation** in rat brains, produced by prolonged exposure to microwave RF.

In this study, exposure was 2 h a day for 35 days an exposure level of **<u>one third</u> of the FCC exposure limit.**

FCC exposure limit = 1 mW/cm^2

Kesari KK, Behari J, Kumar S. Mutagenic response of 2.45 GHz radiation exposure on rat brain. *Int J Radiat Biol* (2010a); 86(4):334-343.

RF exposure: 2.45 GHz @ 0.34 mW/cm2, 2 hours per day x 35 days



Depletion of antioxidants in RF-exposed rat brains.

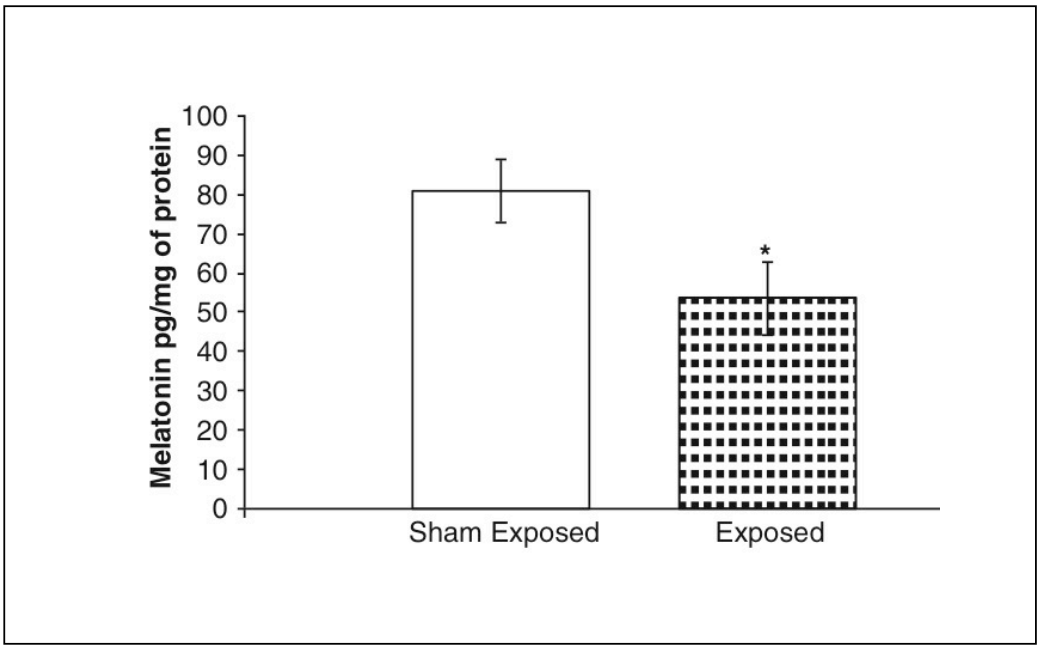
This consumption of anti-oxidants is **evidence of increased oxidant stress**, due to excess free radical production.

Kesari KK, Behari J, Kumar S. Mutagenic response of 2.45 GHz radiation exposure on rat brain. *Int J Radiat Biol* (2010a); 86(4):334-343.

Abstract

Purpose: To investigate the effect of 2.45 GHz microwave radiation on rat brain of male wistar strain. Material and methods: Male rats of wistar strain (35 days old with 130 + 10 g body weight) were selected for this study. Animals were divided into two groups: Sham exposed and experimental. Animals were exposed for 2 h a day for 35 days to 2.45 GHz frequency at 0.34 mW/cm2 power density. The whole body specific absorption rate (SAR) was estimated to be 0.11 W/Kg. Exposure took place in a ventilated Plexiglas cage and kept in anechoic chamber in a far field configuration from the horn antenna. After the completion of exposure period, rats were sacrificed and the whole brain tissue was dissected and used for study of double strand DNA (Deoxyribonucleic acid) breaks by micro gel electrophoresis and the statistical analysis was carried out using comet assay (IV-2 version software). Thereafter, antioxidant enzymes and histone kinase estimation was also performed. Results: A significant increase was observed in comet head (P50.002), tail length (P50.0002) and in tail movement (P 5 0.0001) in exposed brain cells. An analysis of antioxidant enzymes glutathione peroxidase (P 5 0.005), and superoxide dismutase (P50.006) showed a decrease while an increase in catalase (P50.006) was observed. A significant decrease (P 5 0.023) in histone kinase was also recorded in the exposed group as compared to the control (sham-exposed) ones. One- way analysis of variance (ANOVA) method was adopted for statistical analysis. Conclusion: The study concludes that the chronic exposure to these radiations may cause significant damage to brain, which may be an indication of possible tumour promotion (Behari and Paulraj 2007).

RF exposure: 2.45 GHz @ 0.21 mW/cm2, 2 hours per day x 45 days



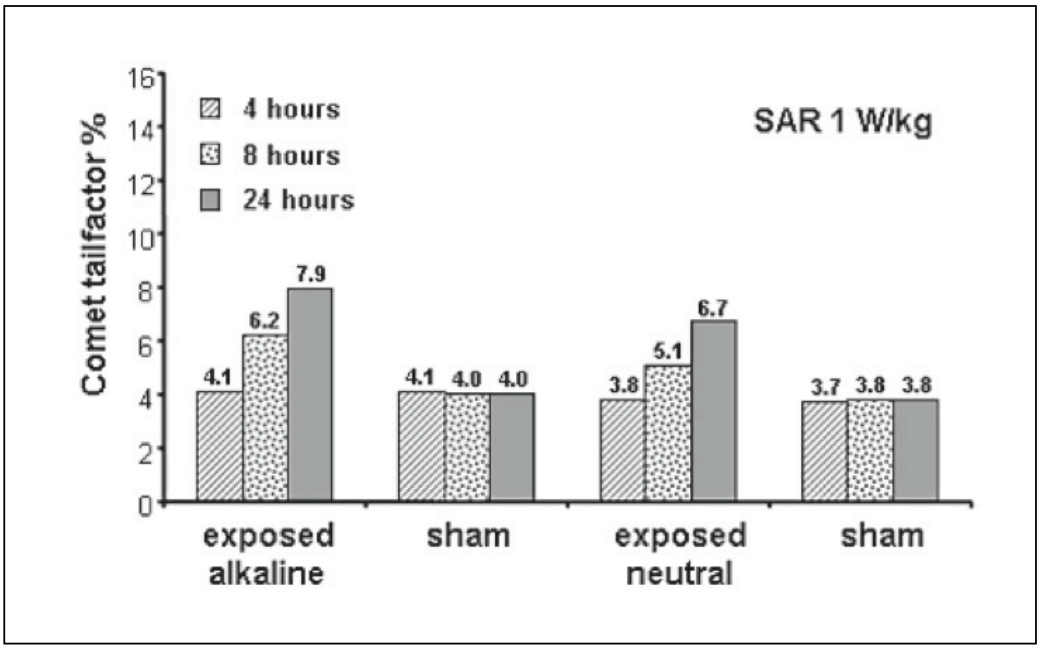
Suppression of melatonin secretion by 2.45 GHz RF:

Bad news, since melatonin is also a potent antioxidant.

Kesari KK, Kumar S, Behari J. Pathophysiology of microwave radiation: effect on rat brain. *Appl Biochem Biotechnol* (2012); 166(2):379-388.

10 MINUTE BREAK HERE

Evidence of DNA damage by microwave RF.



Another study, using Human fibroblasts.

1950 MHz, 5 minutes on/10 minutes off.

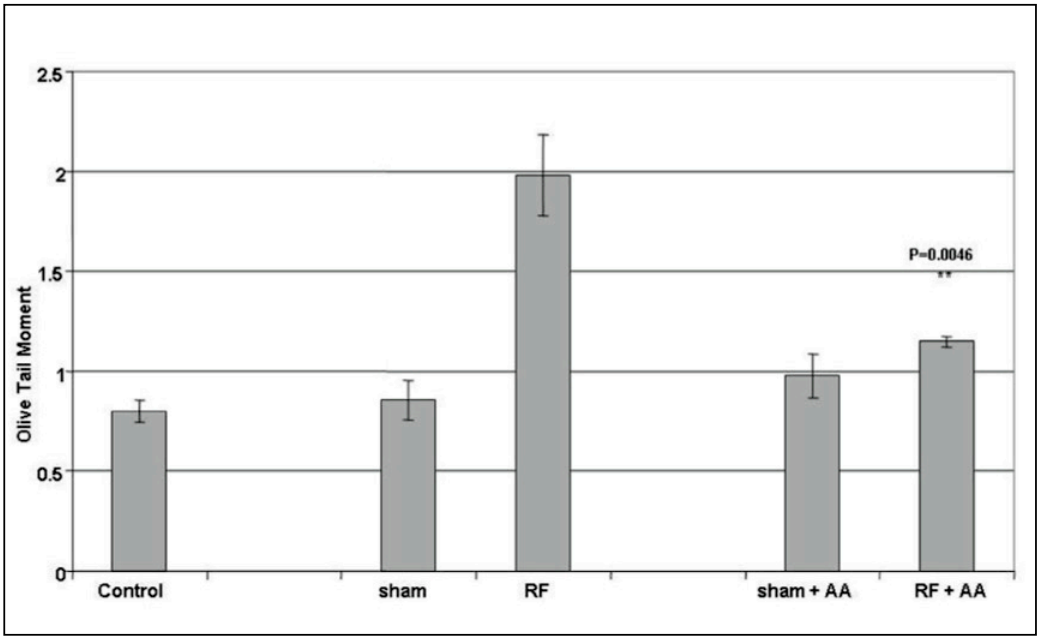
Total exposure for 4, 8, or 24 hours.

DNA fragmentation measured by Comet Assay.

Figure 9. Intermittent RF-EMF exposure (1950 MHz, 5 minutes on/10 minutes off, 1 and 2 W/kg, 4, 8 and 24 hours) increases the DNA strand break frequency in human fibroblasts dependent on the duration of exposure as measured with the alkaline and neutral Comet assay (H.-W. Rüdiger et al., Division of Occupational Medicine, University of Vienna, Austria).

Adlkofer F. Risk Evaluation of Potential Environmental Hazards from Low Energy Electromagnetic Field Exposure Using Sensitive In Vitro Methods. *Bioelectromagnetics* (2006); 331-354.

DNA damage blocked by anti-oxidants



A cell study, with human fibroblasts, exposed to 1950 MHz RF, 5 minutes on/10 minutes off.

(right hand columns => **DNA damage blocked by anti-oxidant** effect of vitamin C (ascorbic acid).

The research group of Prof. Tauber, Berlin, investigated the effect of RF- EMF on HL-60 cells, i.e. a human promyelocytic cell line. After continuous exposure to RF-EMF of 1800 MHz and a SAR value of 1.3 W/kg they observed a highly significant increase in the number of single and double DNA strand breaks as measured by the alkaline Comet assay and of micronuclei as measured with the micronucleus test, thus fully confirming the findings obtained in the Vienna laboratory. Additionally, as clearly shown in Figures 12 and 13, the generation of DNA strand breaks and micronuclei can be prevented, when the radical scavenger ascorbic acid is added to the culture medium before exposure.

Figure 12, from: Adlkofer F. Risk Evaluation of Potential Environmental Hazards from Low Energy Electromagnetic Field Exposure Using Sensitive In Vitro Methods. *Bioelectromagnetics* (2006); 331-354.

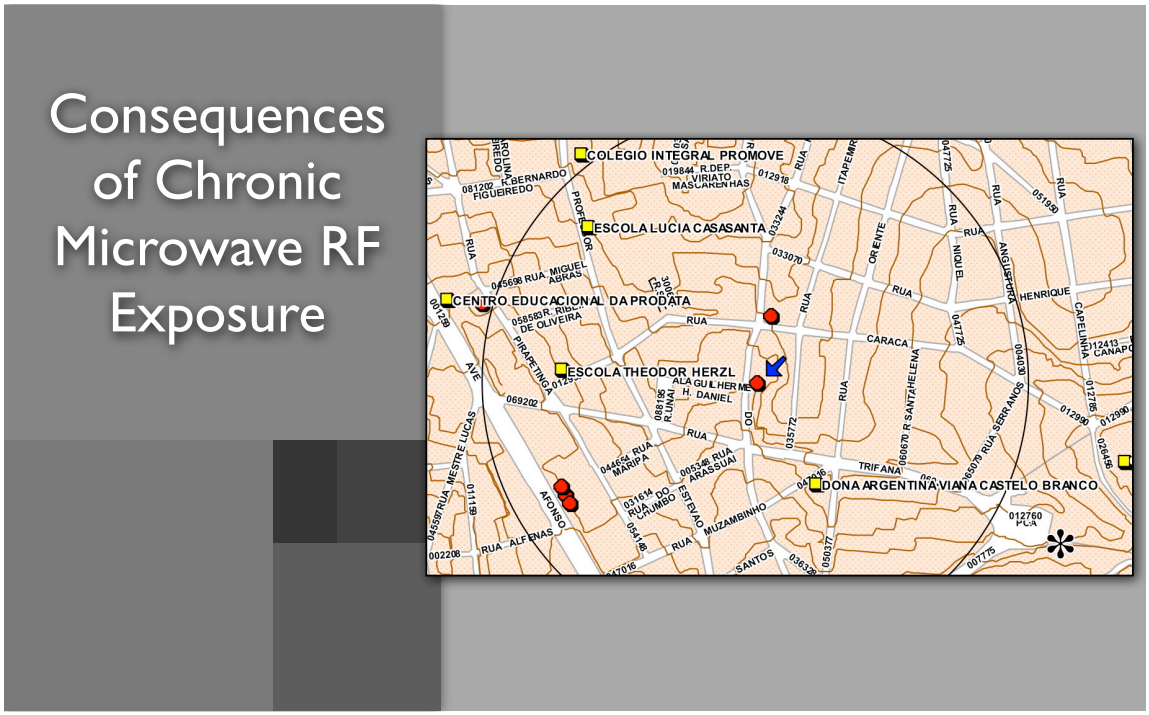
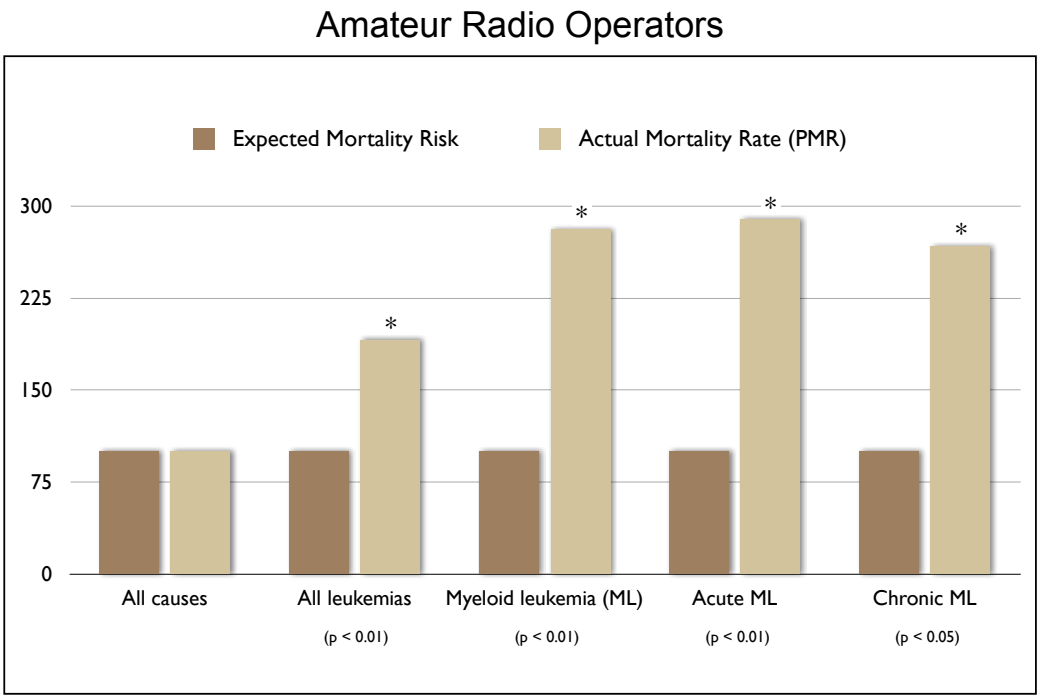


Fig. 2. Geographical location of BS Site BH 20 at 1373 Rua do Ouro Street, in the Serra neighborhood, Belo Horizonte municipality

Dode AC, Leao MM, Tejo Fde A et al. Mortality by neoplasia and cellular telephone base stations in the Belo Horizonte municipality, Minas Gerais state, Brazil. *Sci Total Environ* (2011); 409(19):3649-3665.

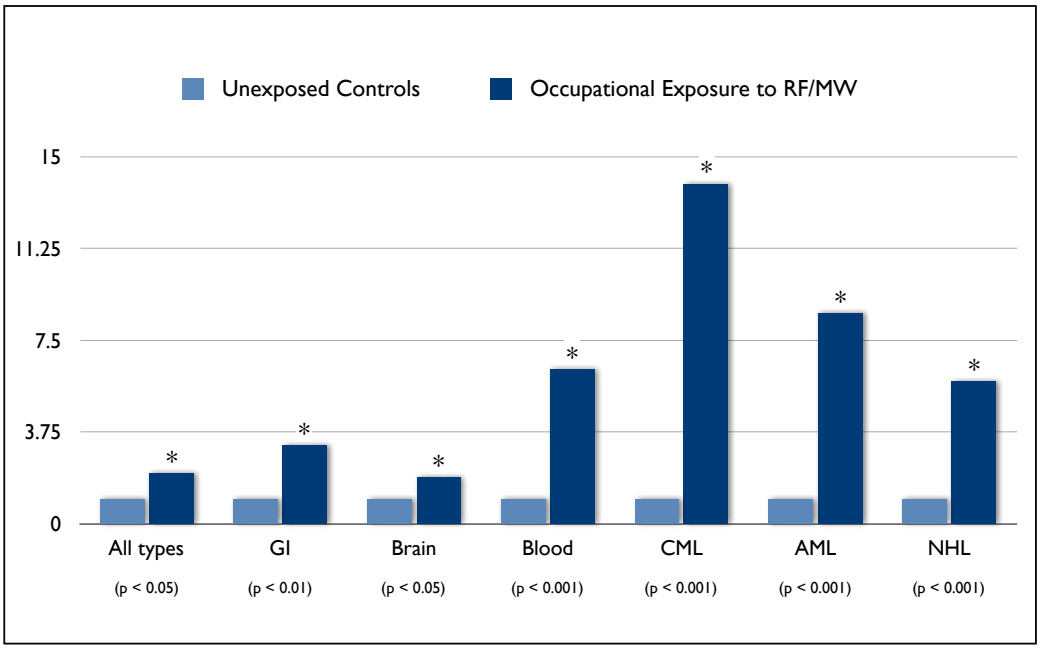


Analysis of leukemia deaths in male members of the American Radio Relay League resident in Washington and California, 1971-1983

Milham SJ. Silent keys: leukaemia mortality in amateur radio operators. *Lancet* (1985); 1(8432):812.

Cherry N. Evidence in support of the a priori hypothesis that Electromagnetic Radiation across the spectrum is a Ubiquitous Universal Genotoxic Carcinogen. (2002):1-52. *http://www.neilcherry.com/documents.php*

Polish Military (1971-1985)



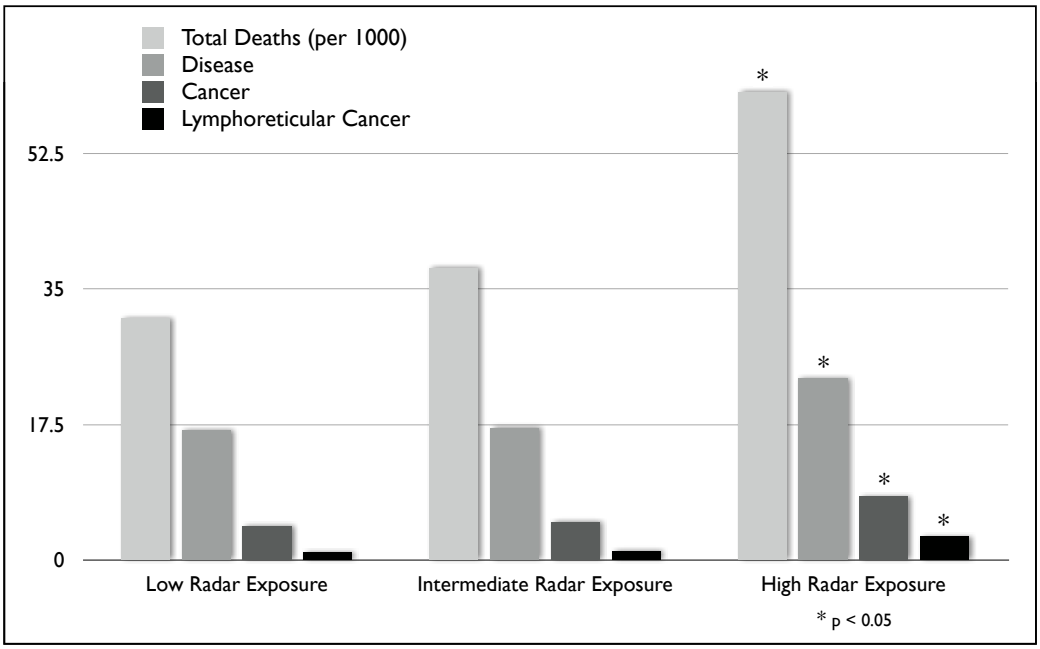
Polish military personnel with occupational exposure to radio and microwave frequency radiation.

Odds ratio of cancer incidence (1971-1985)

CML = chronic myelocytic leukemia
AML = acute myeloblastic leukemia
NHL = non-Hodgkin lymphoma

Szmigielski S. Cancer morbidity in subjects occupationally exposed to high frequency (radiofrequency and microwave) electromagnetic radiation. *Sci Total Environ* (1996); 180(1):9-17.

U.S. Navy Korean War Veterans (1950-1974)



Mortality in U.S. Navy Korean War Veterans (1950-1974) stratified by levels of occupational radar exposure.

Mortality 1950-1974. (Y axis = crude mortality per 1000) Stratified by level of radar exposure.

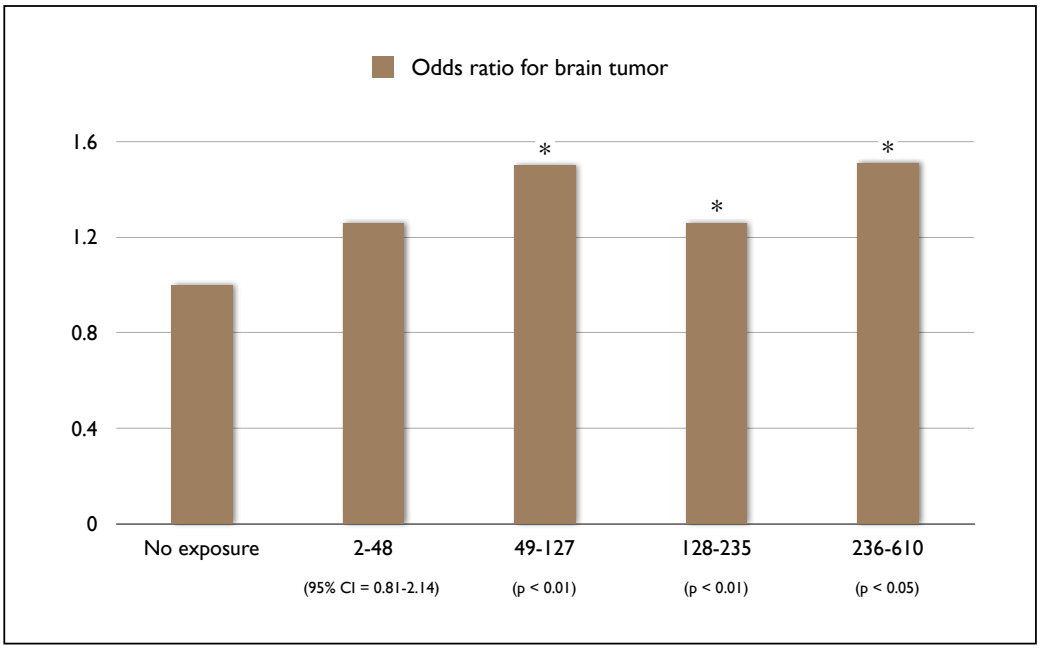
In the original paper, Robinette et al evaluated job exposure hazard levels of 6 categories of navy personnel and grouped them into two groups, low exposure and high exposure. The electronic technicians (ET) had a significantly lower hazard rating and lower levels of pathology than the other two job categories in the high risk group, so this classification diluted out the high exposure risk pool.

Dr. Cherry took Robinette et al's published data and divided the workers into three exposure levels. The above chart is the result of Dr. Cherry's analysis of the data set.

Robinette CD, Silverman C, Jablon S. Effects upon health of occupational exposure to microwave radiation (radar). *Am J Epidemiol* (1980); 112(1):39-53.

Cherry N. Health Effects in the vicinity of Radio/TV towers and mobile phone base stations. (2002): 1-40. *http://www.neilcherry.com/documents.php*

US Air Force (1970-1989)



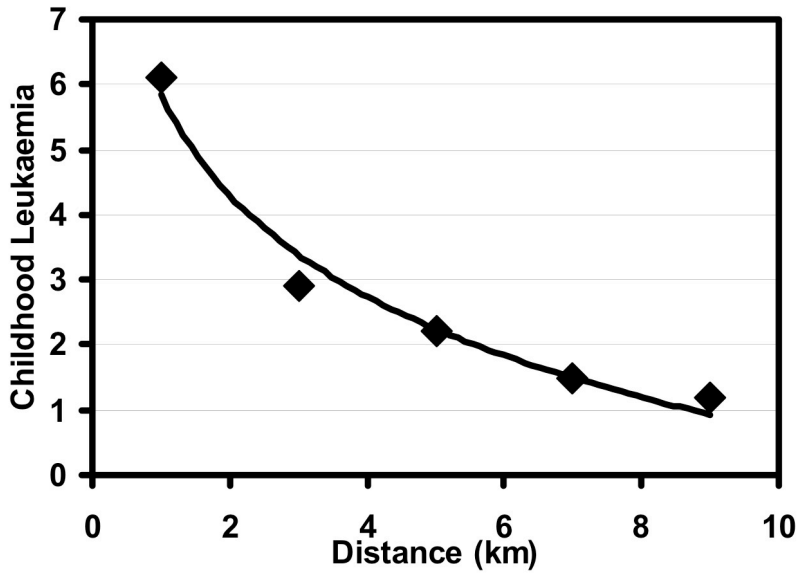
US Air Force Workers with occupational exposure to microwave RF (1970–1989)

Y axis: Odds ratio for brain tumor

X axis: Exposure intensity score x months exposed)

Grayson JK. Radiation exposure, socioeconomic status, and brain tumor risk in the US Air Force: a nested case-control study. *Am J Epidemiol* (1996); 143(5):480-486.

Vatican Radio Tower (1987-1999).



Cumulative childhood leukaemia near the Vatican Radio Transmitters in Rome, 1987–1999.

Multiple powerful transmitters on site.

10 km radius around towers contains a population of >49,650 (1990 census).

exponential fitted trend line, R2=0.9756, **p = 0.002**

Cherry N. Health Effects in the vicinity of Radio/TV towers and mobile phone base stations. (2002): 1-40.
http://www.neilcherry.com/documents.php

Michelozzi P, Capon A, Kirchmayer U et al. Adult and childhood leukemia near a high-power radio station in Rome, Italy. *Am J Epidemiol* (2002); 155(12):1096-1103.