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 effects of RF exposures.

First, we'll look at the evidence that RF exposures can produce acute symptoms in many individuals.

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)

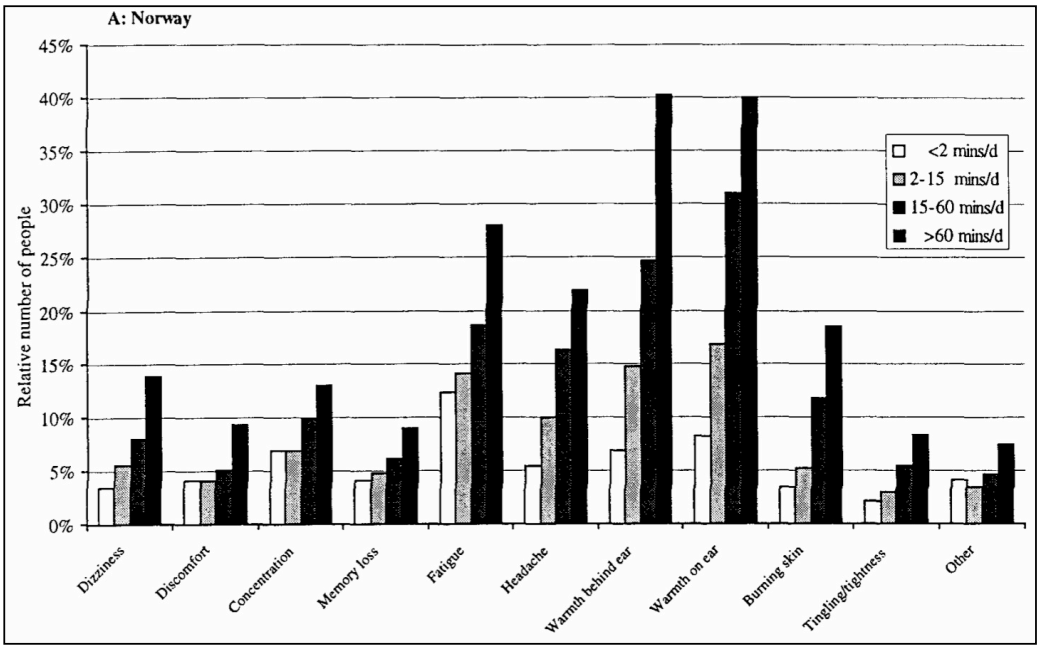
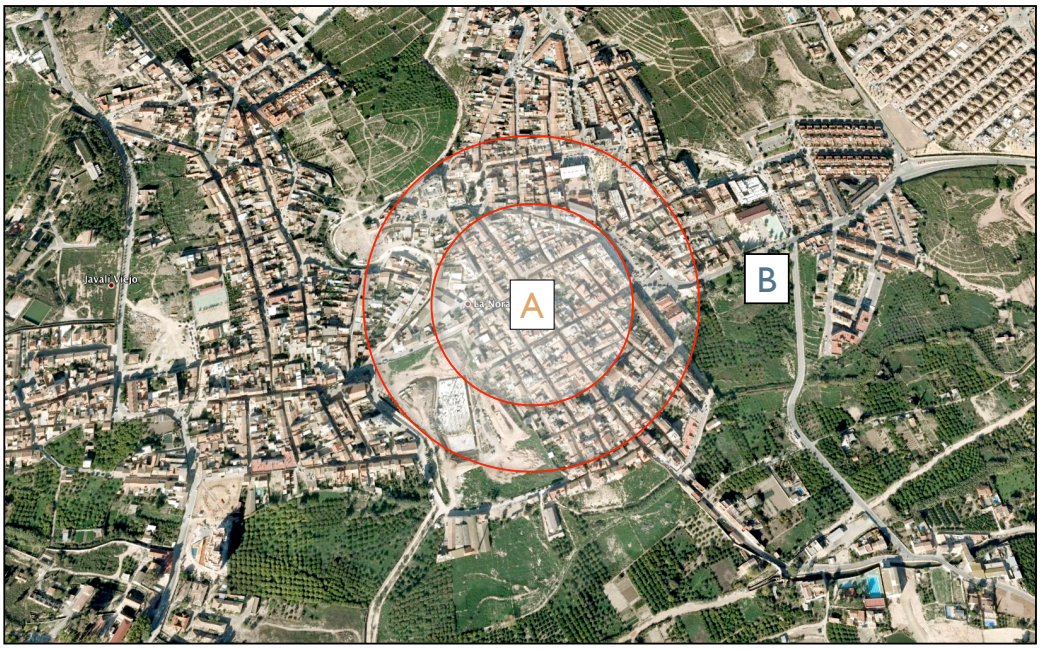


Figure 11: Prevalence of symptoms for Norwegian mobile phone users, mainly analogue, with various categories of length of calling time per day, from Mild et al. (1998).

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.

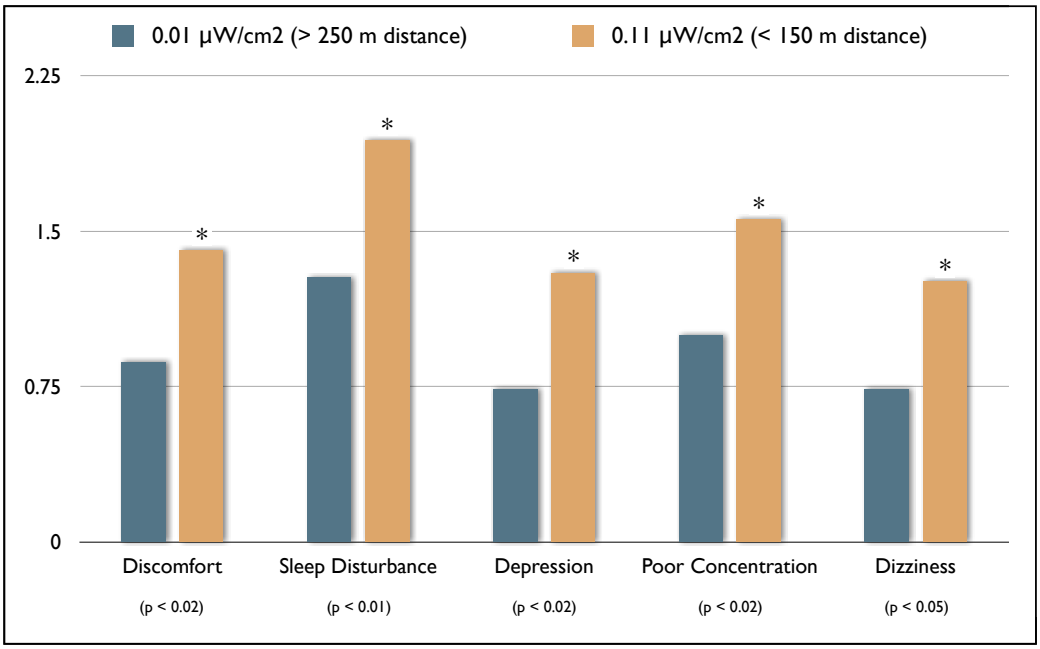
Power density of signal in bedrooms of respondents was measured.

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

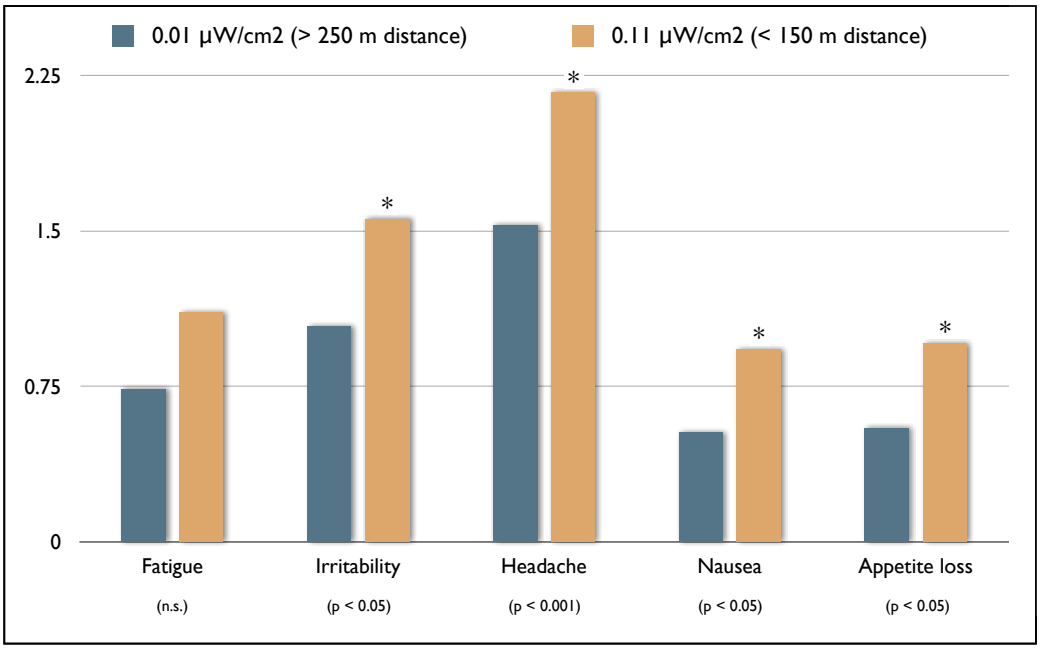
FCC Guidelines: **600 - 1000 μW/cm^2**

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.

La Ñora, Spain (2001)



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”.

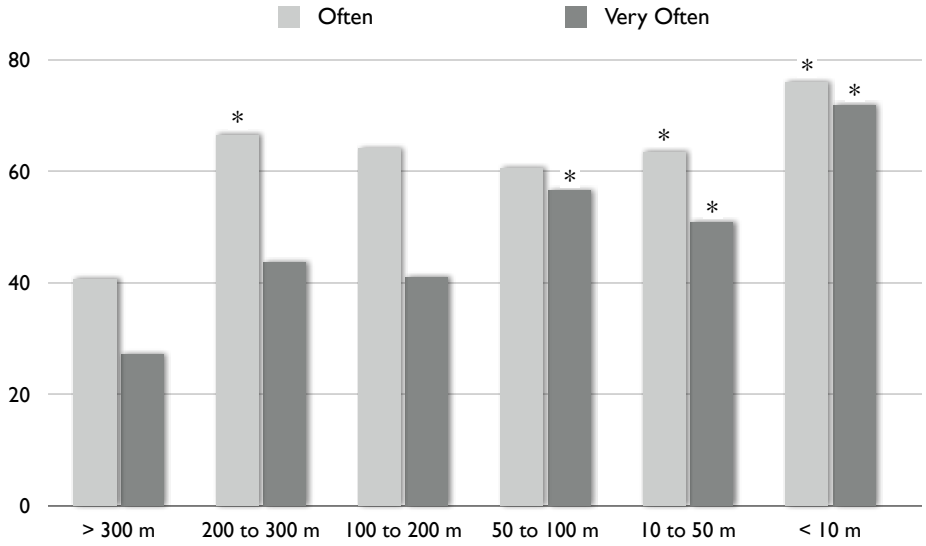
n = 530

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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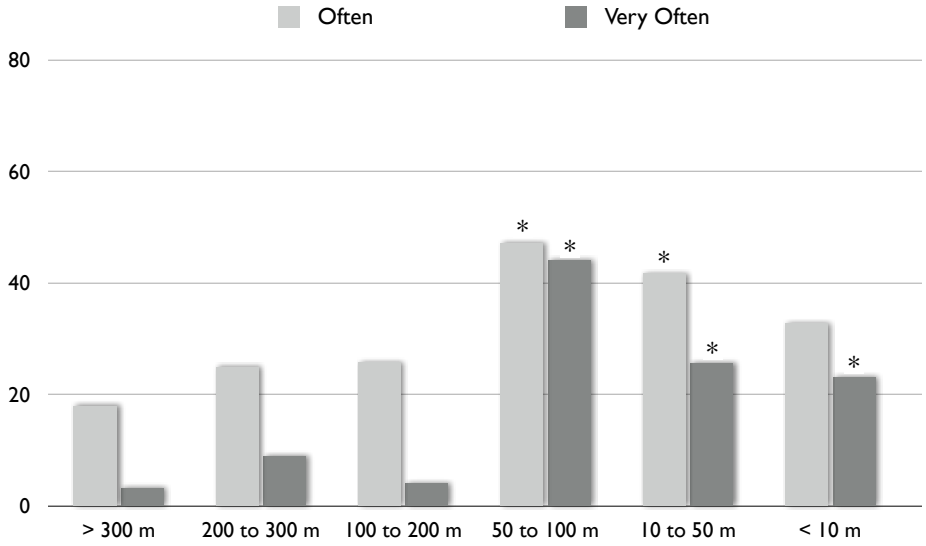
Irritability



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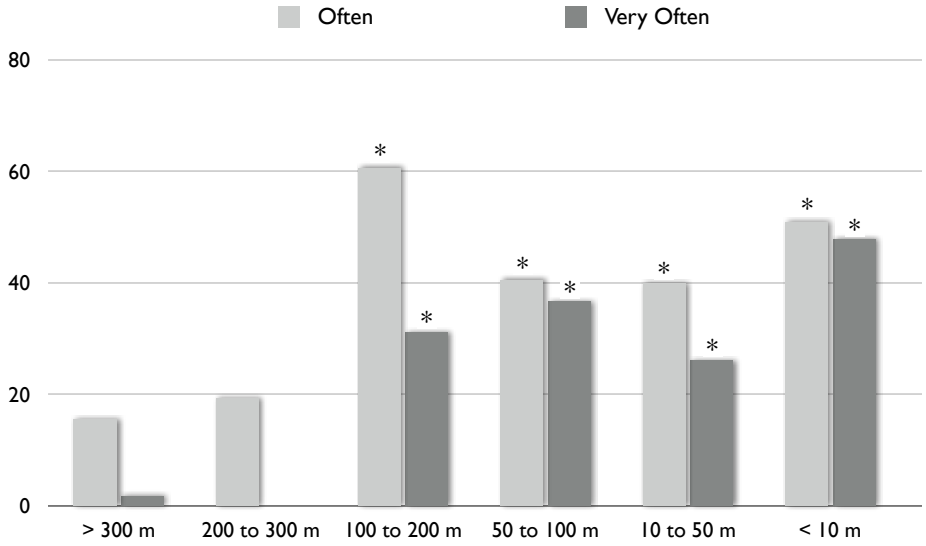
Headache



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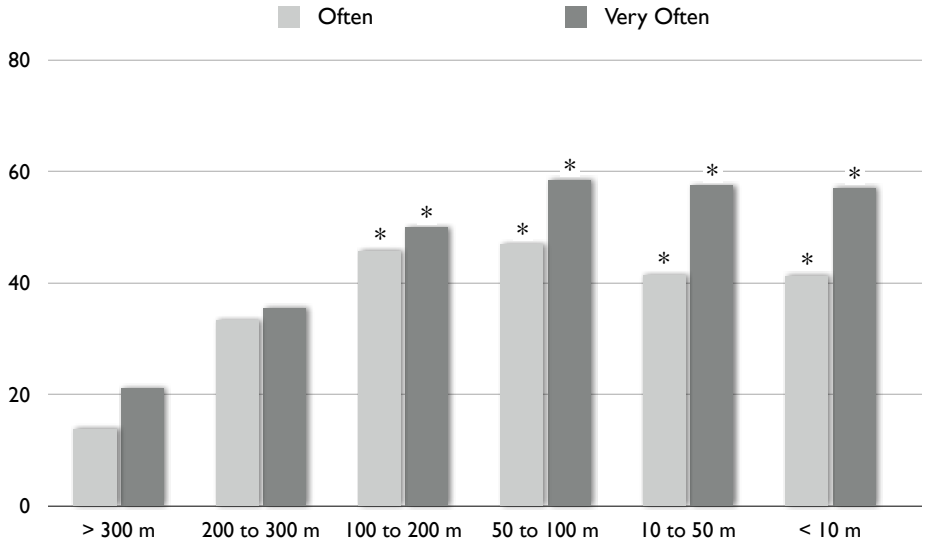
Sleep Disruption



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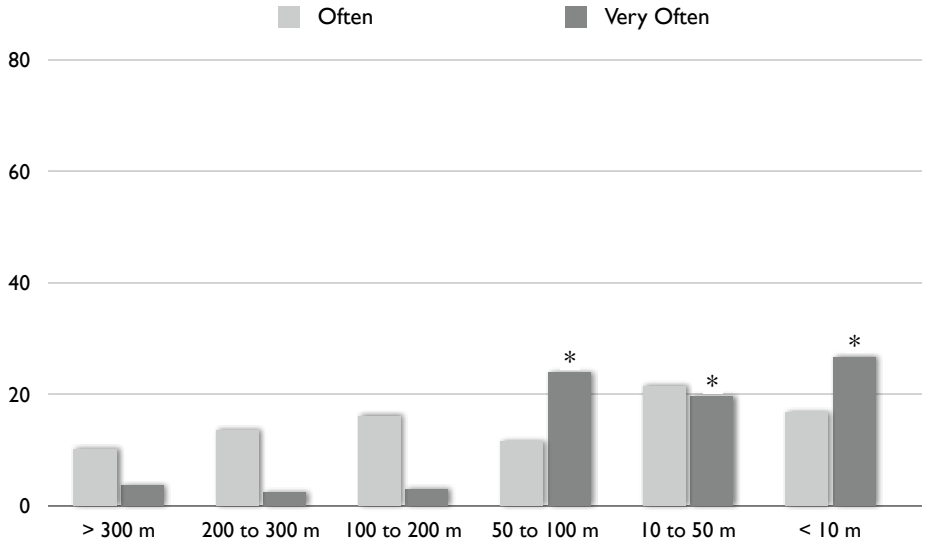
Depression



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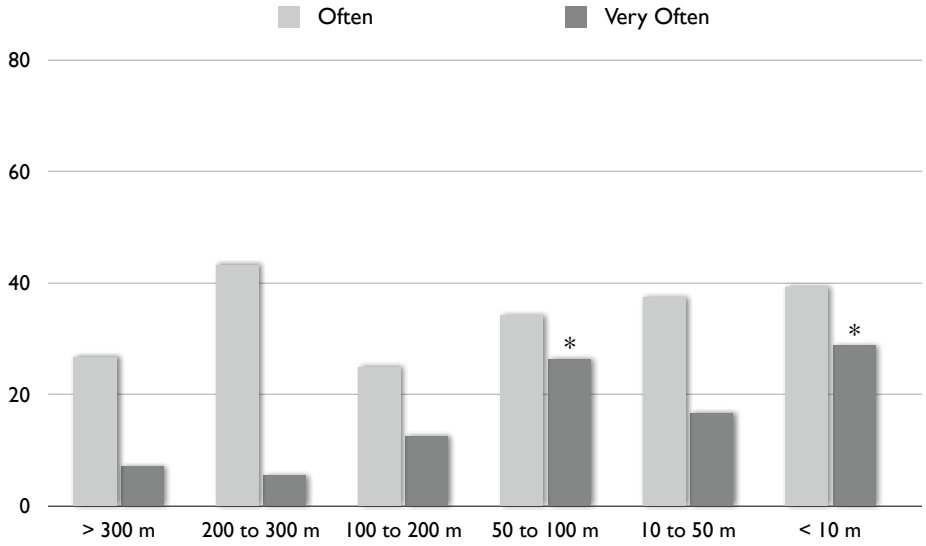
Difficulty in Concentration



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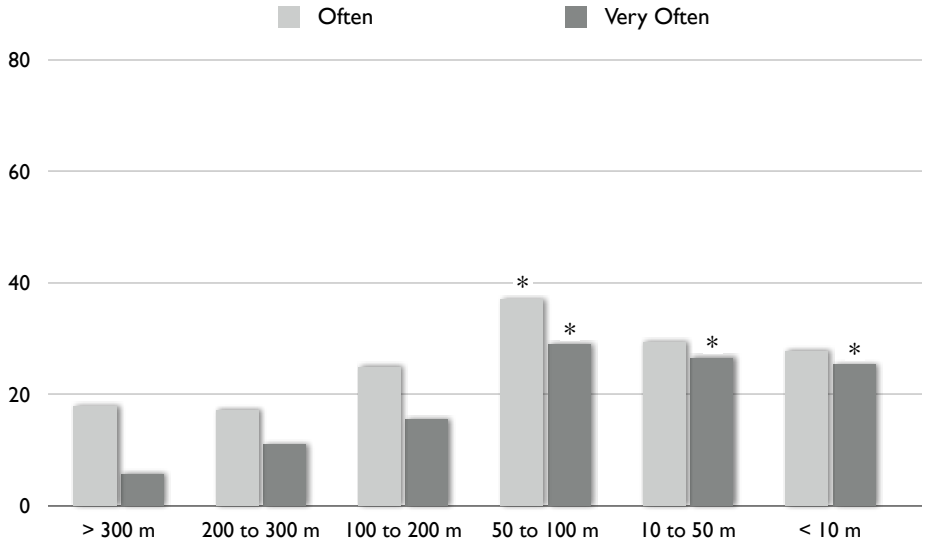
Memory Loss



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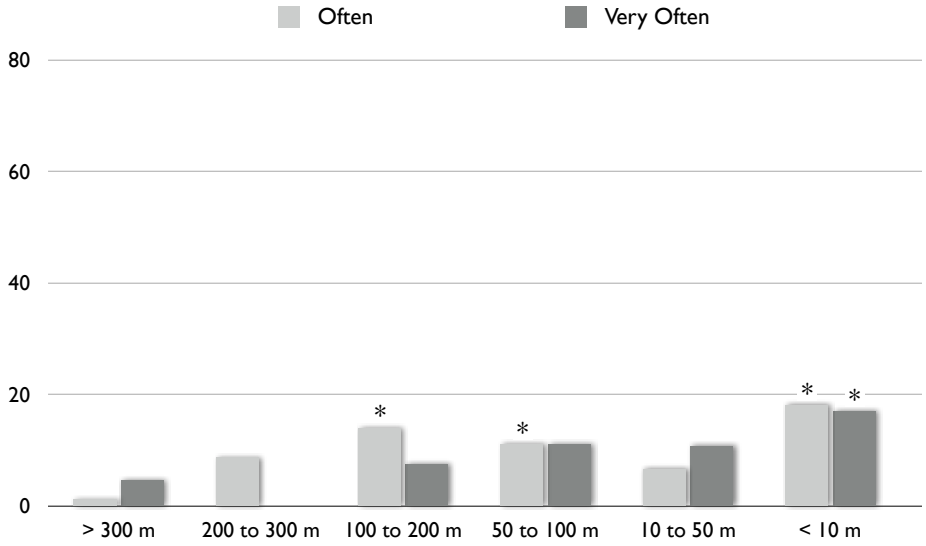
Skin Problems



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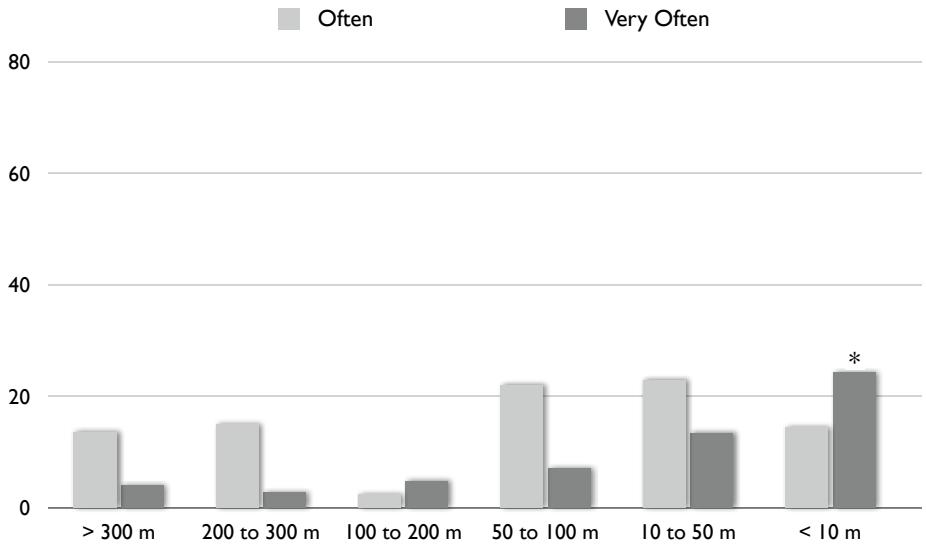
Visual Disruption



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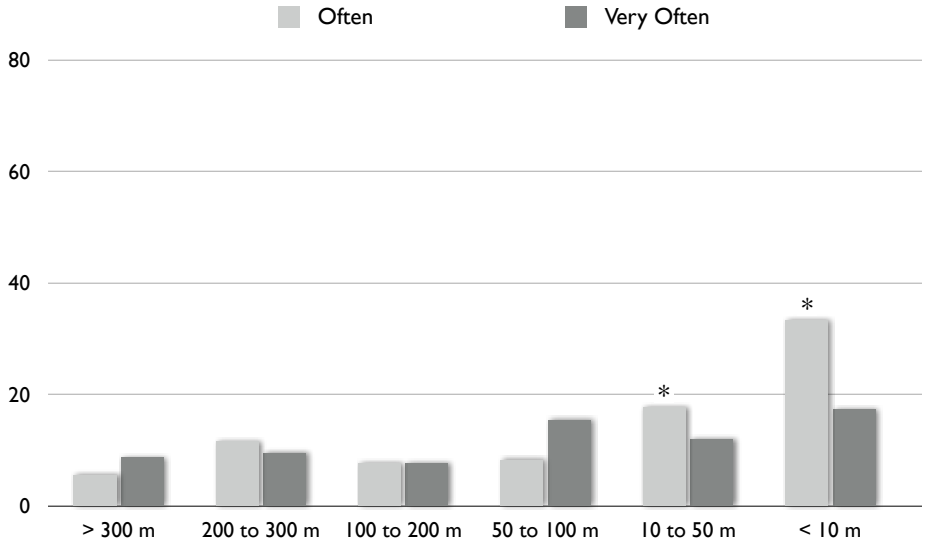
Hearing Disruption



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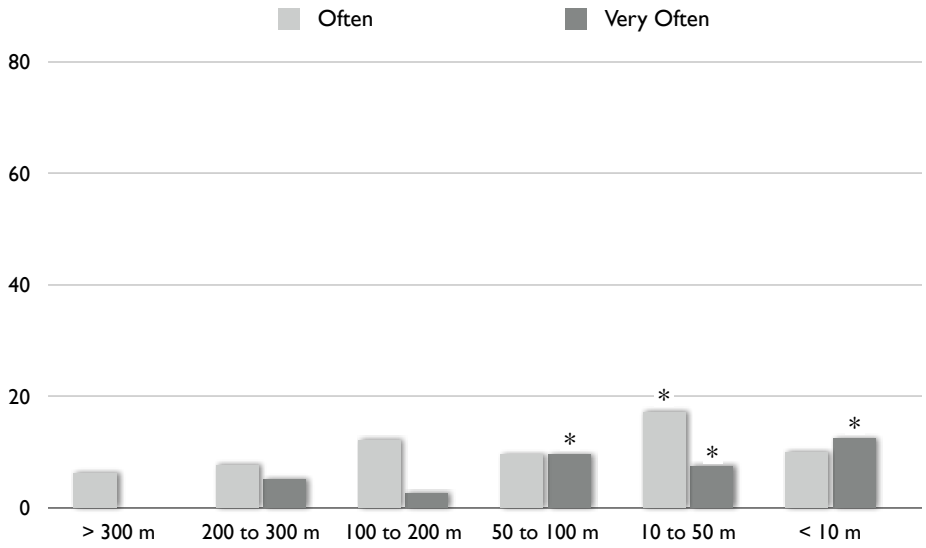
Dizziness



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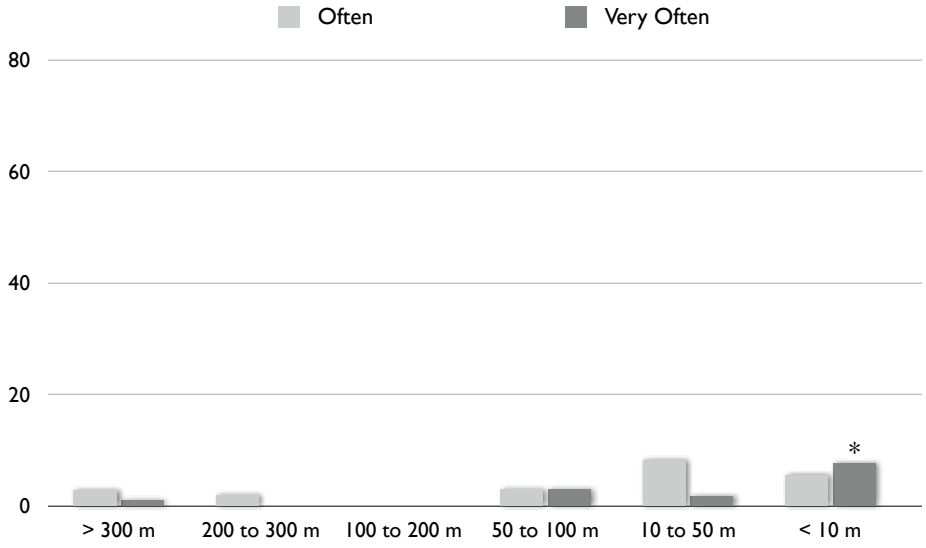
Movement Difficulties



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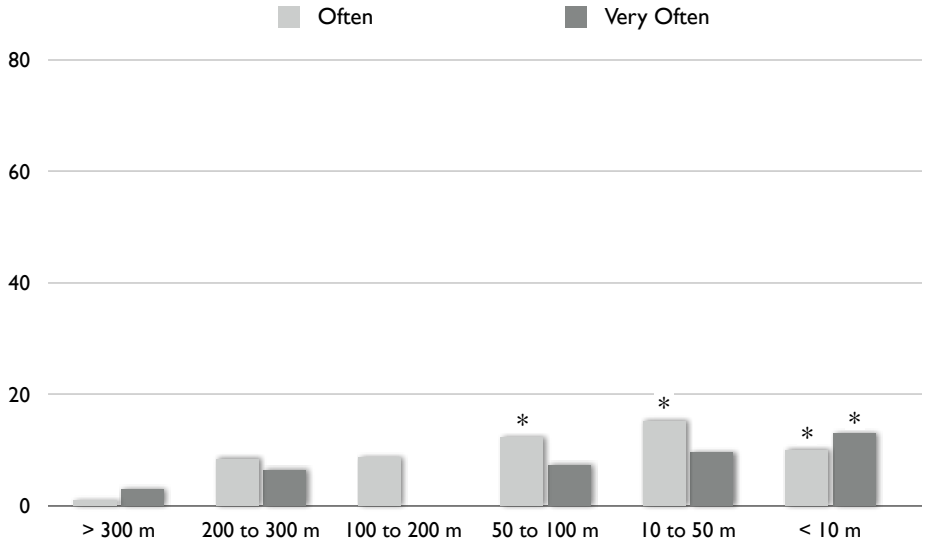
Cardiovascular Problems



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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

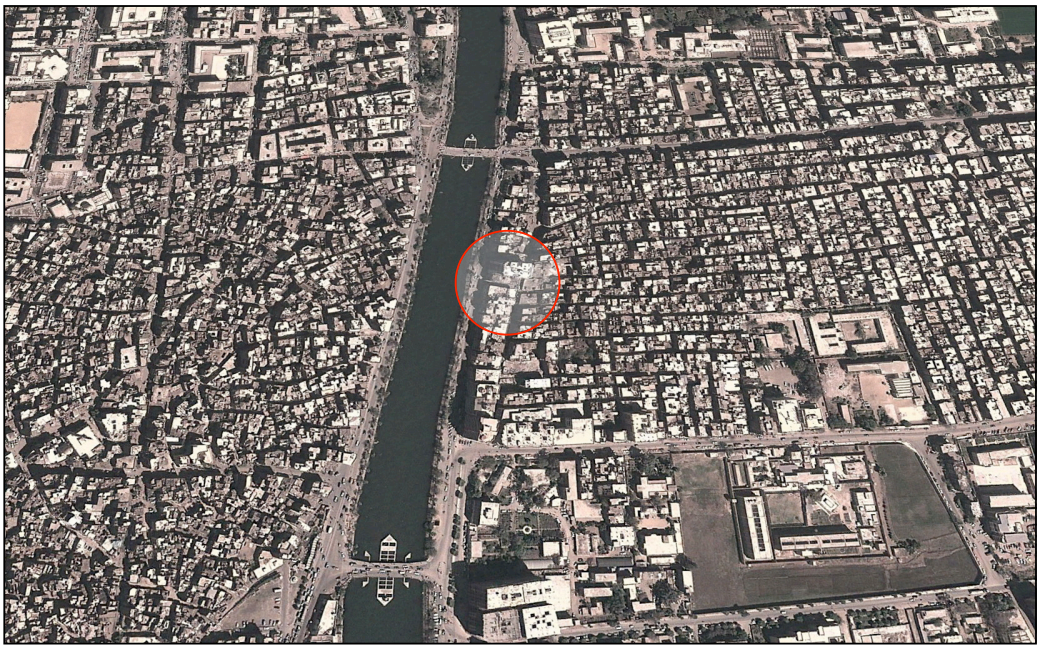
for 16 Non Specific Health Symptoms experienced by 530 people (270 men + 260 women) in relation to their distances from cellular phone base stations (≤ 300 m vs. >300 m [reference group]).
* = $P < 0.05$ for levels of complaints 2 + 3 pooled.

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)

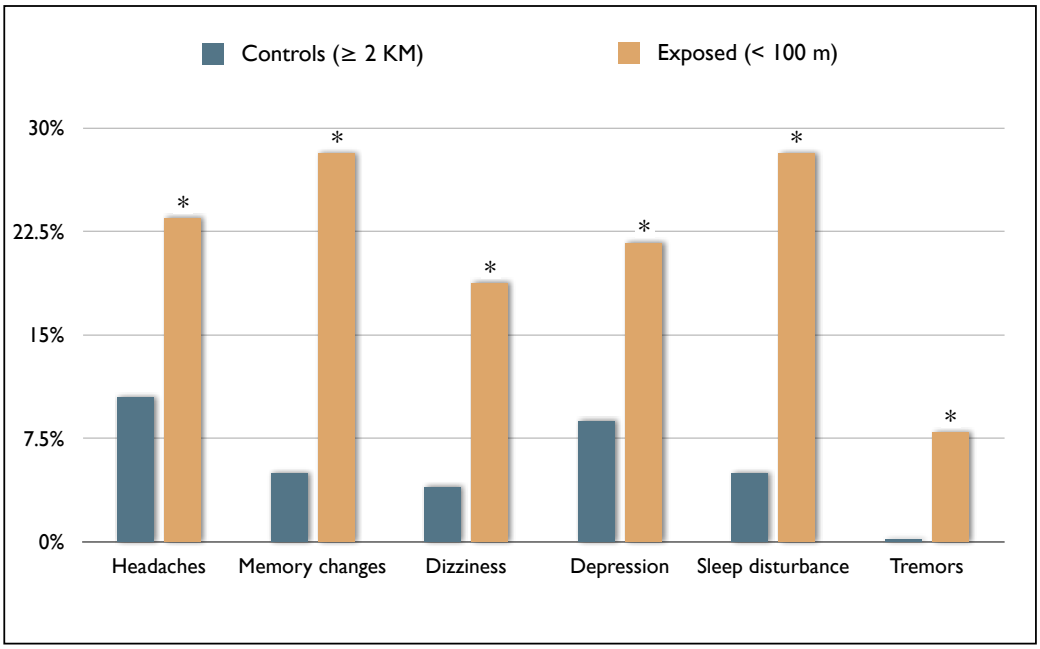
37 subjects lived in the building under the transmitters.

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.

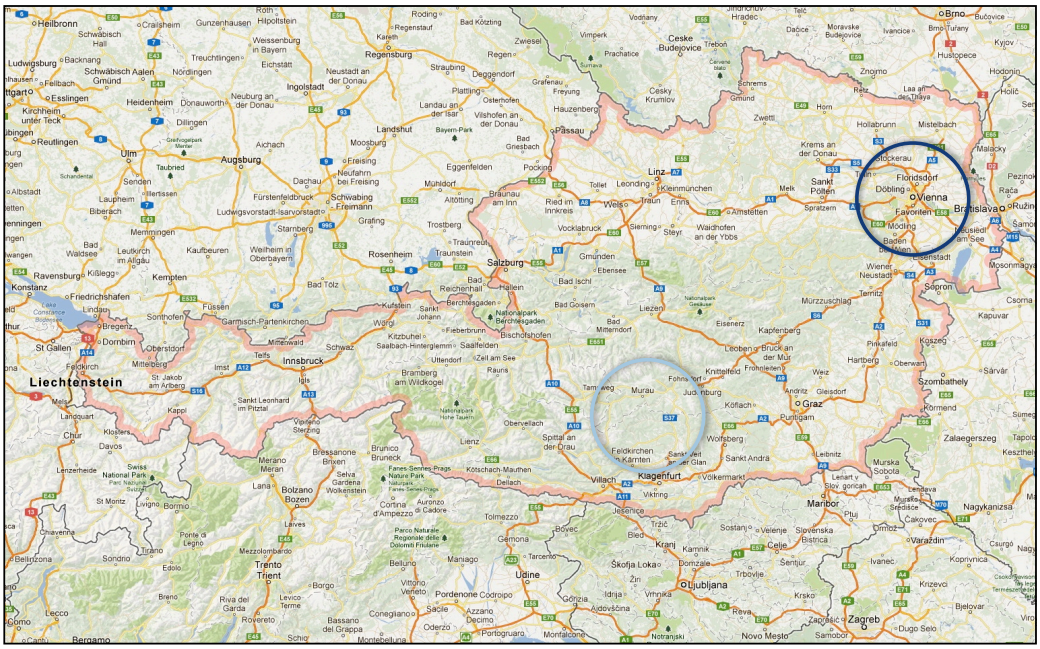
Shebeen El-Kom, Egypt (2003)



* = 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).

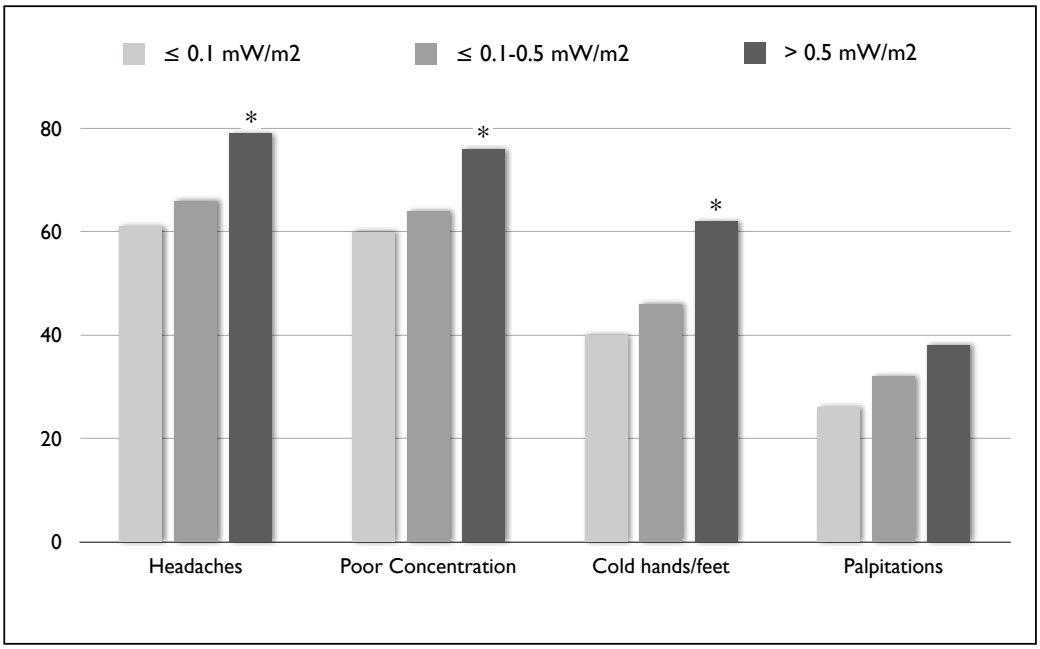
900 MHz transmission.

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.

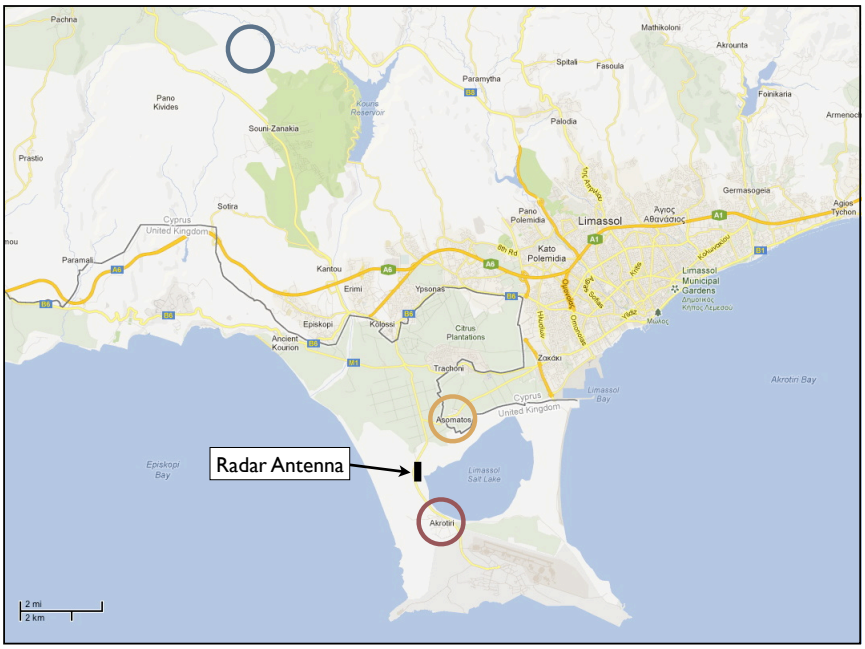
* = statistically significant for this sample size.

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)

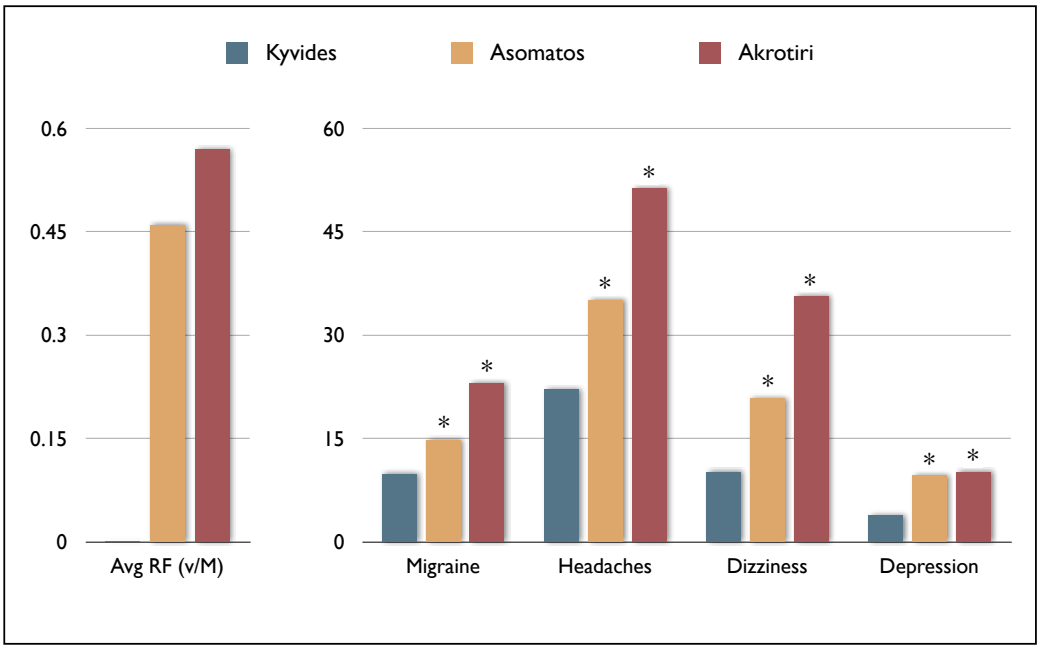


Evaluation of health concerns near a military radar antenna:

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.

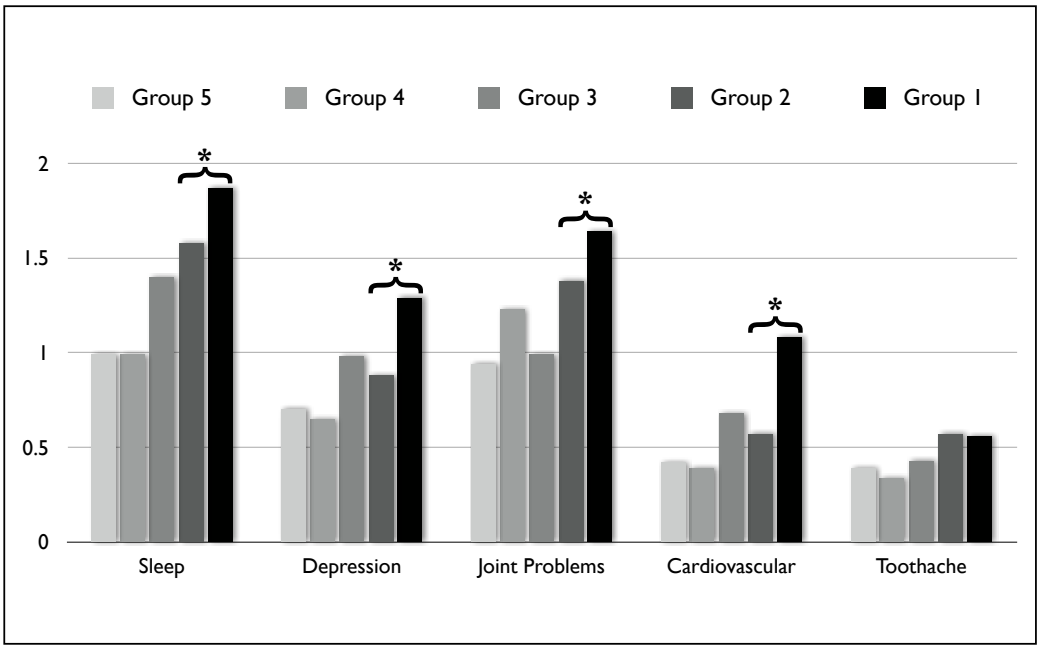
Field measurements stratified exposures into two regions:

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)



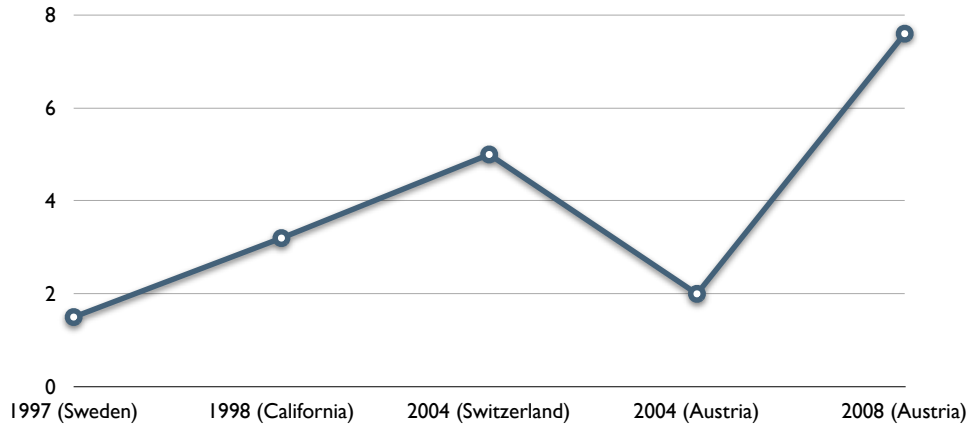
Some sample data from the study. Symptoms scored on 0 – 5 scale.

*** = 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.

Incidence of self-identified electrohypersensitivity (%)



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

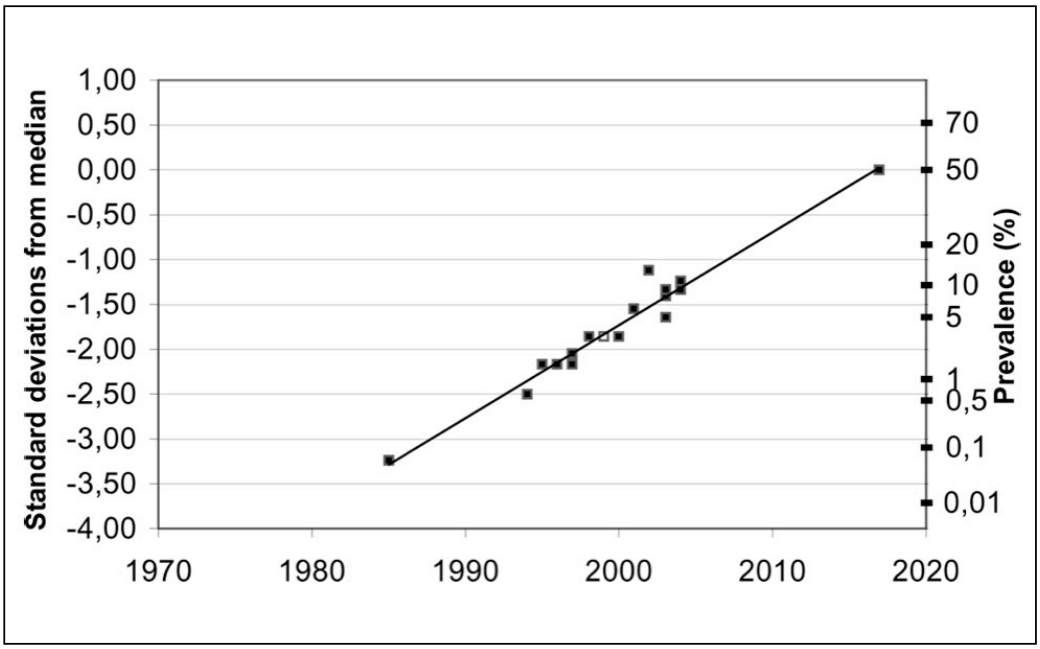
The people who had those symptoms may or may not have been aware that RF was a factor.

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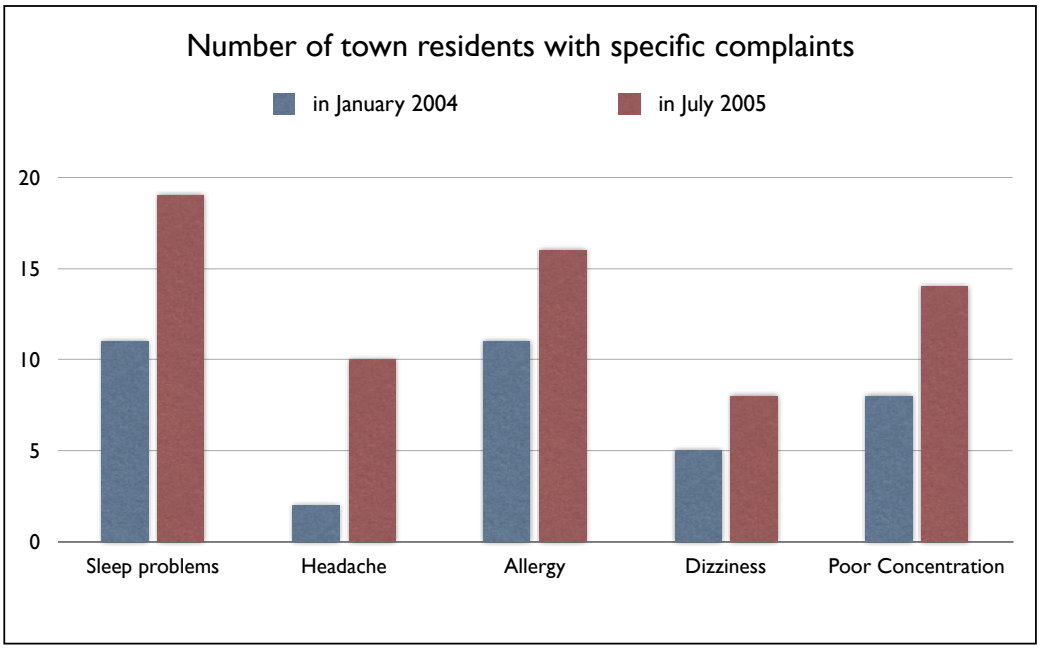
Buchner K EH. Changes of Clinically Important Neurotransmitters under the Influence of Modulated RF Fields--A Long-term Study under Real-life Conditions. *Umwelt-Medizin-Gesellschaft* (2011); 24(1):44-57.

Rimbach, Bavaria (2004 - 2005)

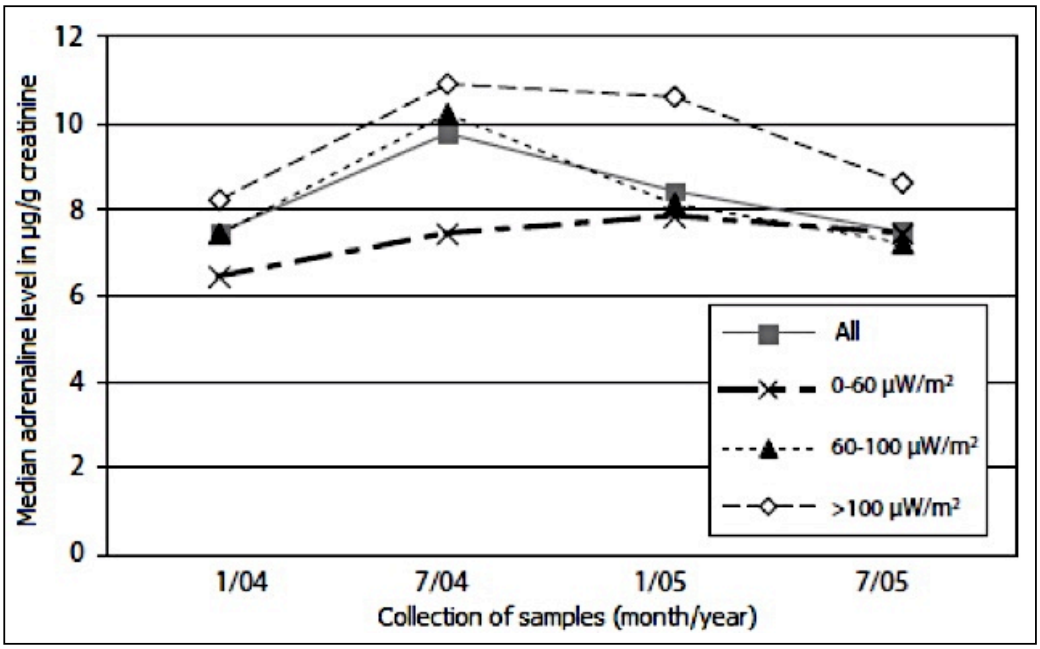


Here we see some symptom scores before tower activation (blue) and after a year of tower transmission (red)
Some health complaints increased over the course of the study.

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.

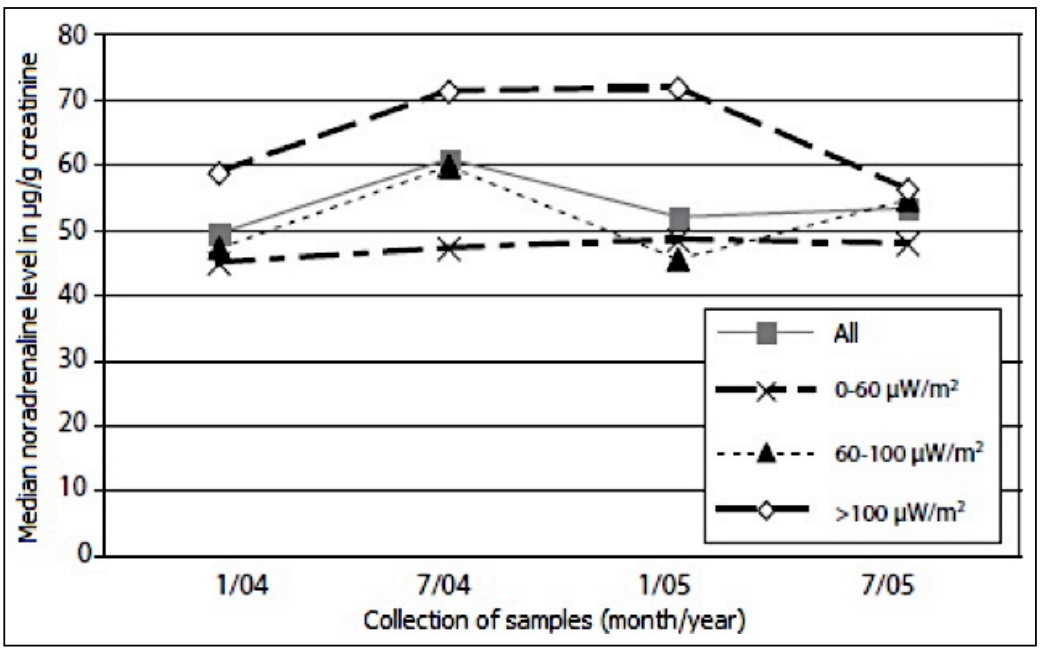
Abstract: This follow-up of 60 participants over one and a half years shows a significant effect on the adrenergic sys- tem after the installation of a new cell phone base station in the village of Rimbach (Bavaria). After the activation of the GSM base station, the levels of the stress hormones adrenaline 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)

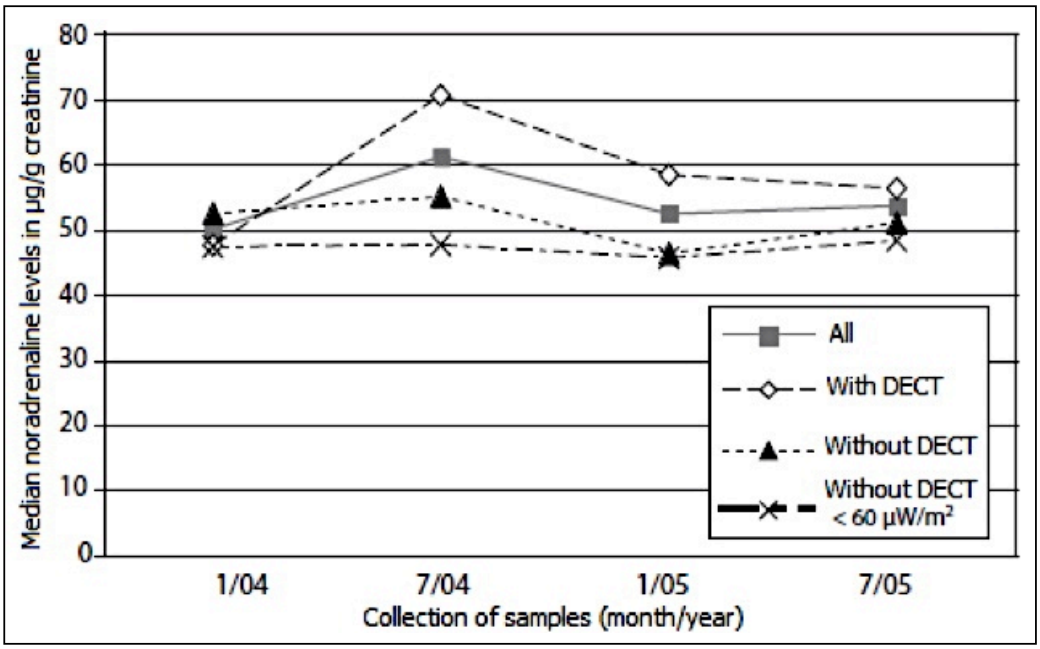
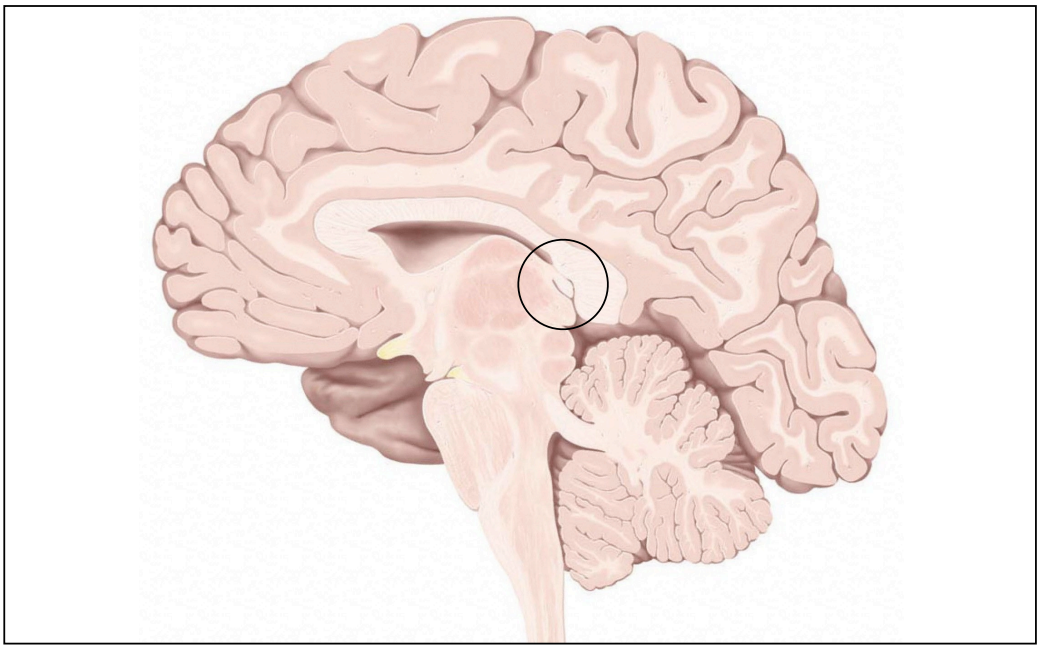


Fig. 8: Median noradrenaline values for subjects who had a DECT phone or other wireless devices at home, for those without indoor wireless devices, as well as for subjects without indoor wireless devices and with a GSM radiation exposure up to 60 µW/m2 (peak value measured in front of residence)

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

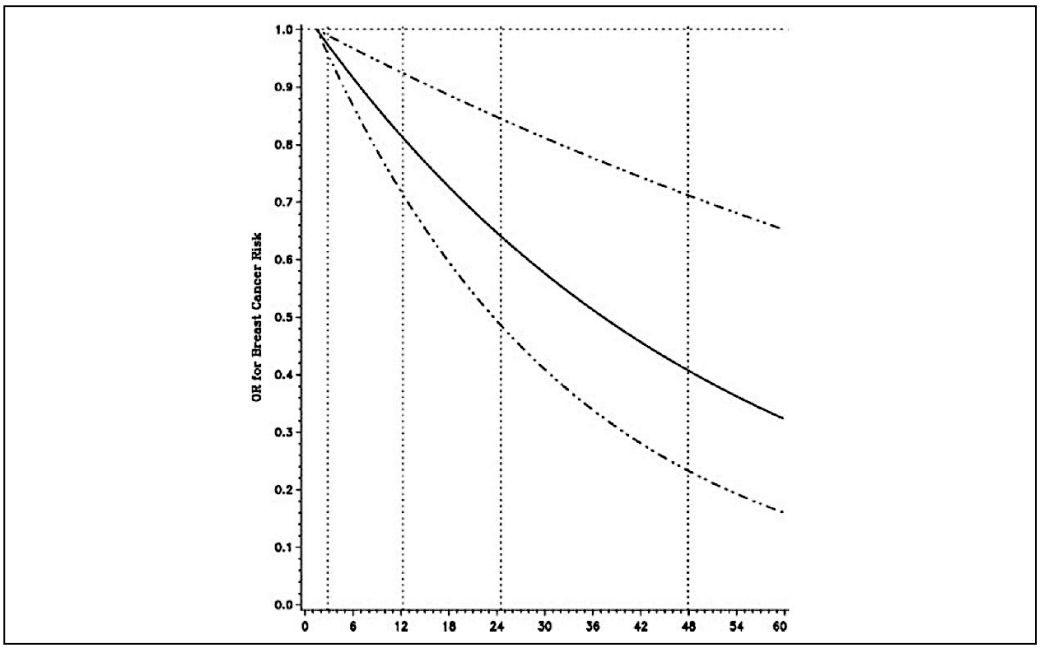


The pineal gland secretes melatonin. Ambient light suppresses melatonin secretion. So melatonin secretion is high during the night-time hours, peaking shortly after midnight. **Higher melatonin levels are part of what makes us feel "sleepy" at night.**

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.]

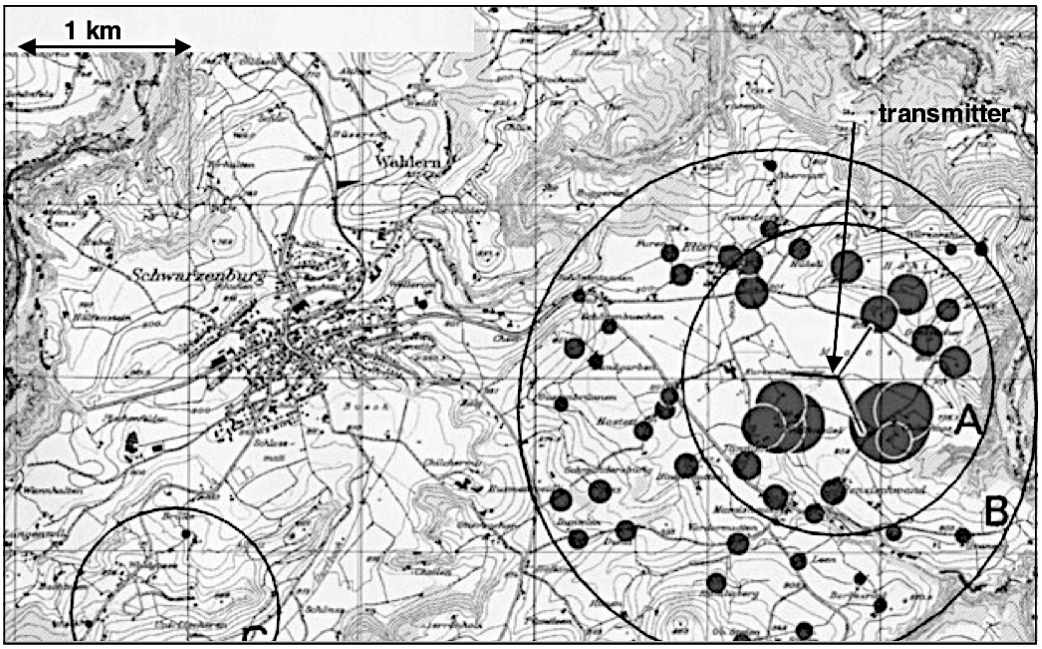
Melatonin is also protective against the growth of cancer cells, and disruption of the circadian melatonin cycle has been shown to lead to increased tumor growth in a variety of cancer types.

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.

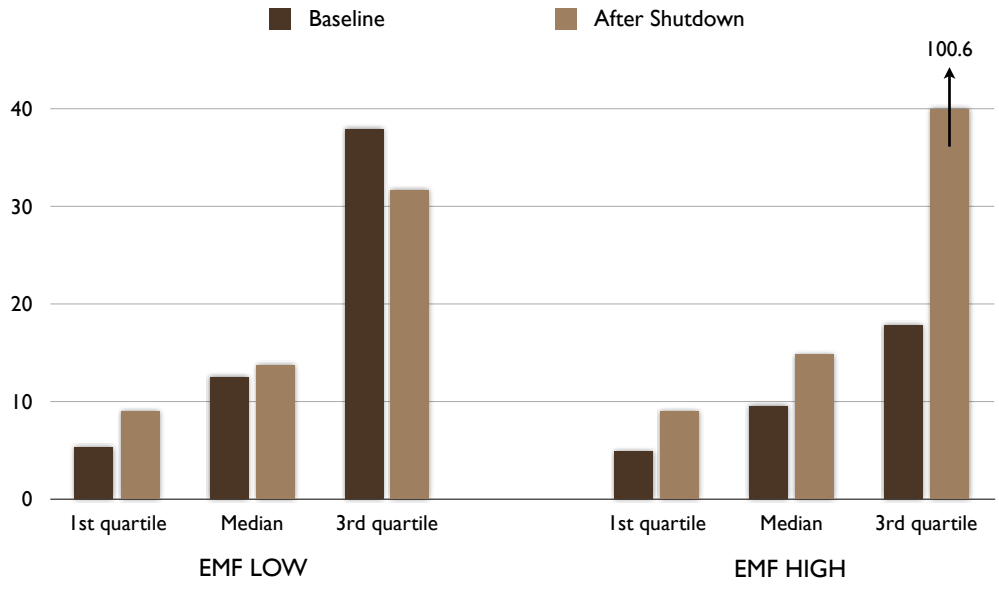
Schwarzenburg experiment: Decommissioning the Swiss national short-wave radio transmitter of Schwarzenburg, about 20 km south of the Swiss Capital city of Berne, transmitting since 1939. It operated at frequencies of 3 to 30 MHz, with a maximum power of two times 150 kW.

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.))

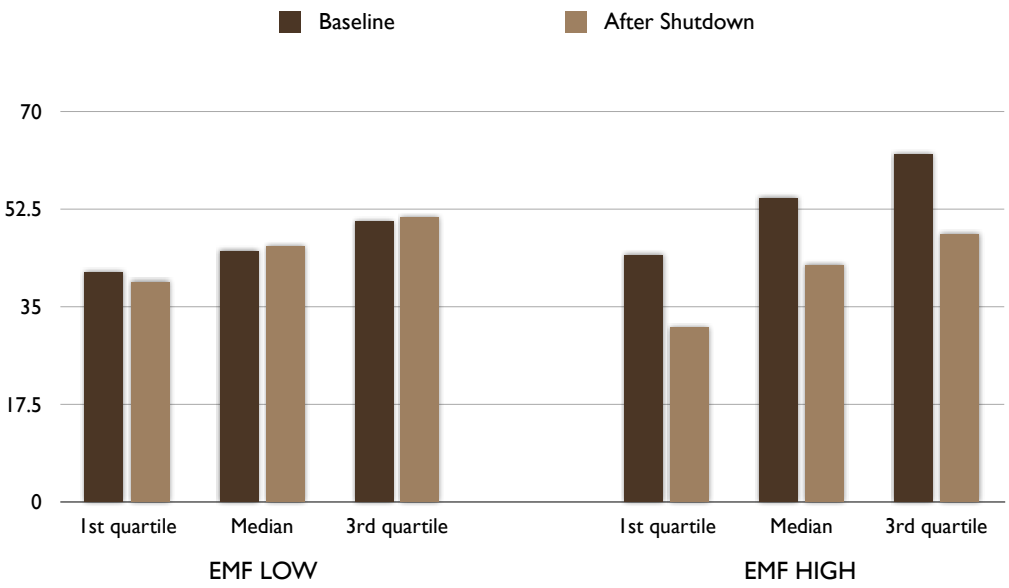
Abelin T, Altpeter E, Roosli M. Sleep Disturbances in the Vicinity of the Short-Wave Broadcast Transmitter Schwarzenburg. Somnologie (2005); 9:203-209.

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.

Melatonin Excretion (pg/ml)

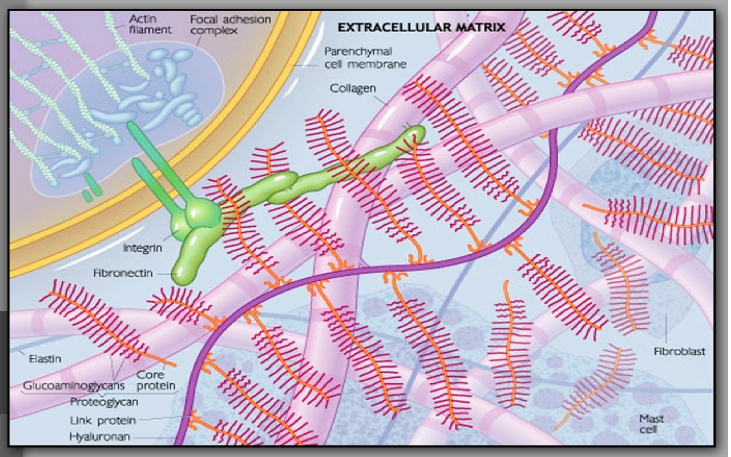


Altpeter ES, Roosli M, Battaglia M, Pfluger D, Minder CE, Abelin T. Effect of short-wave (6-22 MHz) magnetic fields on sleep quality and melatonin cycle in humans: the Schwarzenburg shut-down study. Bioelectromagnetics (2006); 27(2):142-150.



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.

Microwave RF Interacts with Molecular Structures



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

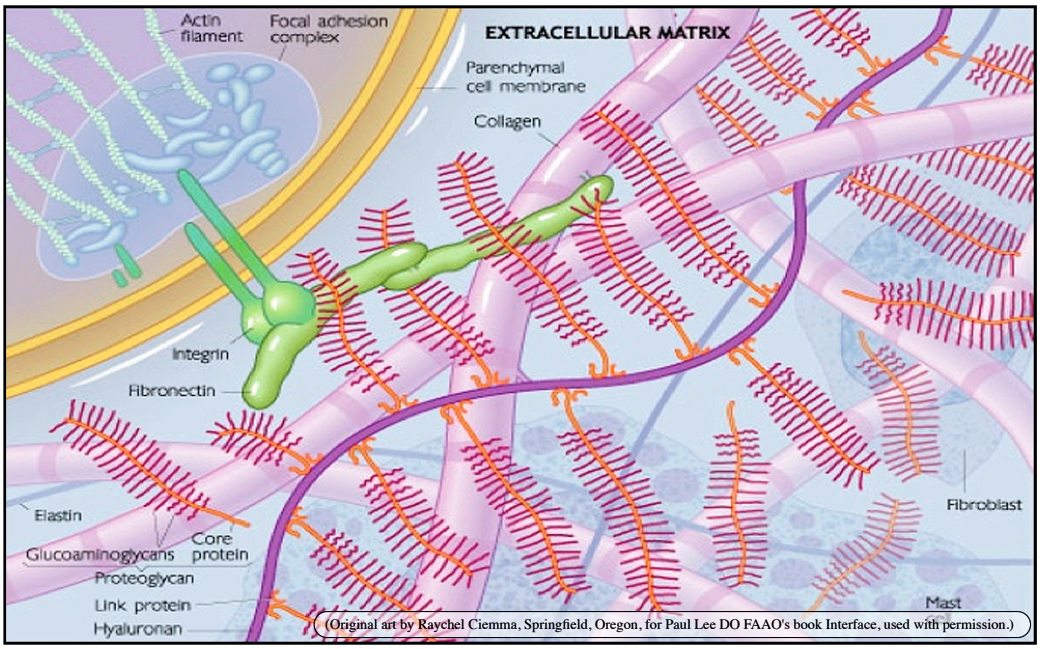
The molecules in our bodies vary in size and in total electric charge.

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.



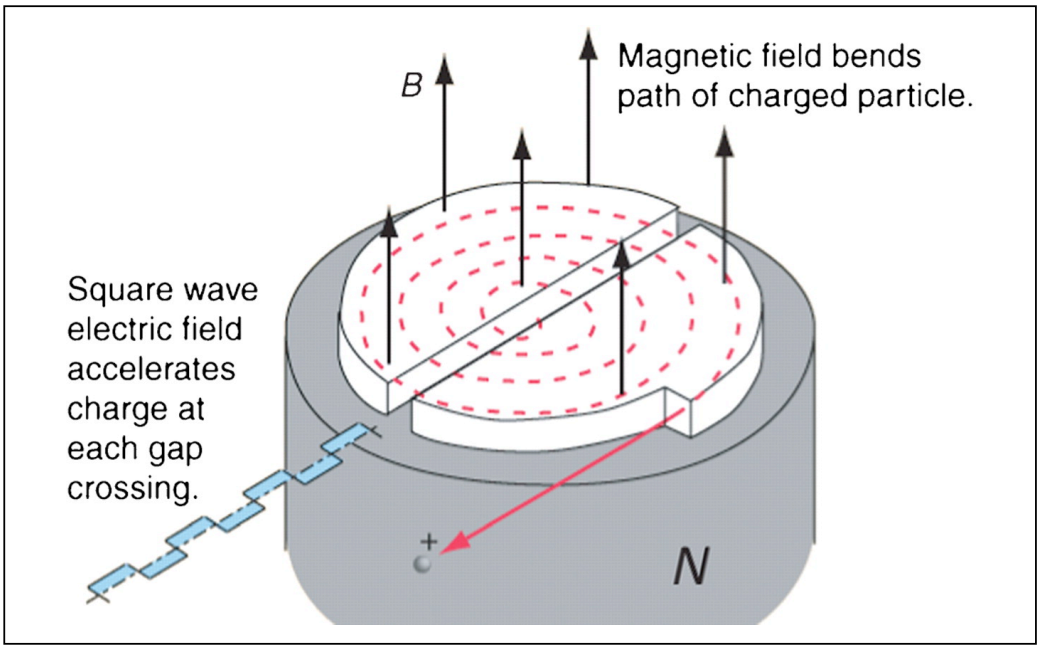
The molecules in our bodies vary in size and total electric charge.

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

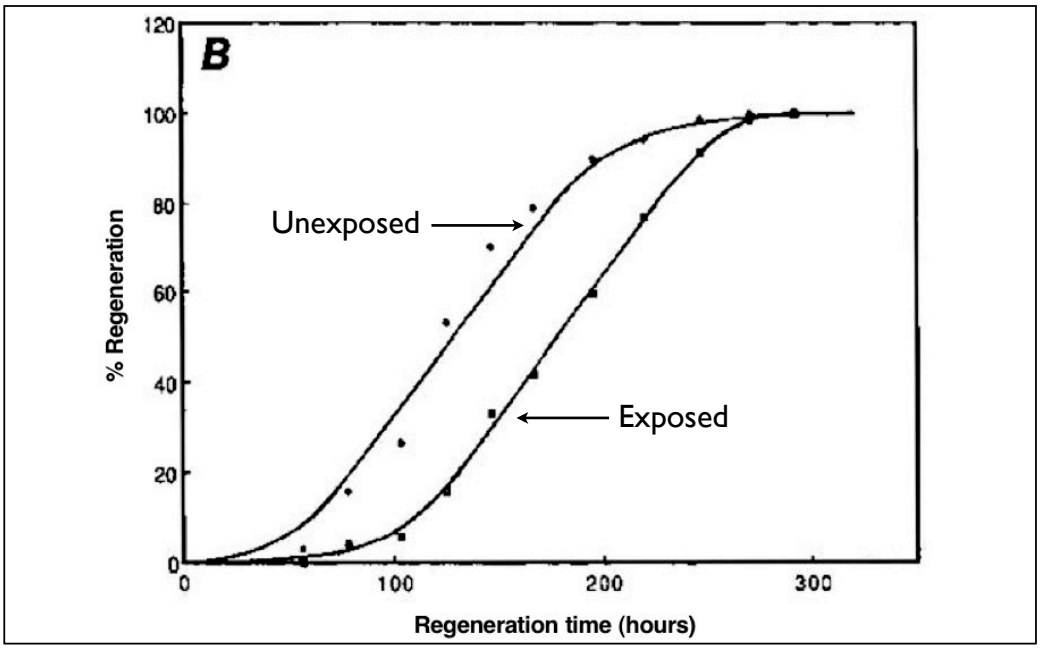


Placing the particle in an electromagnetic field that fluctuates at the resonant frequency will amplify the motion of the particle.

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.

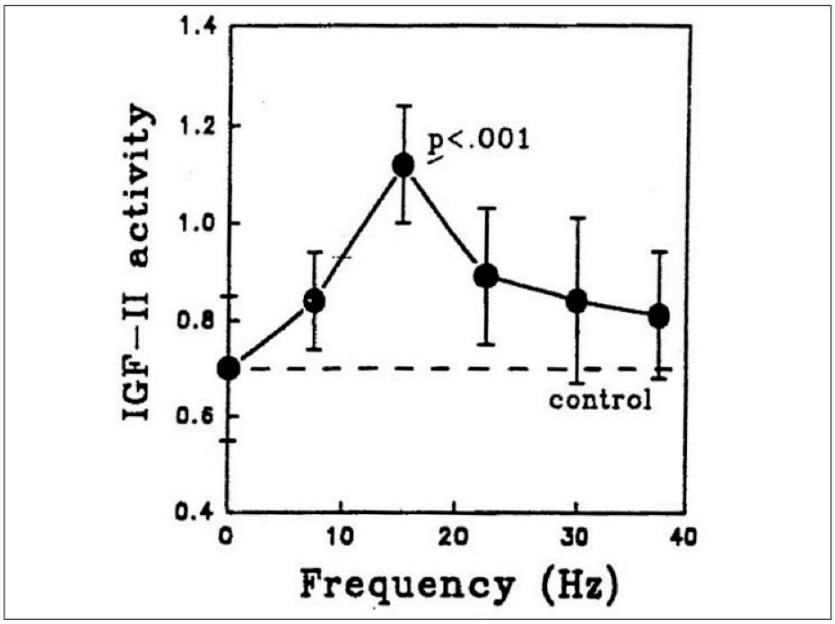
Resonance Effect



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*

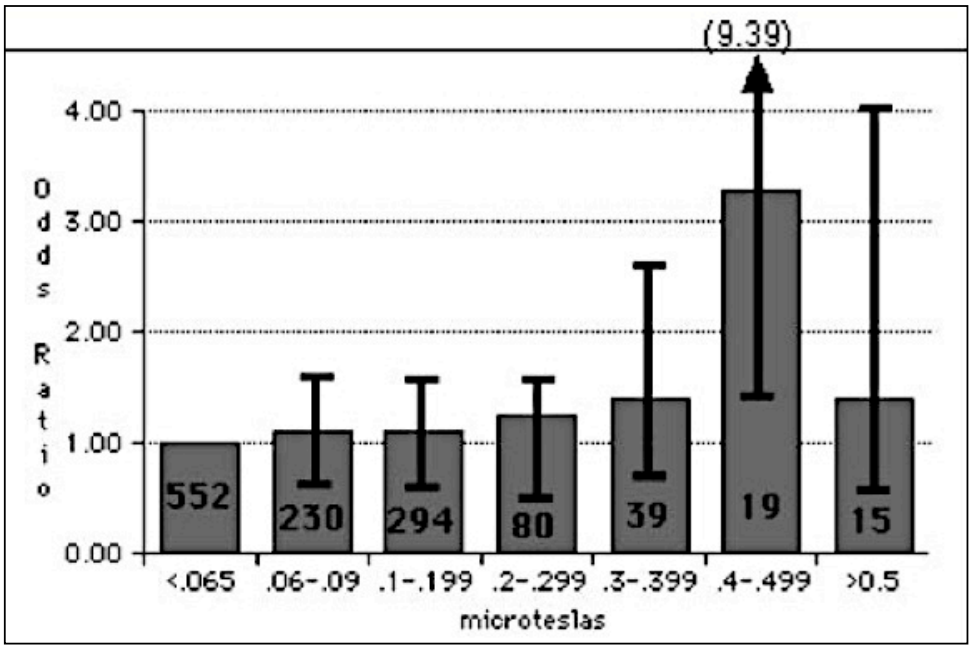
"frequency window"



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”

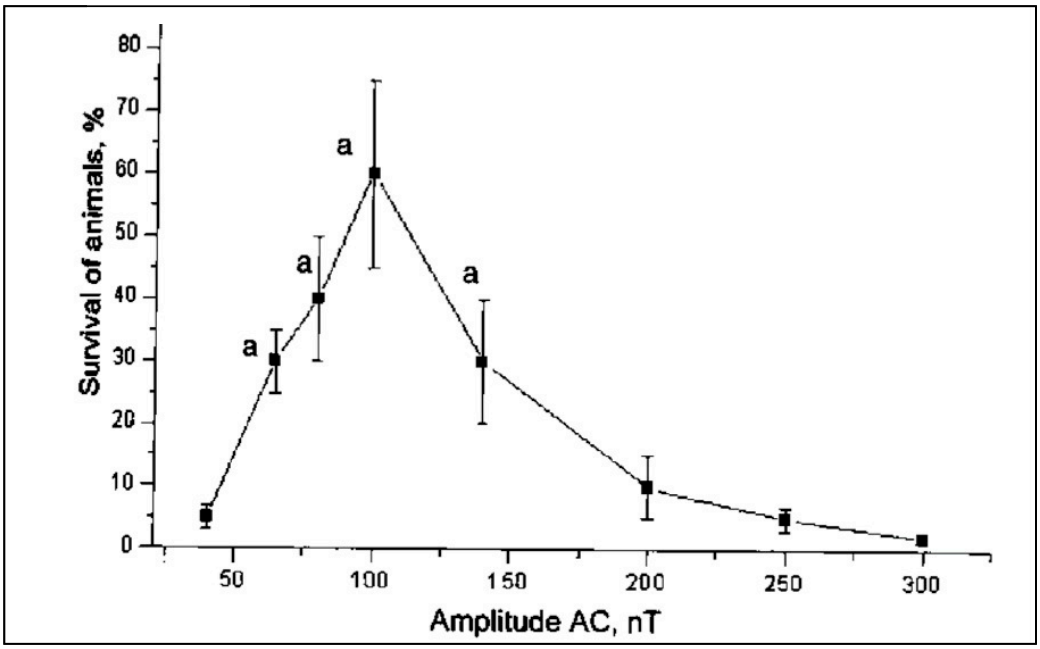
In this illustration, the odds ratio for childhood onset of Acute Lymphoblastic Leukemia is significantly higher if they are exposed to 60 cycle magnetic fields at a magnitude of 0.4 to 0.499 microtesla.

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,

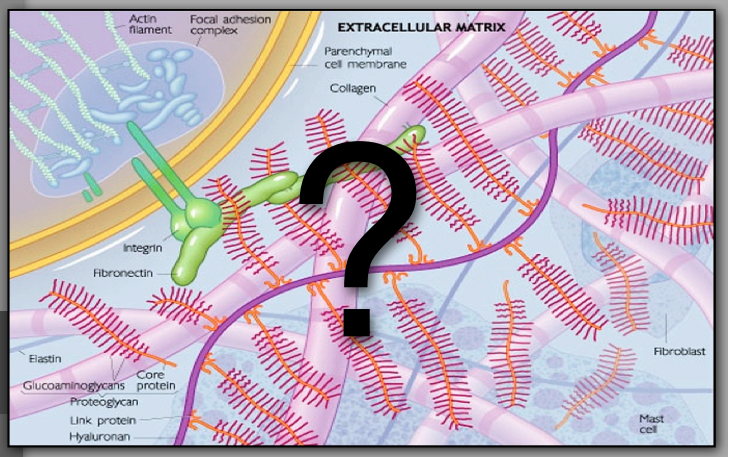
exposed to a fluctuating EM field tuned to the ICR frequency for aspartic acid and glutamic acid ions.

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.)

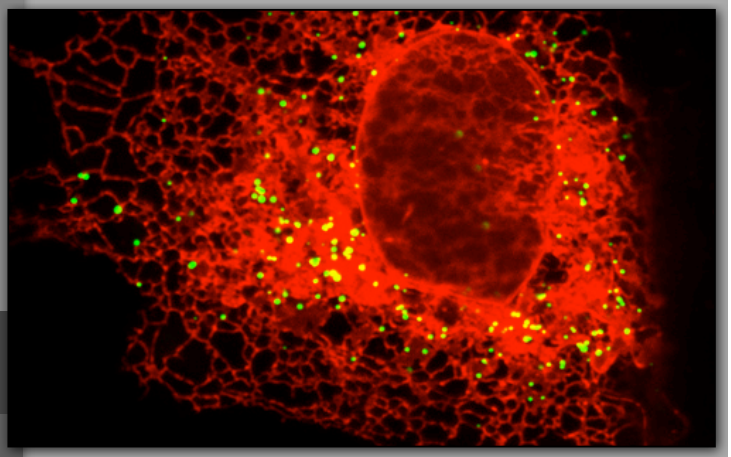
There are thousands of enzymes and other molecules in the human body.

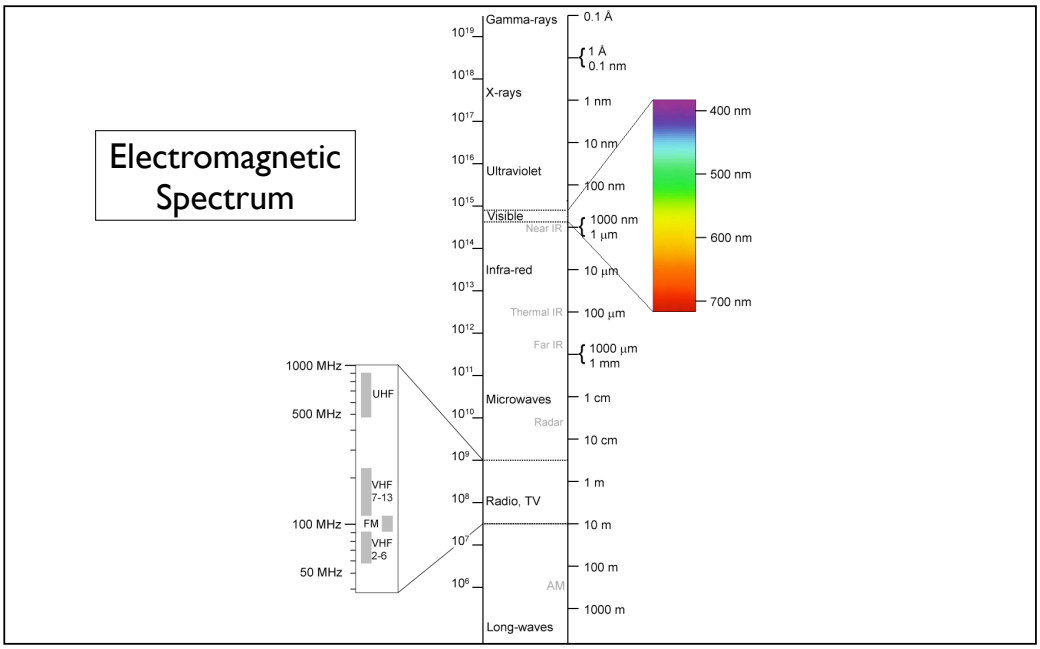
Each has its own mass, charge, and resonant frequency.

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.

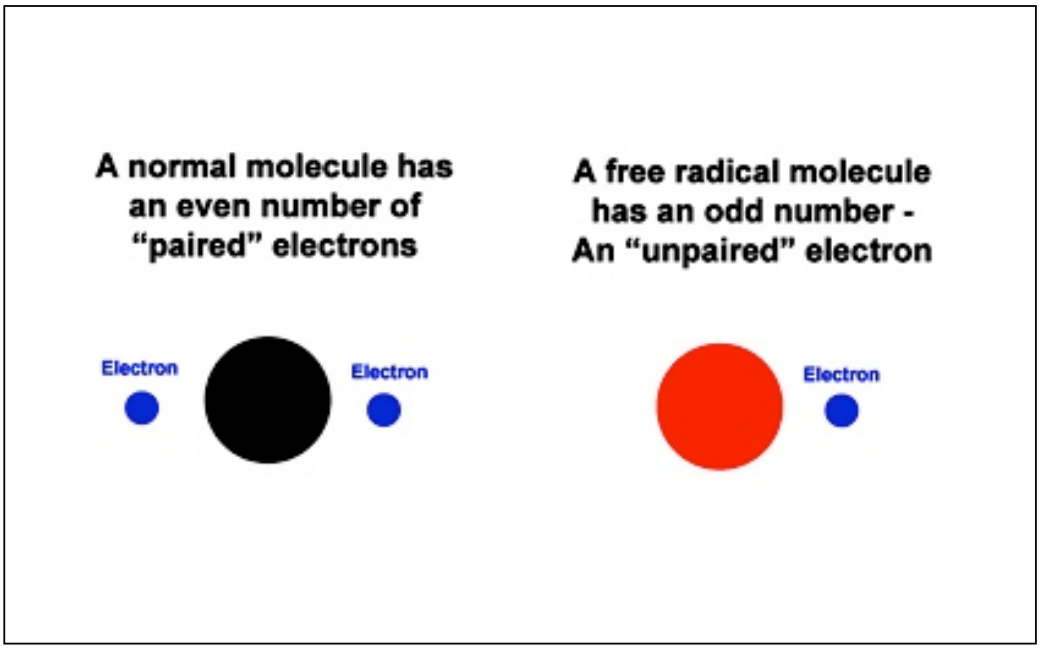
But photons of microwave RF do not have enough energy to directly break covalent molecular bonds.

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.

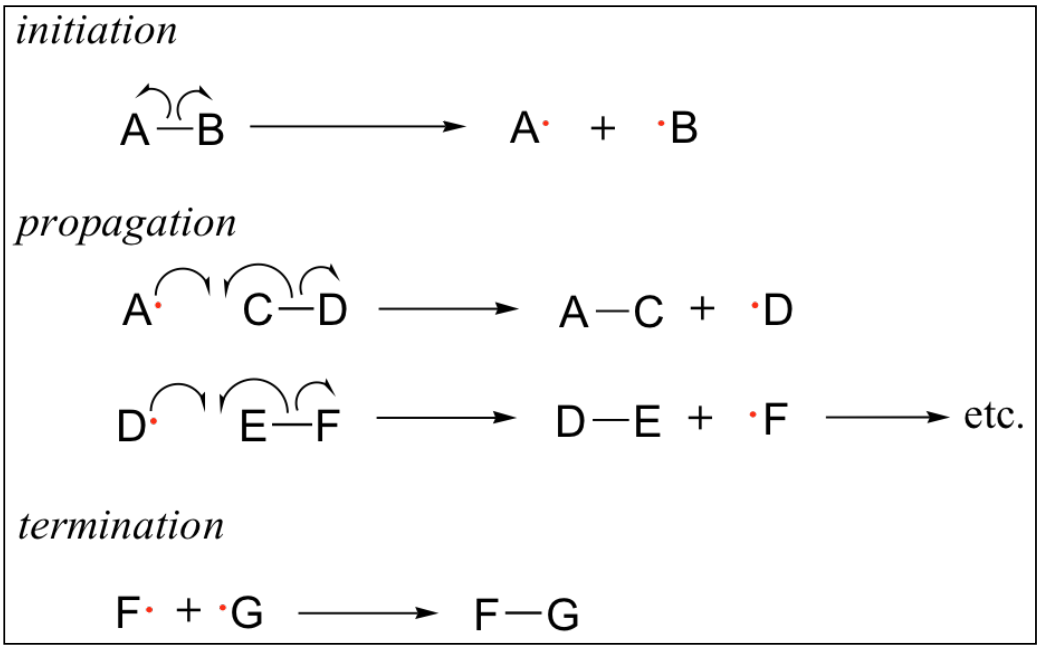
Free Radicals



Free radicals are oxidizing agents.

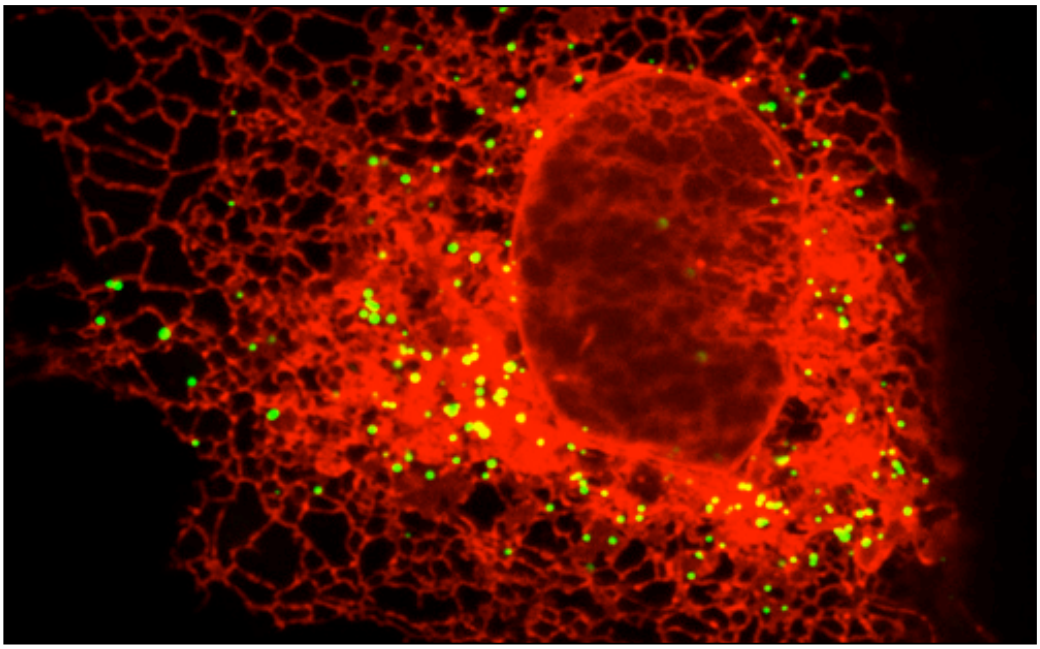
They take electrons from other atoms or molecules, which can break molecular bonds.

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.

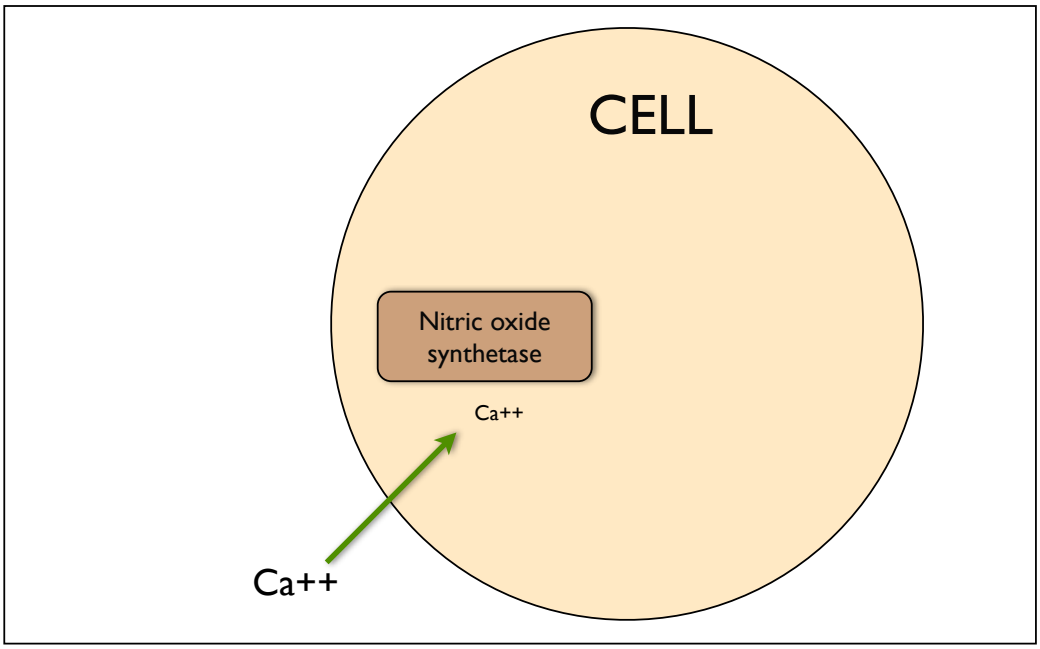
In all these studies, the effects of EMF on increased cellular calcium levels could be blocked by calcium channel blocking drugs.

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

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);

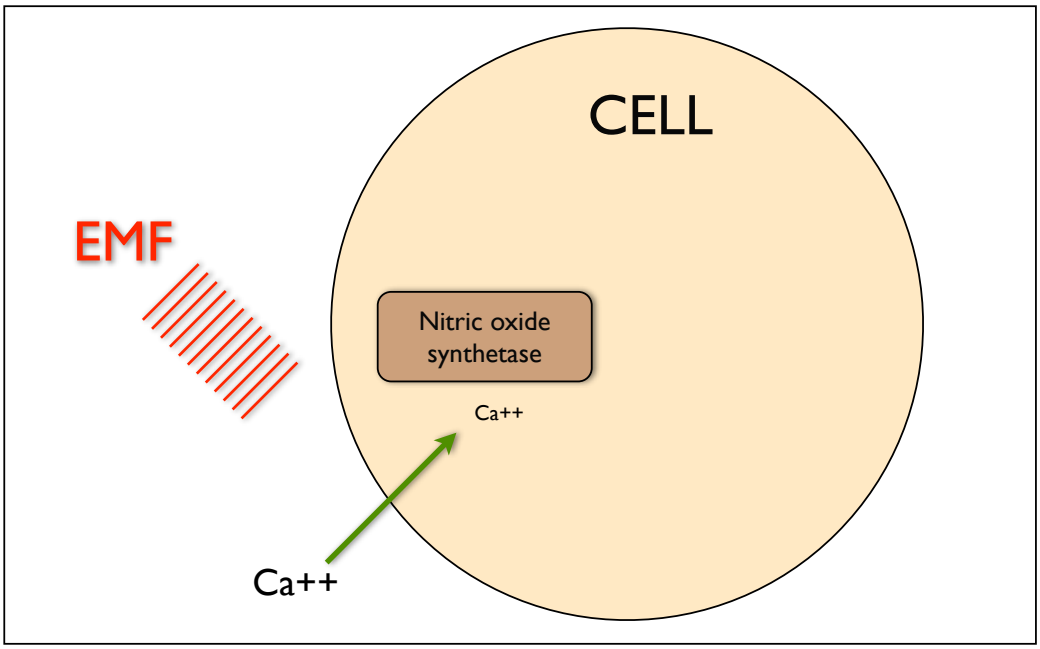
EMF Activation of VGCCs Increases Free Radical Production



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).

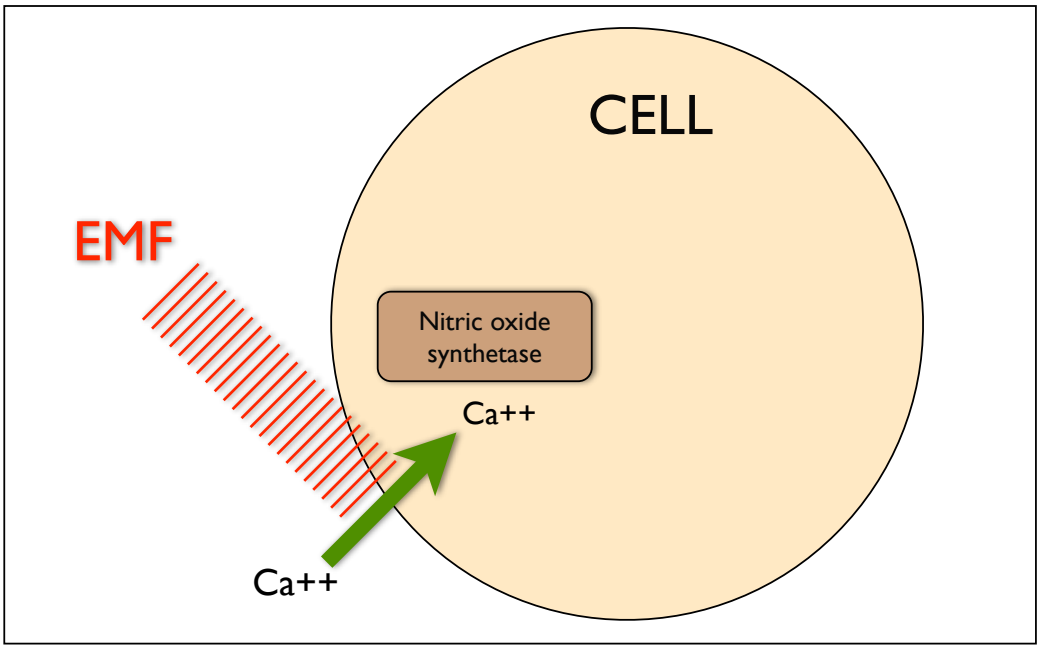
As discussed by Pall ML. Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects. *J Cell Mol Med* (2013);

EMF Activation of VGCCs Increases Free Radical Production



An electromagnetic field arrives at the cell wall.

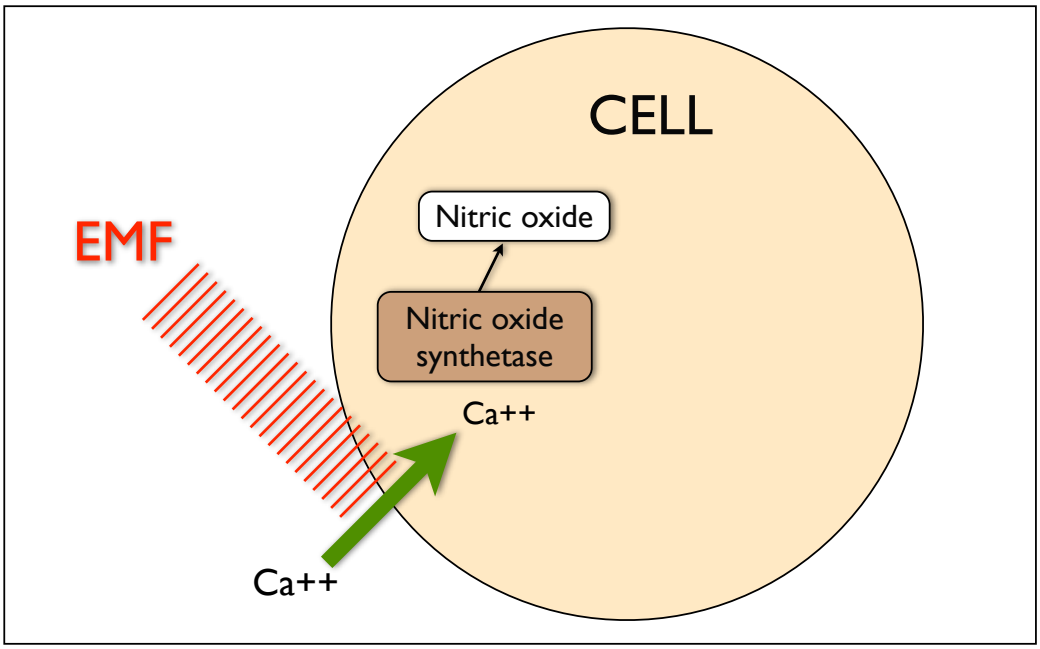
EMF Activation of VGCCs Increases Free Radical Production



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

This increases Ca++ entry into the cell.

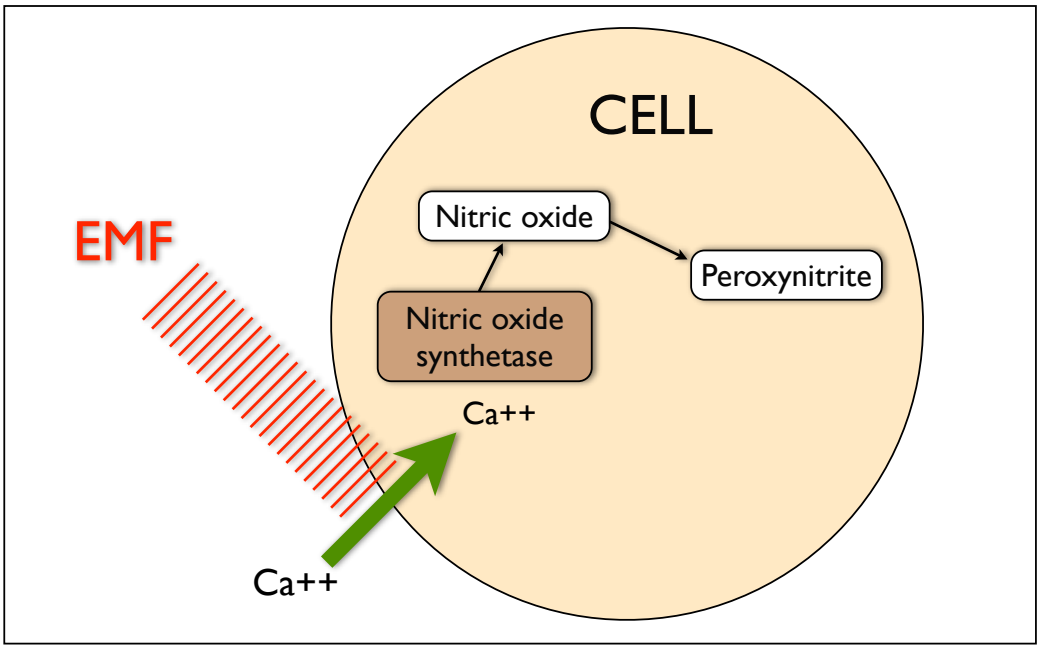
EMF Activation of VGCCs Increases Free Radical Production



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

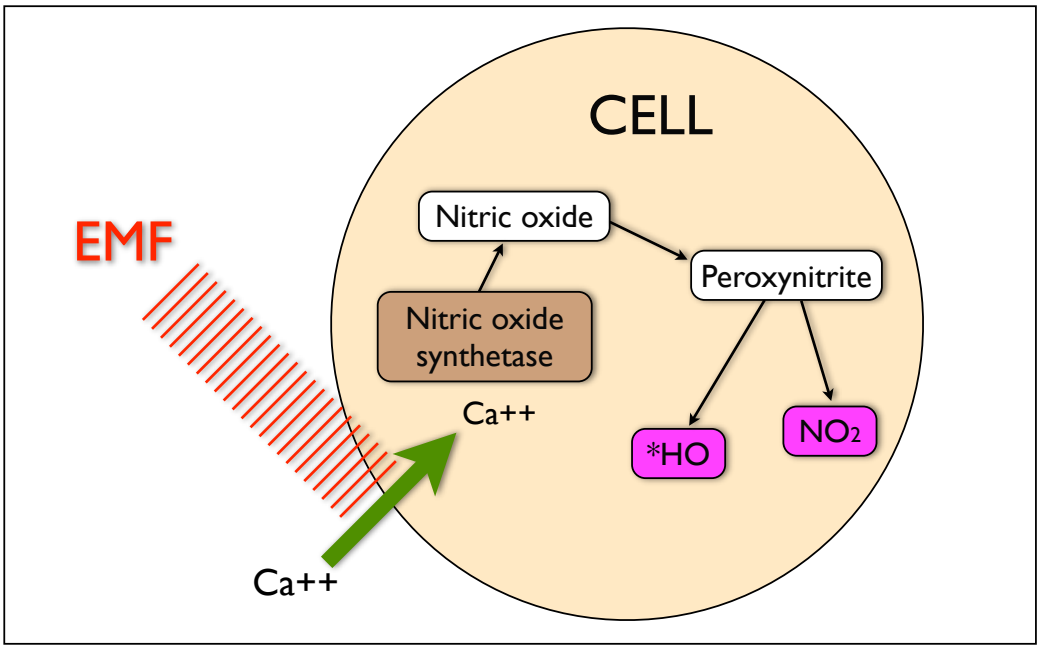
Which leads to increased production of nitric oxide in the cell.

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

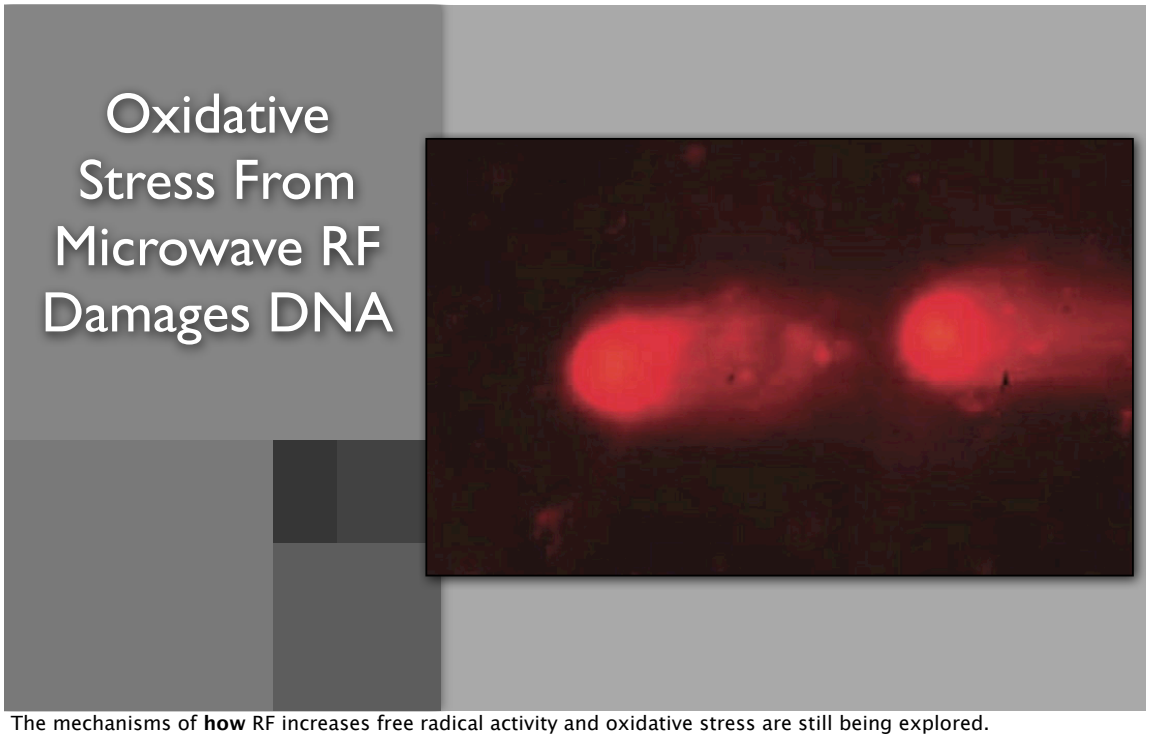


Peroxynitrite produces free radicals, including hydroxyl radical and NO_2.

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.

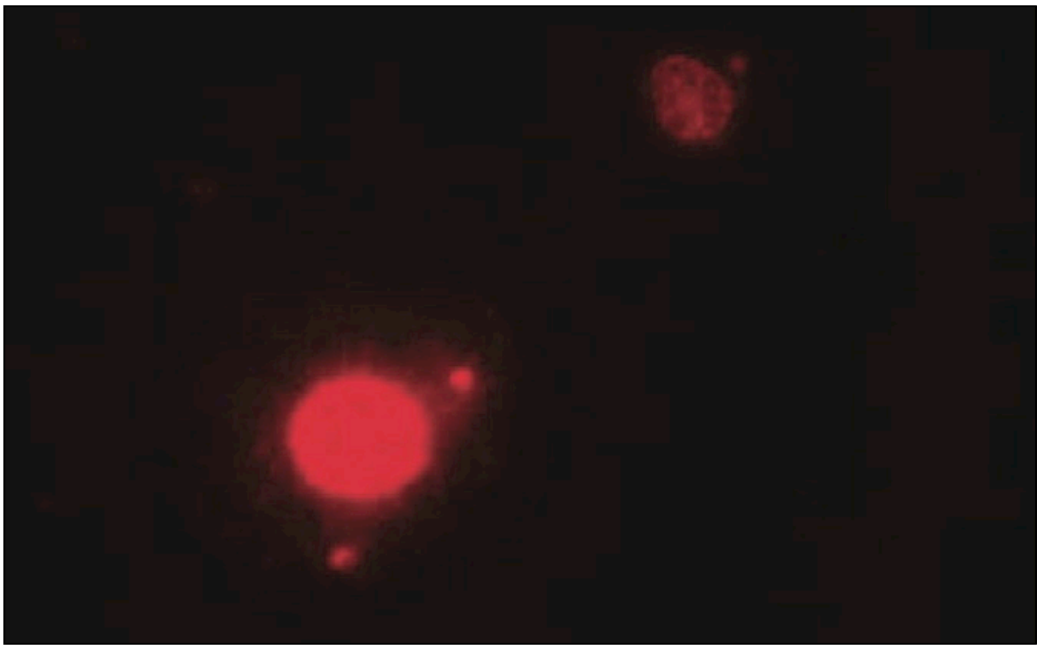


The mechanisms of **how** RF increases free radical activity and oxidative stress are still being explored.

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.

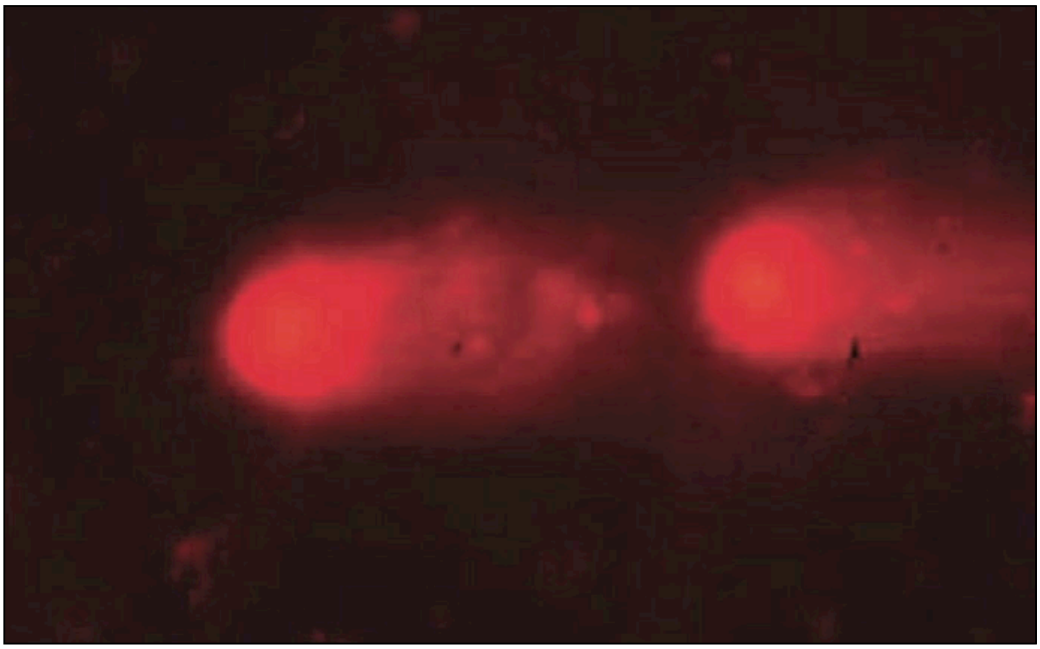
Comet assay: Unexposed control



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.

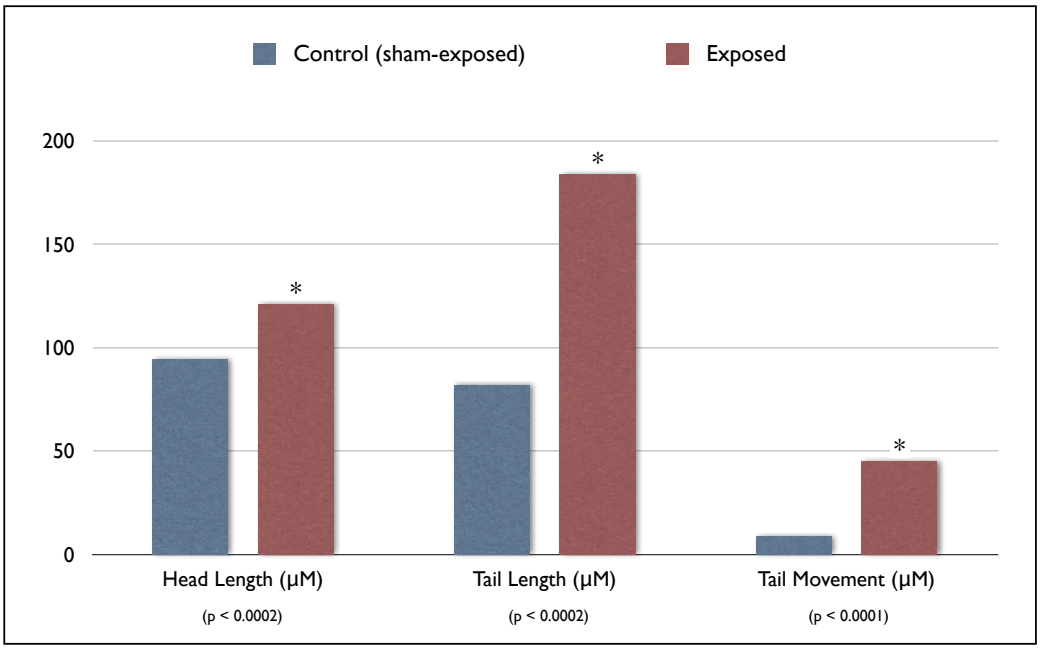
RF exposure: 2.45 GHz @ 0.34 mW/cm2, 2 hours per day x 35 days



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



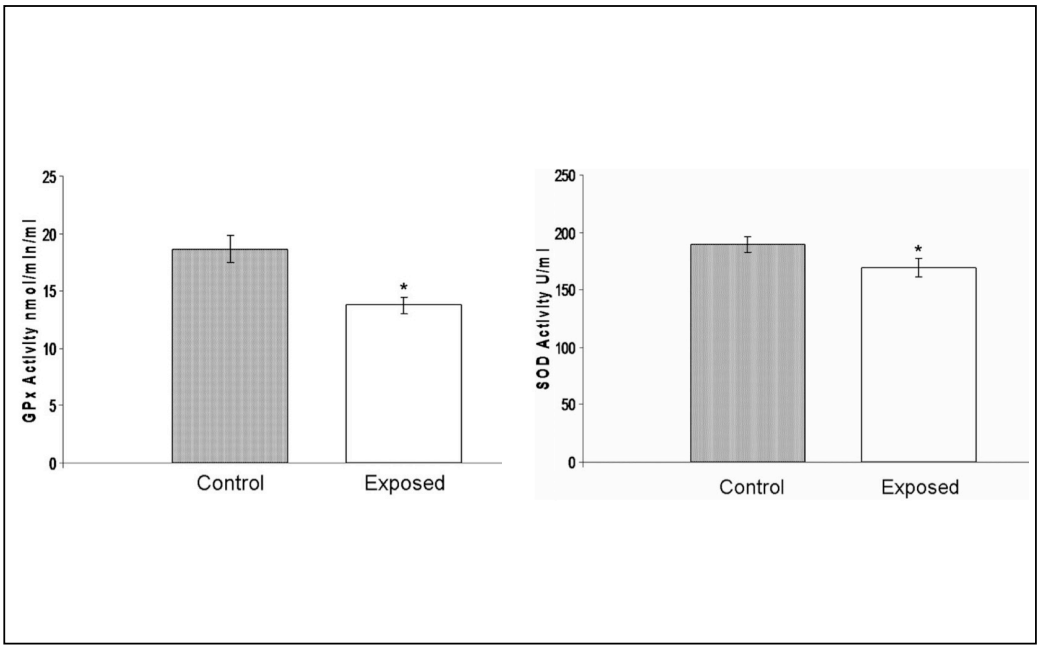
Comet Assay: **Measure of DNA fragmentation** in rat brains, produced by prolonged exposure to microwave RF.

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.

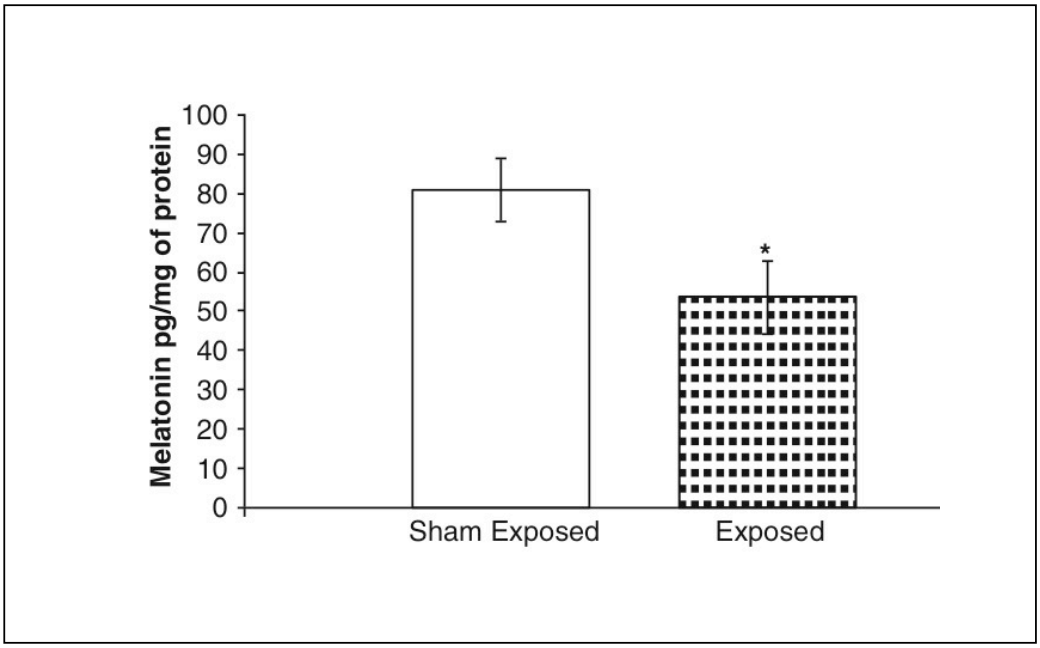
This consumption of anti-oxidants is **evidence of increased oxidant stress**, due to excess free radical production.

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



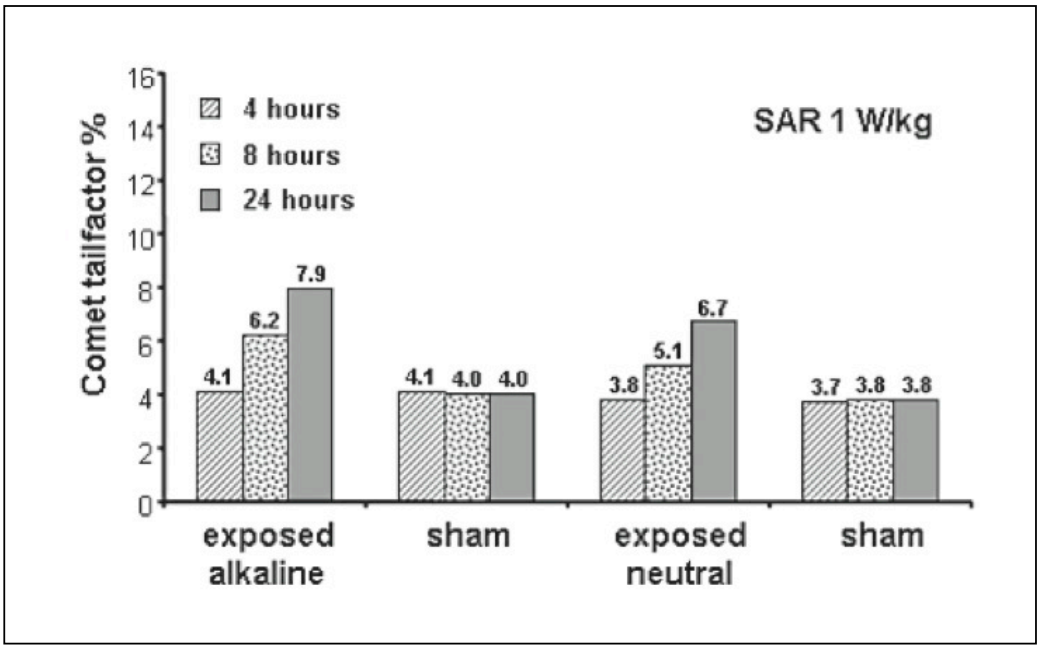
Suppression of melatonin secretion by 2.45 GHz RF:

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.

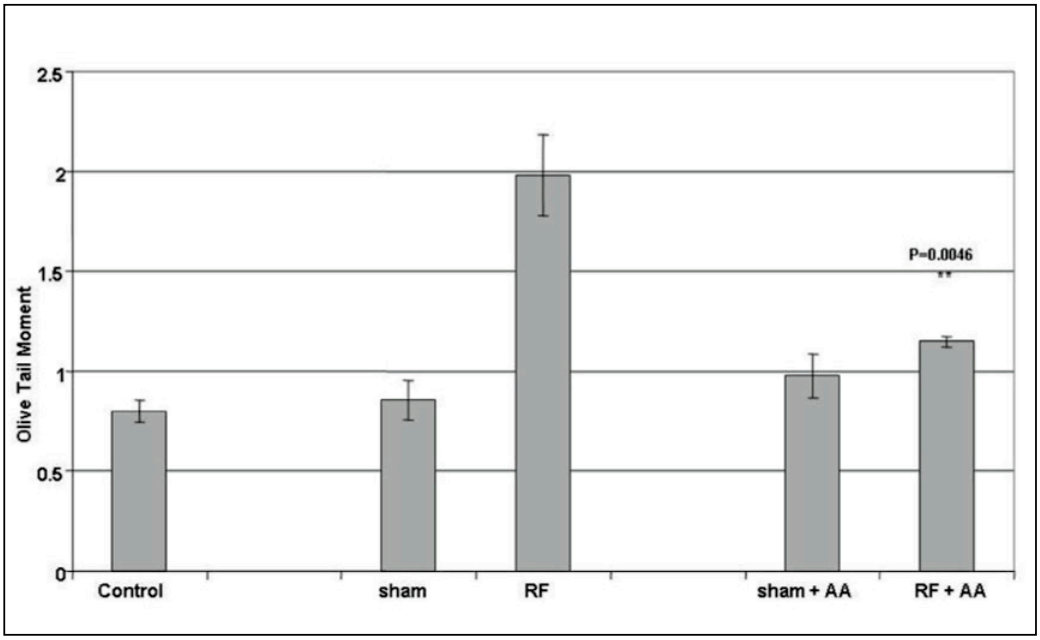
Total exposure for 4, 8, or 24 hours.

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.

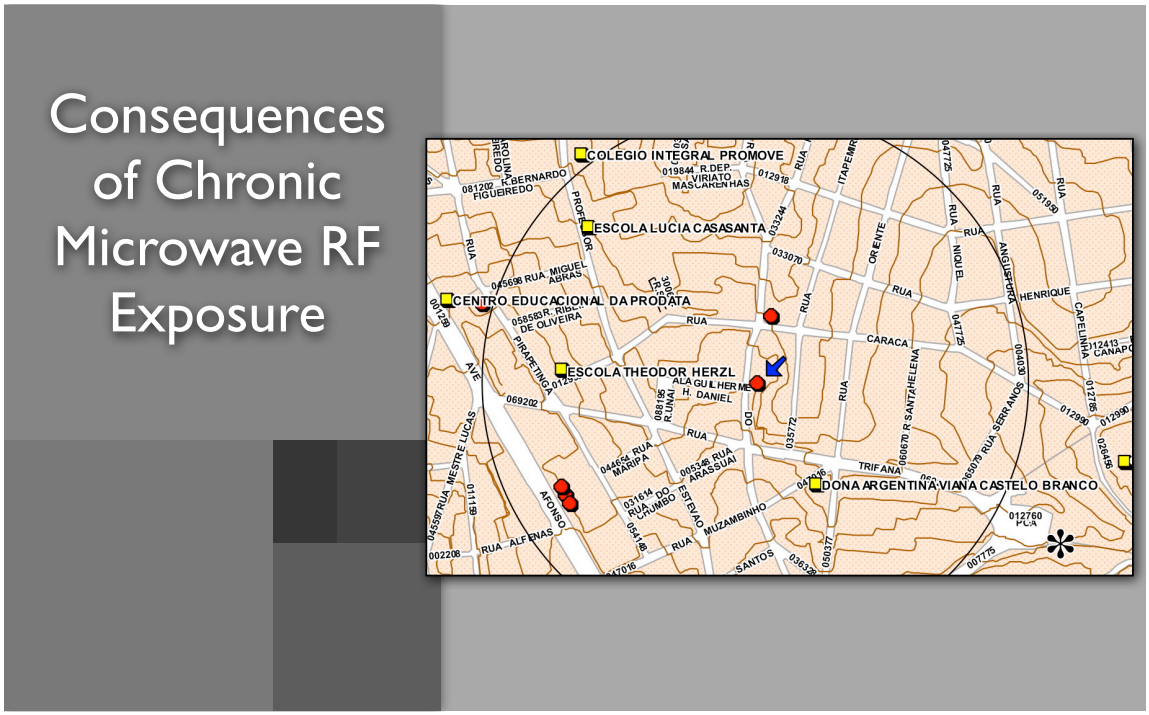
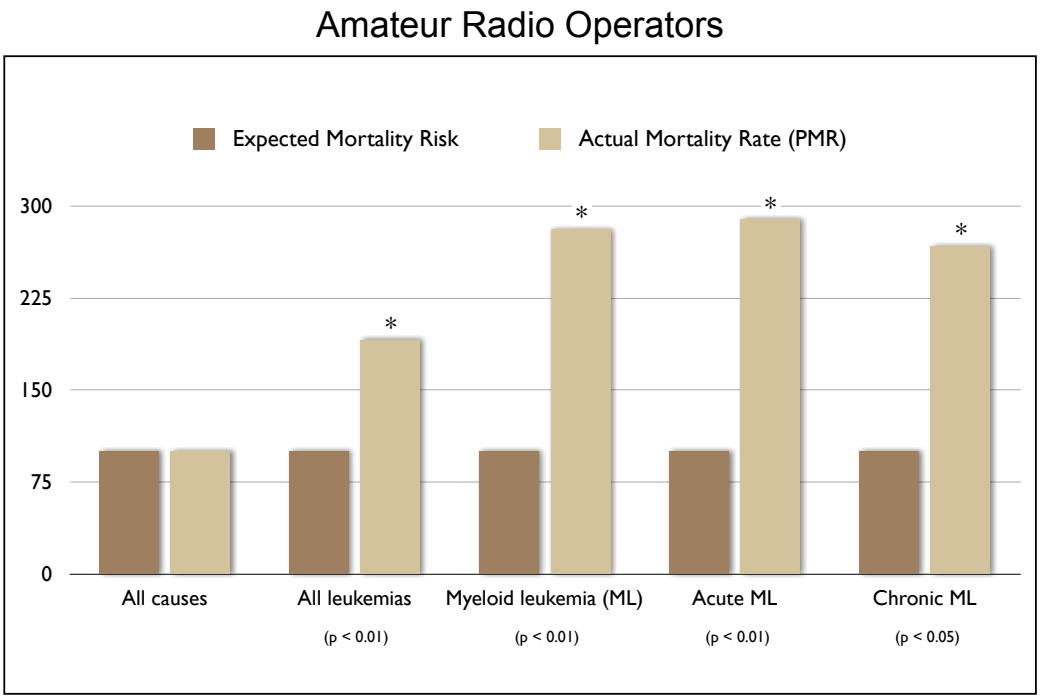


Fig. 2. Geographical location of BS Site BH 20 at 1373 Rua do Ouro Street, in the Serra neighborhood, Belo Horizonte municipality

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.

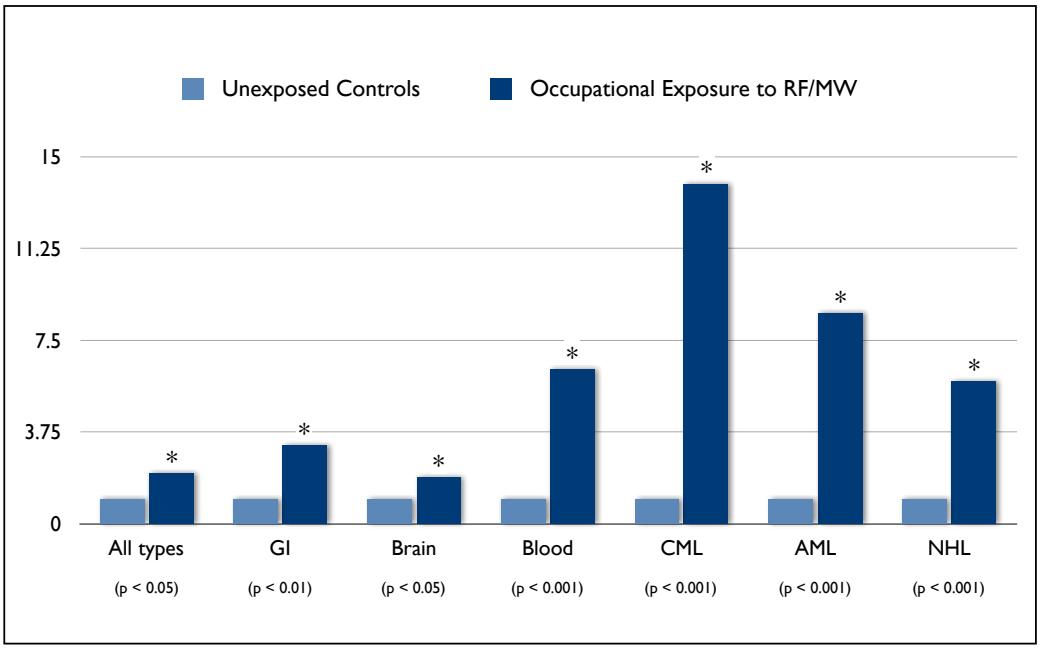


Analysis of leukemia deaths in male members of the American Radio Relay League resident in Washington and California, 1971-1983

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)



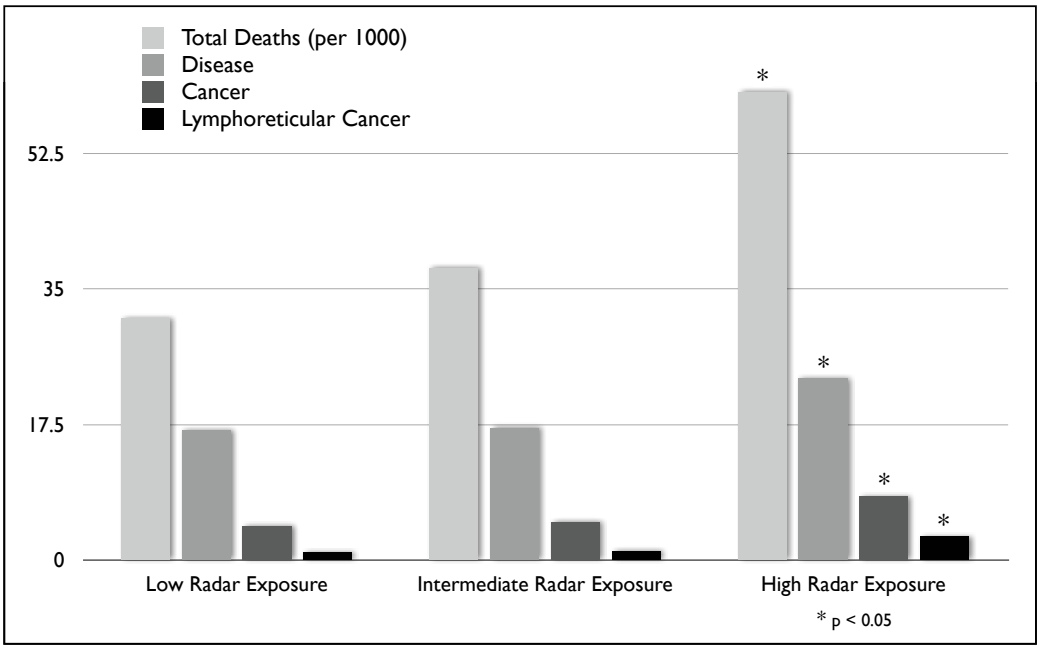
Polish military personnel with occupational exposure to radio and microwave frequency radiation.

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.

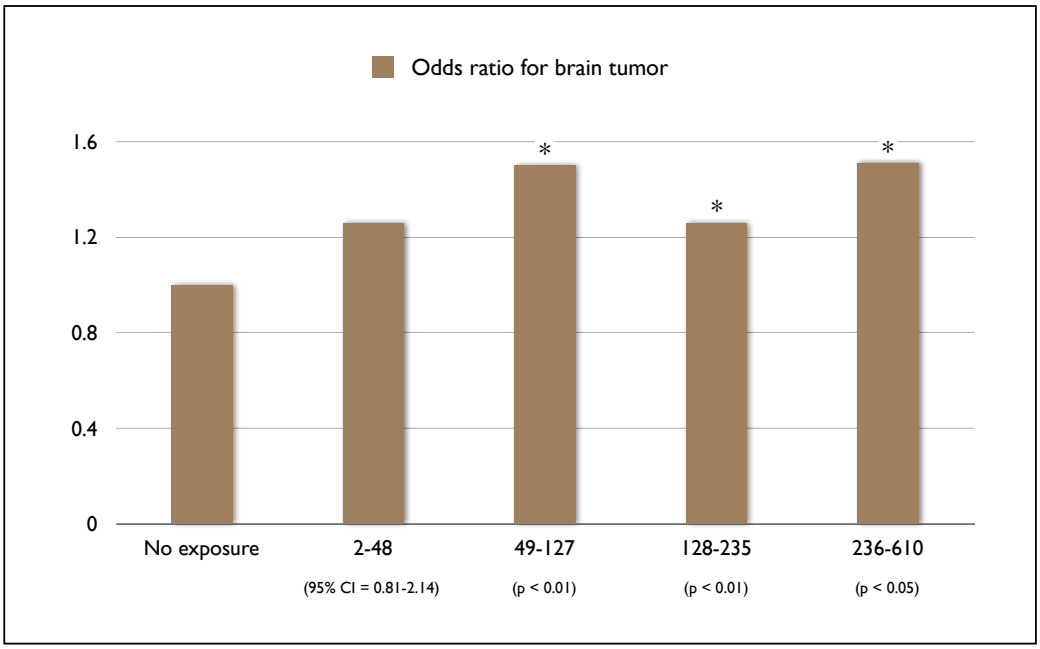
In the original paper, Robinette et al evaluated job exposure hazard levels of 6 categories of navy personnel and grouped them into two groups, low exposure and high exposure. The electronic technicians (ET) had a significantly lower hazard rating and lower levels of pathology than the other two job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



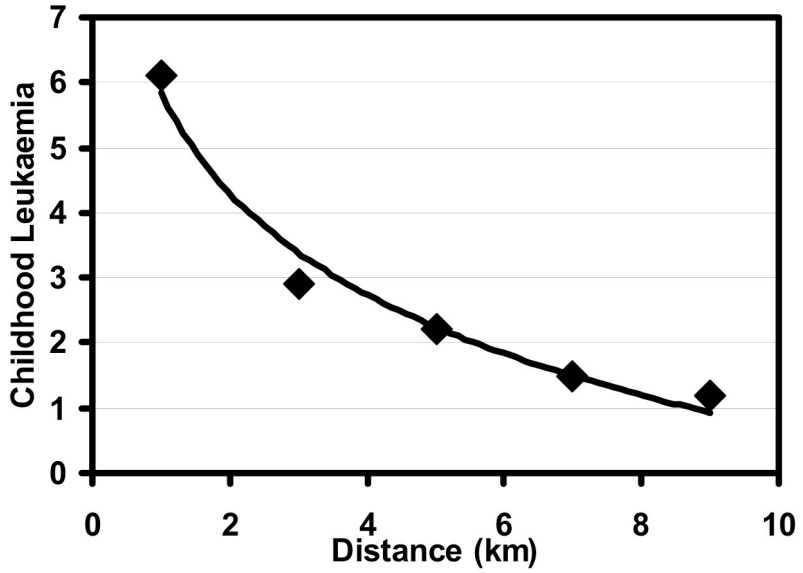
US Air Force Workers with occupational exposure to microwave RF (1970–1989)

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.

Netanya, Israel (1997-1998)

New cell phone tower set up in city of Netanya, Israel, in July, 1996.

1500 watt, 850 MHz.

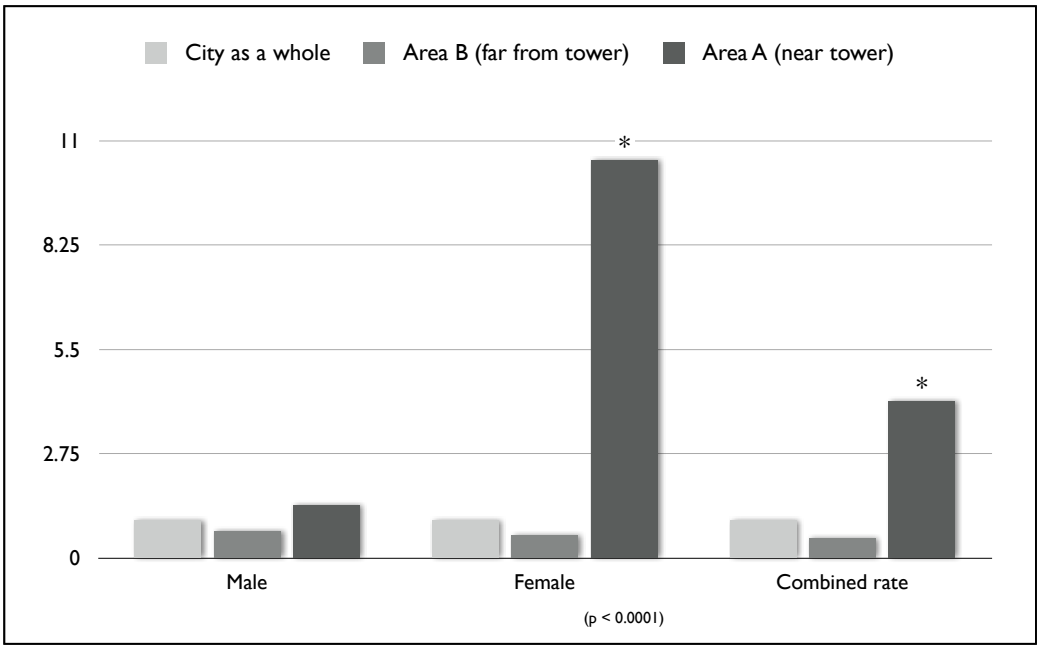
Power density in the whole exposed area was **far below 0.53 µw/cm2**.

This is 1000 times less than the FCC Guidelines of 600 µW/cm^2 for 850 MHz exposure.

Comparison of cancer rates during the second year of exposure, in 677 long-term residents near the tower, compared to 1,222 matched controls living in another area of the city.

Wolf R, Wolf D. Increased Incidence of Cancer Near a Cell-Phone Transmitter Station. *International Journal of Cancer Prevention* (2004); 1(2):1-19.

Netanya, Israel - Relative Cancer Risk



Relative risk of cancer in residents near a new cell phone tower in Netanya, Israel, during the second year of exposure.

Overall risk of cancer in Area A was 4.15 times higher than in the town as a whole.

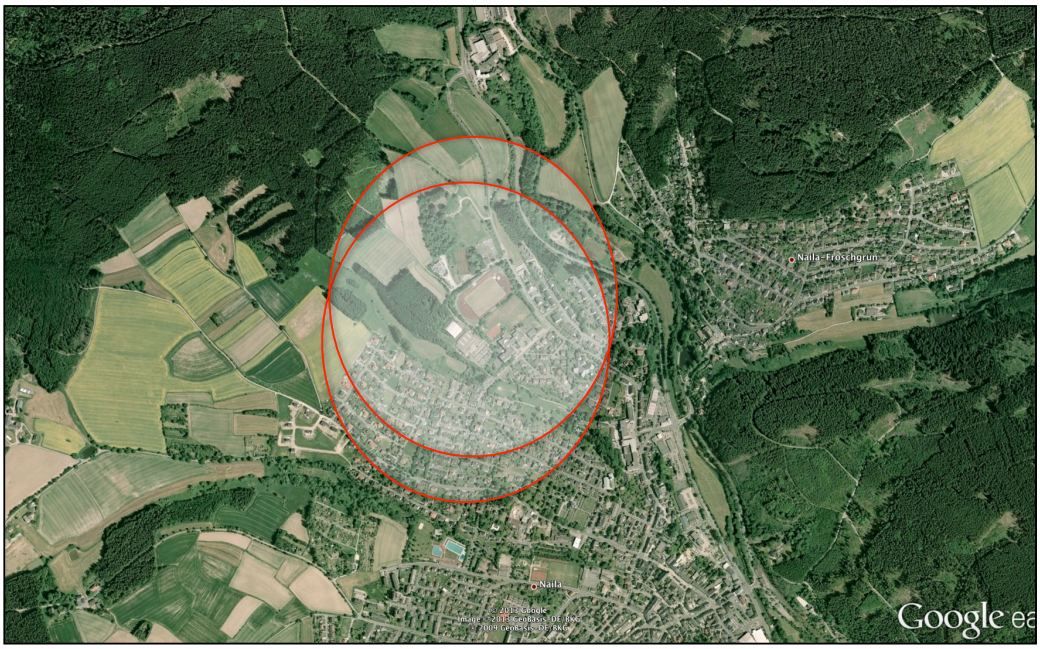
For men in area A, the cancer rate was 1.4 times higher.

For women in area A, the cancer rate was 10.5 times higher ($p < 0.0001$)

[the probability of this beeing a random finding is one hundredth of 1%

Wolf R, Wolf D. Increased Incidence of Cancer Near a Cell-Phone Transmitter Station. *International Journal of Cancer Prevention* (2004); 1(2):1-19.

Naila, Germany (1999-2004)



Town of ~ 1100 residents.

Cell tower installed in 1993.

Medical of 1000 residents reviewed for the years 1994–2004.

Comparison of cancer incidents in residents living within 400 meters of the cell phone tower,
compared to residents living farther away,
and compared to the death rates for the province as a whole.

Eger H, Hagen K, Lucas B, Vogel P, Voit H. The Influence of Being Physically Near to a Cell Phone Transmission Mast on the Incidence of Cancer. *Umwelt·Medizin·Gesell-schaft* (2004); 17(4):1-7.

Cancer Incidence in Naila (1999-2004)

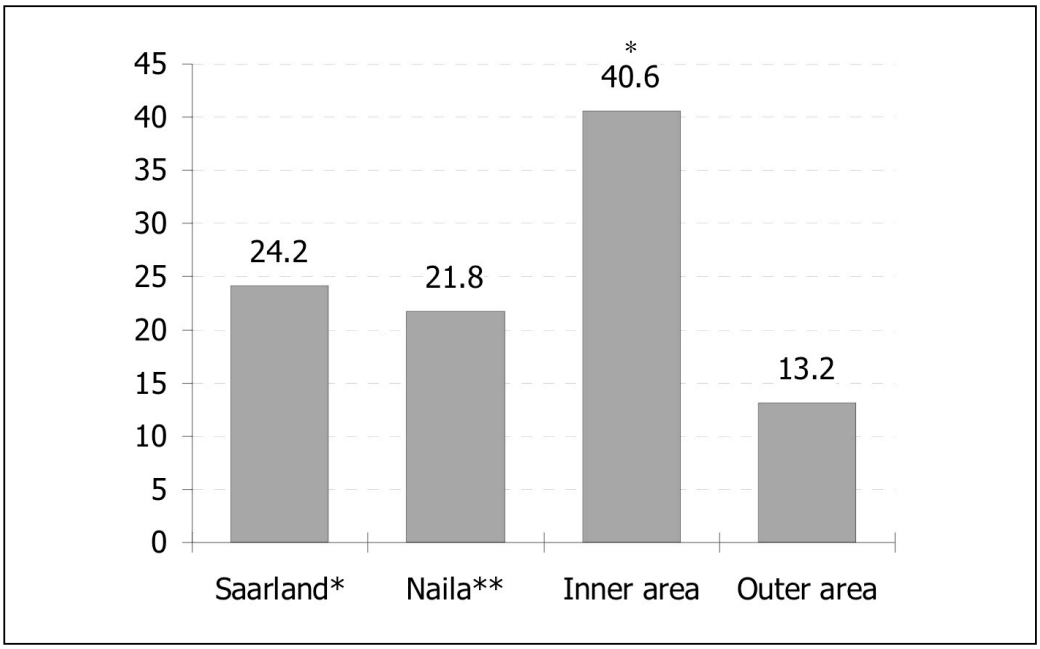


Fig. 3 : Number of new cancer cases 1999 to 2004, adjusted for age and gender, calculated for the 5,000 patient years

Y axis: Cancer incidence 1994 – 2004 (**new cases per 5000 patient years**).

* Saarland = predicted rate based on the cancer registry for the federal state of Saarland.

** Naila = incidence for the town as a whole.

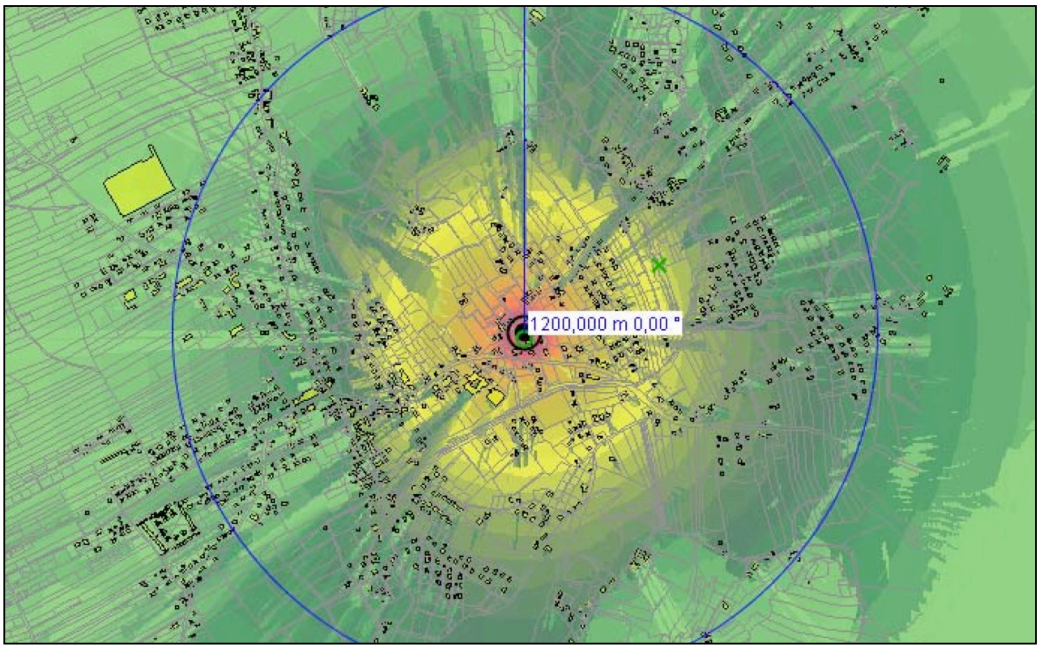
Inner area = residence within 400 meters of the tower.

Outer area = remainder of community.

In the inner area, the risk of cancer incidence was three times as high after five or more years of exposure.

In addition, the **patients that live within 400 metres tend to develop the cancers at a younger age**.

Hausmannstätten & Vasoldsberg, Austria (1984-1997)

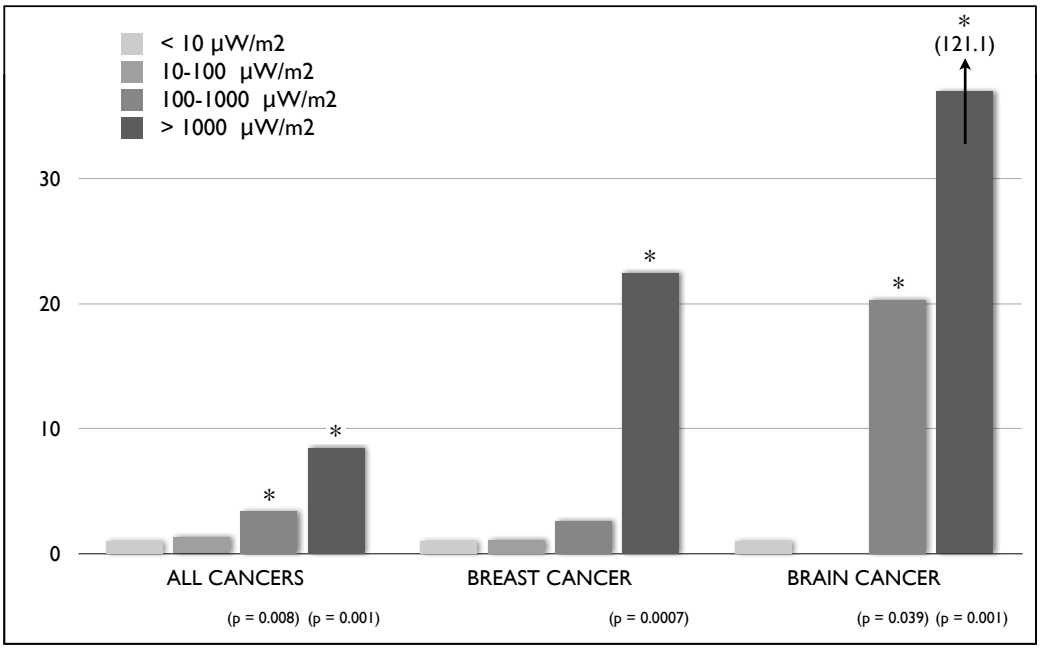


NMT 450 cell tower, operational from 1984–1997.

Case/control study of cancer patients living within 1200 meter radius of the tower.

Oberfeld G. Environmental Epidemiological Study of Cancer Incidence in the Municipalities of Hausmannstätten & Vasoldsberg (Austria). Provincial Government of Styria, Department 8B, Provincial Public Health Office, Graz, Austria (2008):1-10. *http://www.emf-health.com/PDFreports/Austrianstudy.pdf*

Hausmannstätten & Vasoldsberg, Austria (1984-1997)



Odds ratio of cancer incidence — stratified by exposure levels (exterior to dwelling) in $\mu W/m^2$.

Note: **FCC thermal safety guidelines ~ 6,000,000 $\mu W/m^2$**)

In the highest exposure category:

Breast cancer risk was 23 times higher,

Brain cancer risk was 121 times higher.

Oberfeld G. Environmental Epidemiological Study of Cancer Incidence in the Municipalities of Hausmannstätten & Vasoldsberg (Austria). Provincial Government of Styria, Department 8B, Provincial Public Health Office, Graz, Austria (2008):1-10. *http://www.emf-health.com/PDFreports/Austrianstudy.pdf*

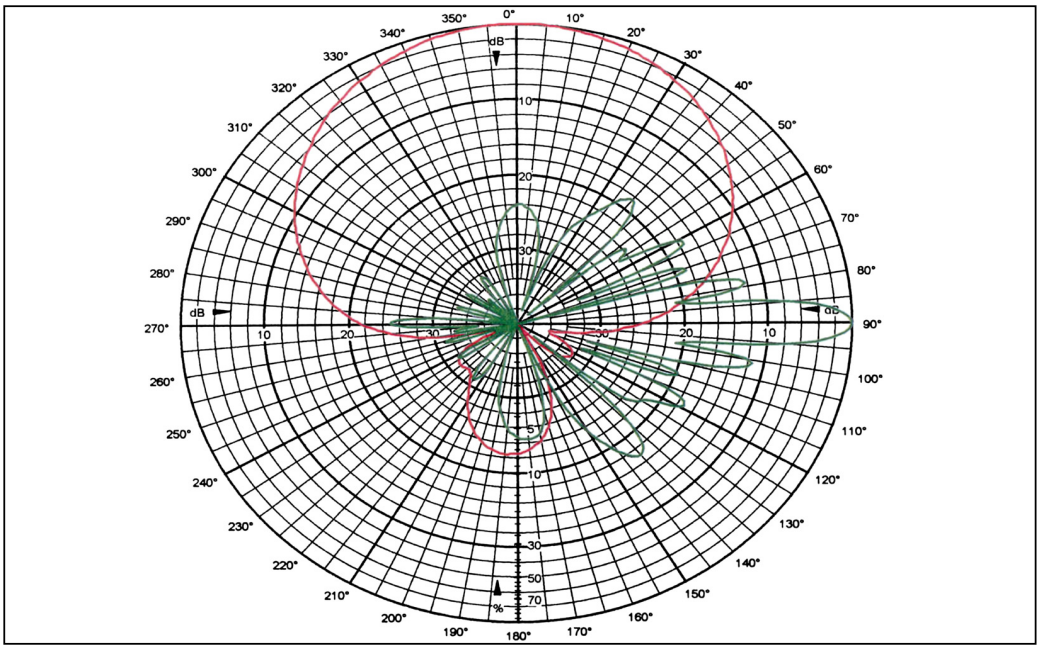
Belo Horizonte, Brazil (2011)

Belo Horizonte is the capital of Minas Gerais state in Brazil, population 2,258,096 in 2010.

Rated by the U.N. in 2007 as having the best quality of life in Latin America.

By 2006, 856 cell phone towers had been installed in the city.

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.



Environmental monitoring of RF power densities in the city was performed.

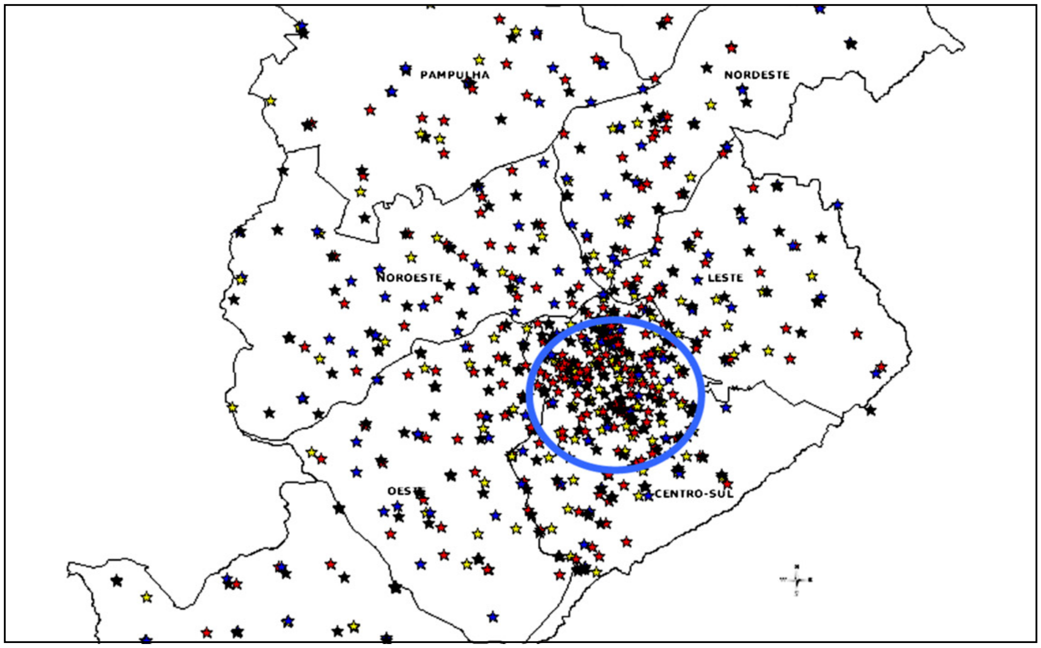
In 2003, the highest recorded power density in the city was 3.06 μW/cm2.

In 2008, the largest recorded power density was 40.78 μW/cm2, 13 times higher than in 2003.

40 μW/cm2 is 15 times less than the FCC Exposure Guidelines.

Fig. 3. Horizontal and vertical radiation patterns per sector of BS site BH 20

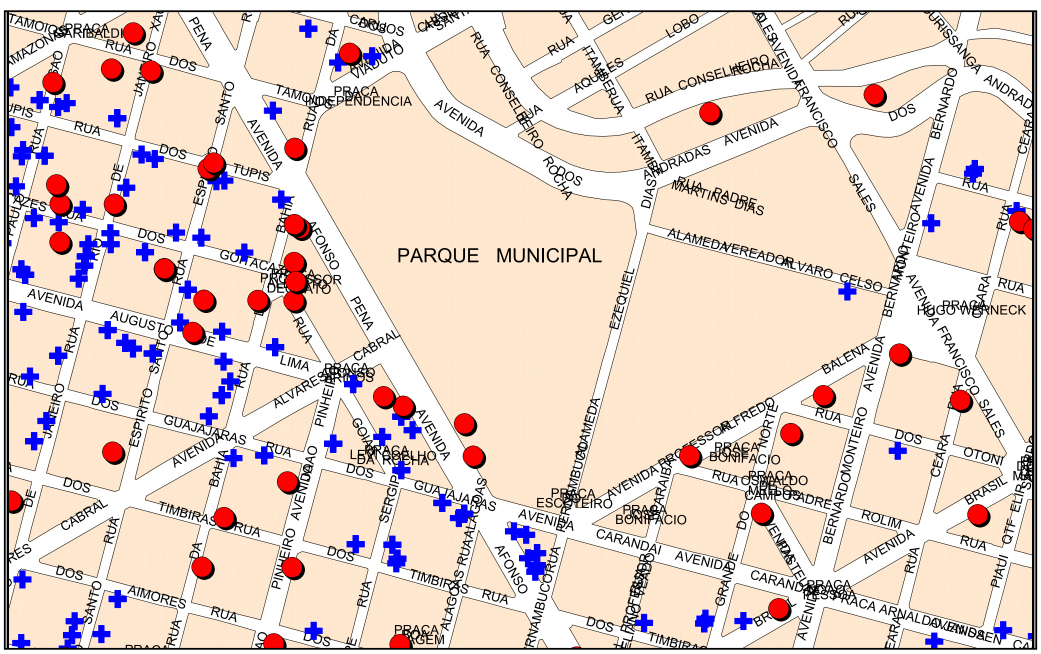
From: Dode AC, Leao MM, Tejo Fde A et al. Mortality by neoplasia and cellular telephone base stations in the Belo Horizonte municipality, Minas Gerais state, Brazil. *Sci Total Environ* (2011); 409(19):3649-3665.



The authors used the Telecommunications National Agency database to map the locations of the 856 cell phone towers that existed in the city as of December 2006.

Fig. 8. Installed BSs in the Belo Horizonte municipality until 2006. Total amount = 856.

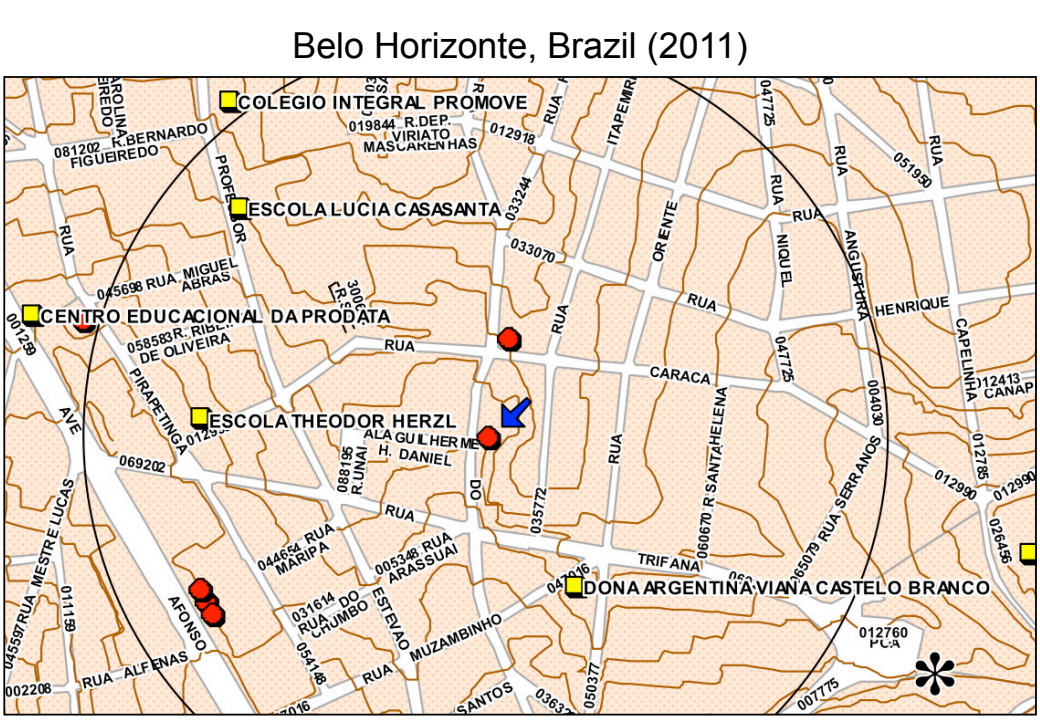
Dode AC, Leao MM, Tejo Fde A et al. Mortality by neoplasia and cellular telephone base stations in the Belo Horizonte municipality, Minas Gerais state, Brazil. *Sci Total Environ* (2011); 409(19):3649-3665.



They then cross-referenced health department records of death by neoplasia
with census and demographic city population data
to **locate the residence** of all individuals who had died of cancer in the city between 1996 and 2006.

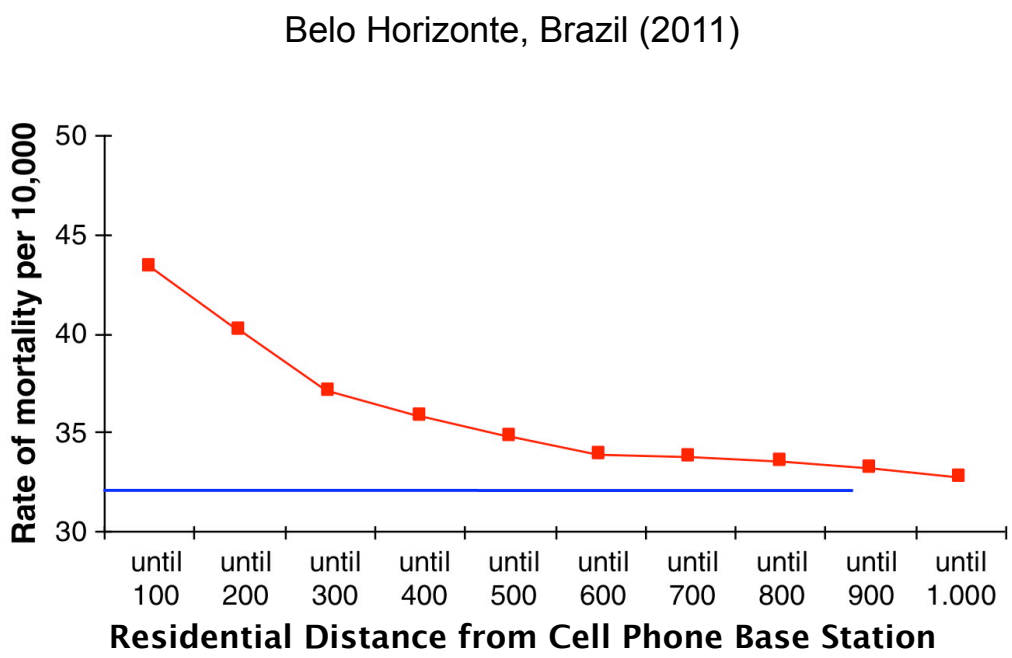
Fig. 10. Sample of geocoded deaths and BS locations in downtown Belo Horizonte City located in Central-Southern region.

From: 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.



This allowed them to calculate the distance between the deceased individuals' residences and the closest cell phone tower, in meters.

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.

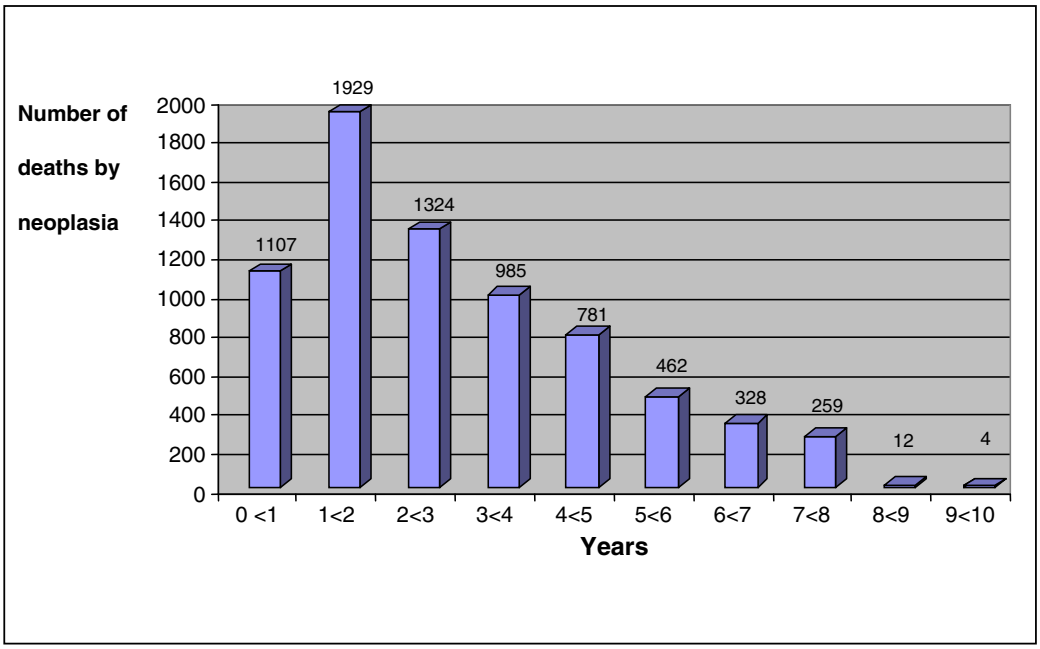


Analysis of this data showed that the cancer death rate was significantly elevated at proximities closer than 500 meters to cell phone towers.

Fig. 15. Rate of mortality by neoplasia, according to the distance from the BS in Belo Horizonte municipality, from 1996 to 2006, and the null hypothesis (blue line).

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.

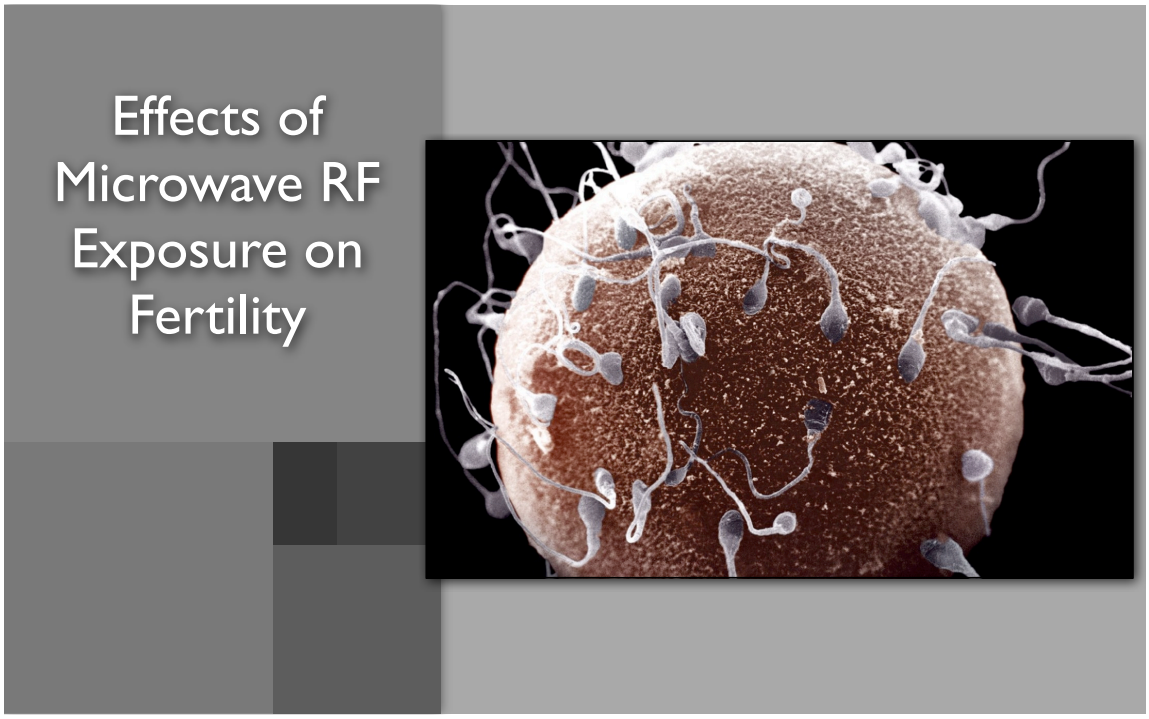
Belo Horizonte, Brazil (2011)



Death rates peaked during the second year of exposure.

Fig. 16. Distribution of the number of deaths by neoplasia versus duration of exposure since the date that the first antenna in each analyzed CT came into operation.

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.



Impaired Fertility in Fruit Flies

Insects are remarkably resistant to ionizing radiation and radioactivity.
They appear to be much more sensitive to the effects of microwave radio frequency exposures.

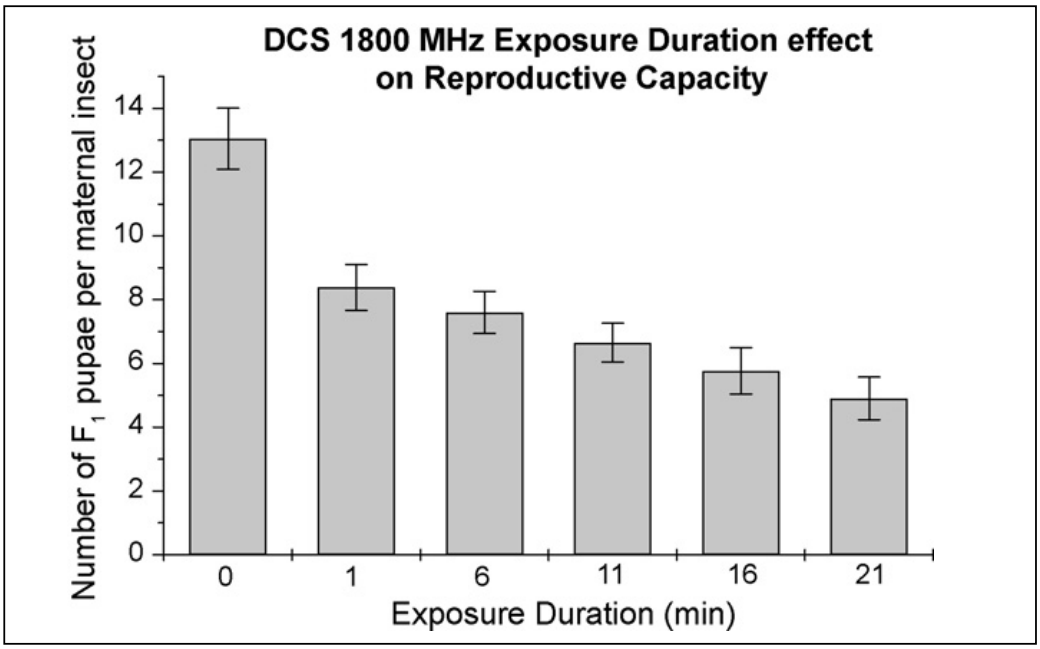
In a recent study, **fruit flies were exposed to 10 µW/cm²** of GSM 900 MHz or 1800 MHz digital RF.

This exposure level is <u>100 times lower</u> than the FCC Guidelines of 1000 µW/cm²

Exposures were for one single exposure intervals per day for five days, ranging from 1 to 21 minutes per day.

Panagopoulos DJ, Margaritis LH. The effect of exposure duration on the biological activity of mobile telephony radiation. *Mutat Res* (2010); 699(1-2):17-22.

Impaired Fertility in Fruit Flies



0 = control group, with no exposure.

Even at one minute of exposure per day, a significant decrease in fertility is seen.

Fig. 2. Reproductive capacity (mean number of F1 pupae per maternal fly) of groups exposed to DCS 1800MHz radiation for different daily exposure durations (1, 6, 11, 16, and 21min) for five consecutive days, and of sham-exposed groups (no exposure).

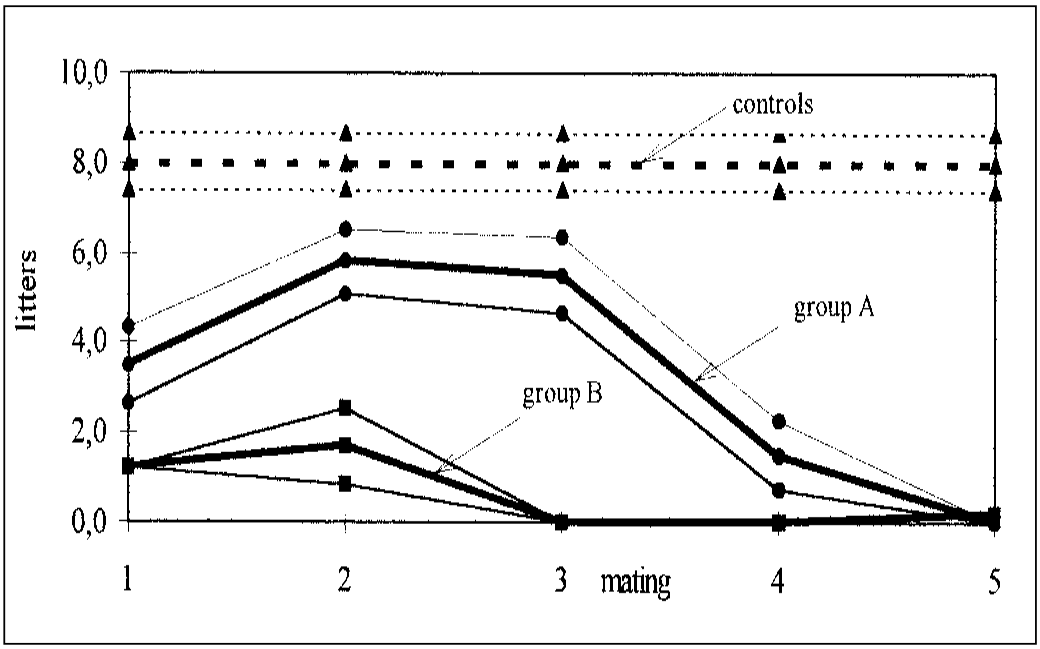
Panagopoulos DJ, Margaritis LH. The effect of exposure duration on the biological activity of mobile telephony radiation. *Mutat Res* (2010); 699(1-2):17-22.

Impaired Fertility in Mammals

This is a Wistar rat.

A great deal of research has been done on the effects of microwave RF on laboratory animals.

Impaired Fertility in Female Mice



In one study, mice were kept in cages in a VHF/UHF antenna park in Thessaloniki, Greece.
Power densities ranged between **0.168 to 1.053 µW/cm²** [reported as 168 - 1053 nanowatts/cm²]

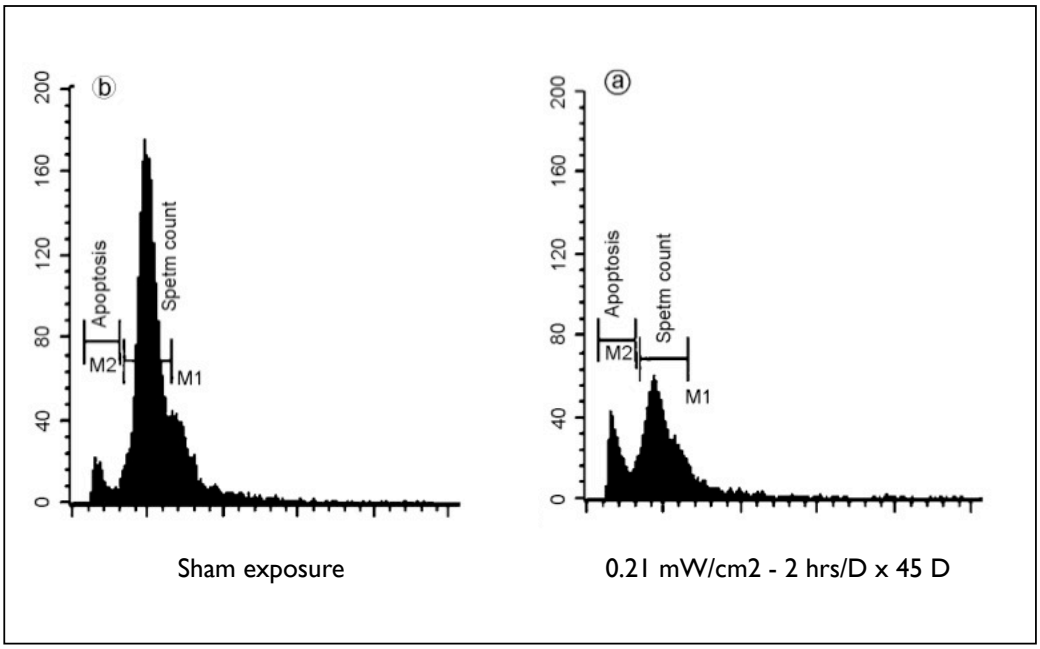
This is about <u>1000 times lower</u> than the FCC Guidelines of 600-1000 µW/cm²

With repeated matings, litter size decreased, until by the 5th mating, all the dams were infertile.

This infertility was irreversible.

Magras IN, Xenos TD. RF radiation-induced changes in the prenatal development of mice. *Bioelectromagnetics* (1997); 18(6):455-461.

Impaired Fertility in Male Rats



Reduced sperm production in male Wistar rats exposed to 10 GHz microwave RF.

0.21 mW/cm^2 = **<u>one fifth</u> of the FCC Guidelines of 1 mW/cm^2**

OTHER EFFECTS: Increases in reactive oxygen species, increased free radical formation, decreased activity of glutathione peroxidase and superoxide dismutase, DNA strand breakage, increased apoptosis (cell death) in sperm cells, distortion of sperm structure, reduced testosterone levels, shrinkage of seminiferous tubules and testicular size, decreased number and weight of progeny.

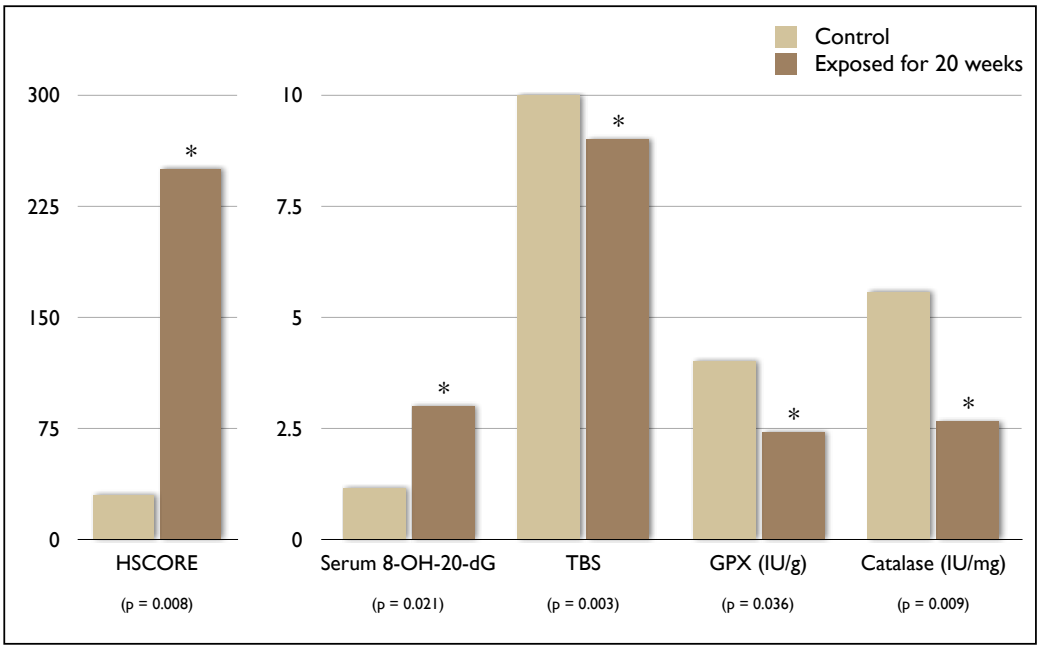
Kesari KK, Kumar S, Behari J. Effects of radiofrequency electromagnetic wave exposure from cellular phones on the reproductive pattern in male Wistar rats. *Appl Biochem Biotechnol* (2011); 164(4):546-559.

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

Kumar S, Kesari KK, Behari J. Influence of microwave exposure on fertility of male rats. *Fertil Steril* (2011); 95(4):1500-1502.

Kumar S, Behari J, Sisodia R. Influence of electromagnetic fields on reproductive system of male rats. *Int J Radiat Biol* (2012); epub Nov 13:1-8

WiFi Exposure Damages Sperm With Oxidant Stress.



The rats were exposed to a Standard WiFi gateway, 24 hours a day for 20 days.

HSCORE = histological staining in testes for 8-OH-20-dG
[8-hydroxy-20-deoxyguanosine, **byproduct of DNA damage**]

Serum 8-OH-20-dG (ng/ml) [byproduct of DNA damage]

TBS = testicular biopsy score
9 = Much spermatogenesis, but germinal epithelium disorganized with marked sloughing or obliteration of lumen

GPX = glutathione peroxidase, an antioxidant (consumed by oxidative stress in exposed rats).

Atasoy HI, Gunal MY, Atasoy P, Elgun S, Bugdayci G. Immunohistopathologic demonstration of deleterious effects on growing rat testes of radiofrequency waves emitted from conventional Wi-Fi devices. *J Pediatr Urol* (2012); March 30.

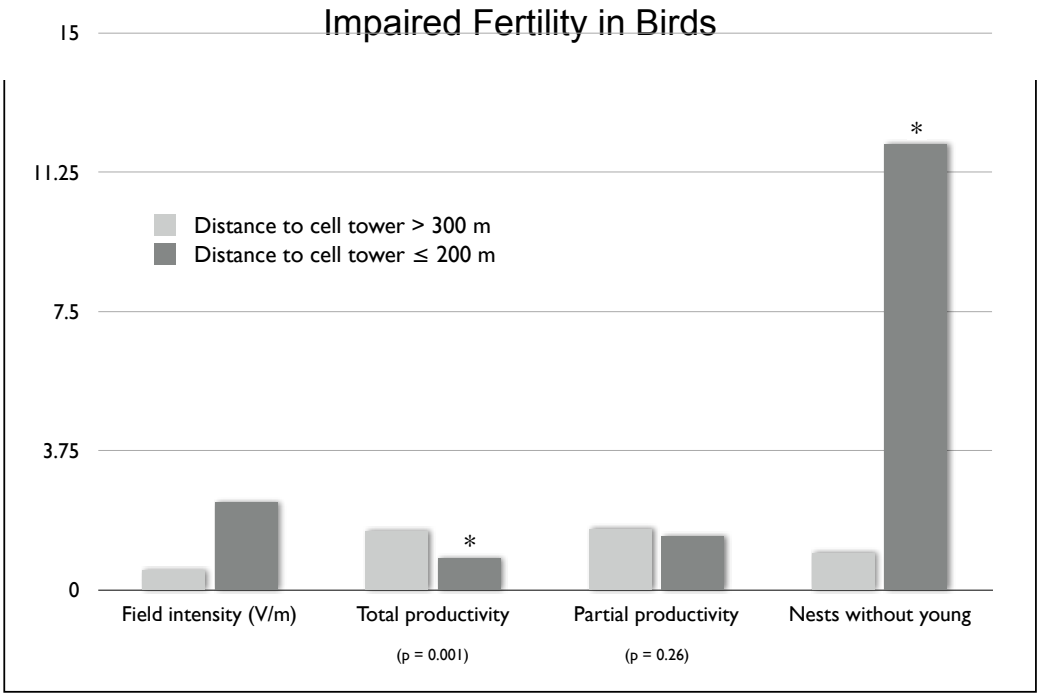
Impaired Fertility in Birds

In Valladido, Spain, a study compared the productivity of storks nesting closer and farther from a cell phone tower site.

30 nests within 200 meters of the antennae, were compared with 30 nests greater than 300 meters from the antennae

Balmori A. Possible Effects of Electromagnetic Fields from Phone Masts on a Population of White Stork. *Electromagn Biol Med* (2005); 24(2):109-119.

Impaired Fertility in Birds



Productivity was significantly reduced in birds in the high exposure group.

Average electric field intensity on nests within 200m = 2.36±0.82V/m **(~ 1.48 µW/cm2**)

This is more than <u>400 times less</u> than the FCC Guidelines of 600-1000 µW/cm^2

Average electric field intensity on nests further than 300m = 0.53 ± 0.82 V/m (~ 0.07 µW/cm2).

Balmori A. Possible Effects of Electromagnetic Fields from Phone Masts on a Population of White Stork. *Electromagn Biol Med* (2005); 24(2):109-119.

Impaired Fertility in Amphibians

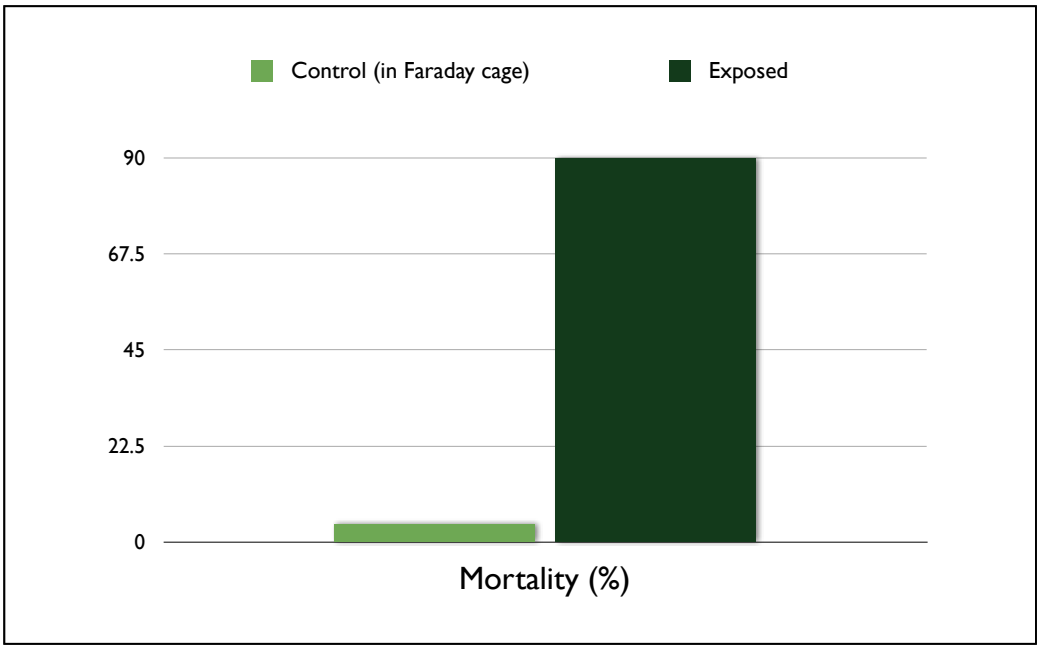
Eggs and tadpoles of the European common frog (Rana temporaria) were exposed to RF/EFM from several cell towers located at a distance of 140 meters.

Duration of exposure was 2 months (from egg phase to advanced tadpole stage).

Control groups were placed in same conditions, but contained in a faraday cage that shielded the eggs from RF exposure.

Balmori A. Mobile phone mast effects on common frog (Rana temporaria) tadpoles: the city turned into a laboratory. *Electromagn Biol Med* (2010a); 29(1-2):31-35.

Impaired Fertility in Amphibians



Exposure intensity 1.8 to 3.5 V/m (~ 0.8–3.2 μW/cm2).

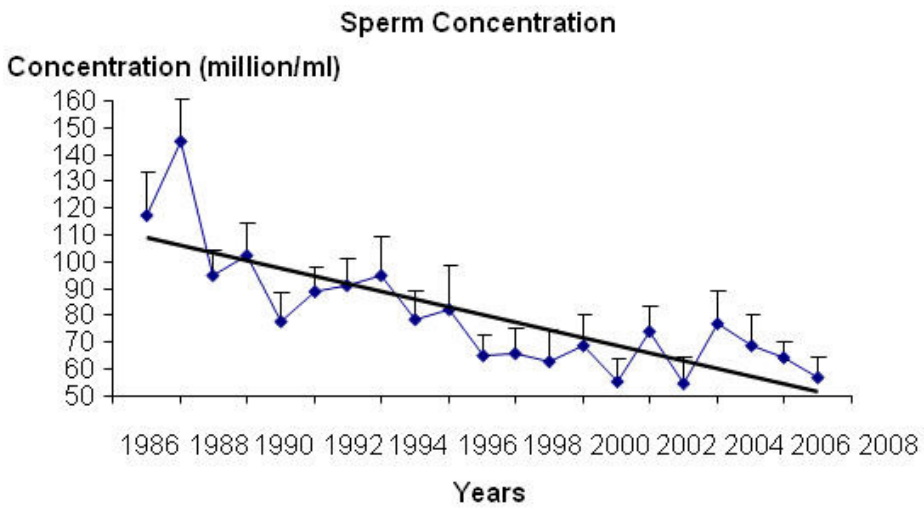
This is <u>200 times less</u> than the FCC Guidelines of 600–1000 μW/cm²

[In the exposed group (n = 70), low coordination of movements and asynchronous growth was observed in living specimens, resulting in both big and small tadpoles. In the control group (n = 70), growth was normal.]

Balmori A. Mobile phone mast effects on common frog (Rana temporaria) tadpoles: the city turned into a laboratory. *Electromagn Biol Med* (2010a); 29(1-2):31-35.

Impaired Fertility in Humans

Figure 2. Sperm concentration in 975 sperm donors recruited over 20 years



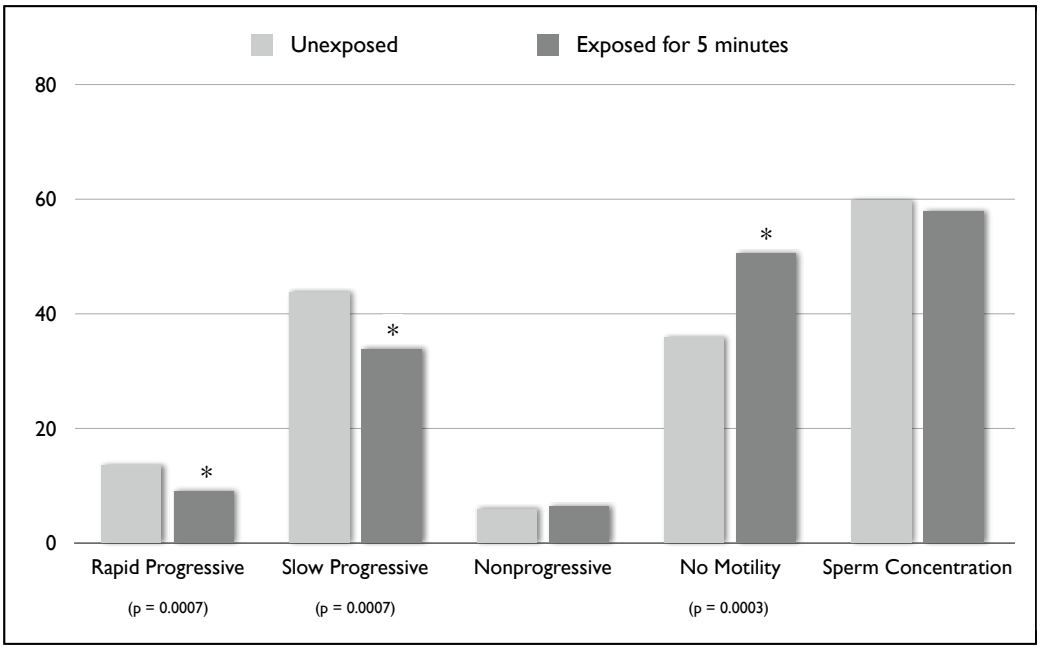
Sperm counts have been dropping worldwide for the last several decades.
(e.g. In New Zealand, 2.5% per year for the last 20 years).

Pesticides have been implicated.

Some evidence suggests that microwave RF exposure may also play a role.

Shine R, Peek J, Birdsall M. Declining sperm quality in New Zealand over 20 years. *N Z Med J* (2008); 121(1287):50-56.

Cell Phone Transmissions Decrease Sperm Motility in Vitro



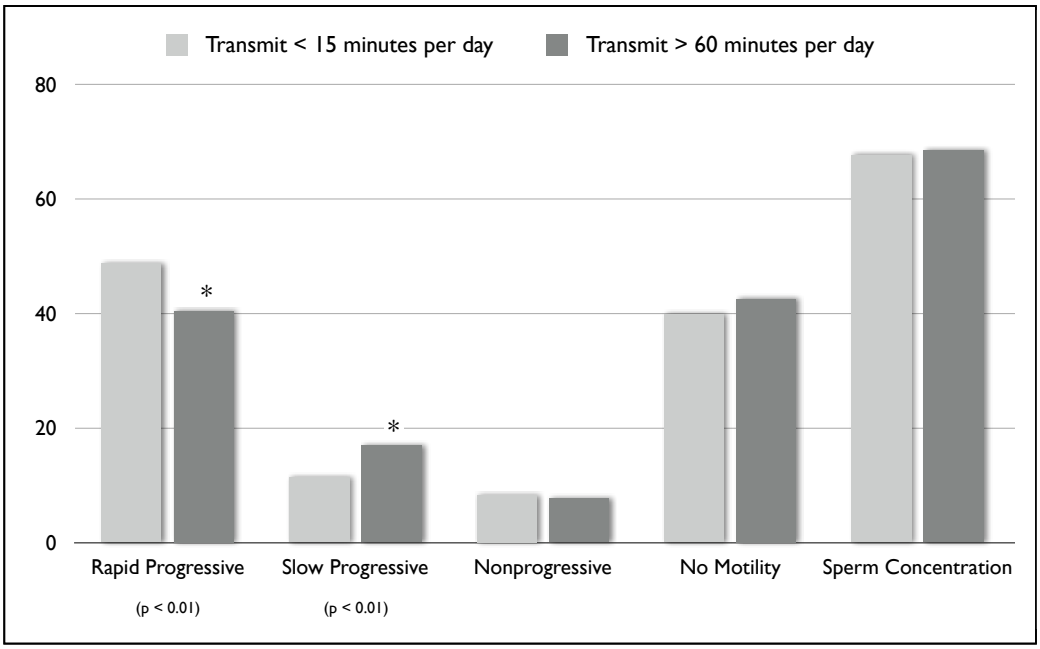
Samples of human sperm received 5 minutes exposure, 10 cm from a transmitting GSM 900 MHz cell phone.
Average power density of exposure: 20 μW/cm^2

This is <u>30 times less</u> than the FCC Exposure Guideline of 600 μW/cm^2

(Y axis = values in %)

Erogul O, Oztas E, Yildirim I et al. Effects of electromagnetic radiation from a cellular phone on human sperm motility: an in vitro study. *Arch Med Res* (2006); 37(7):840-843.

Cell Phone Use Decreases Sperm Motility in Vivo



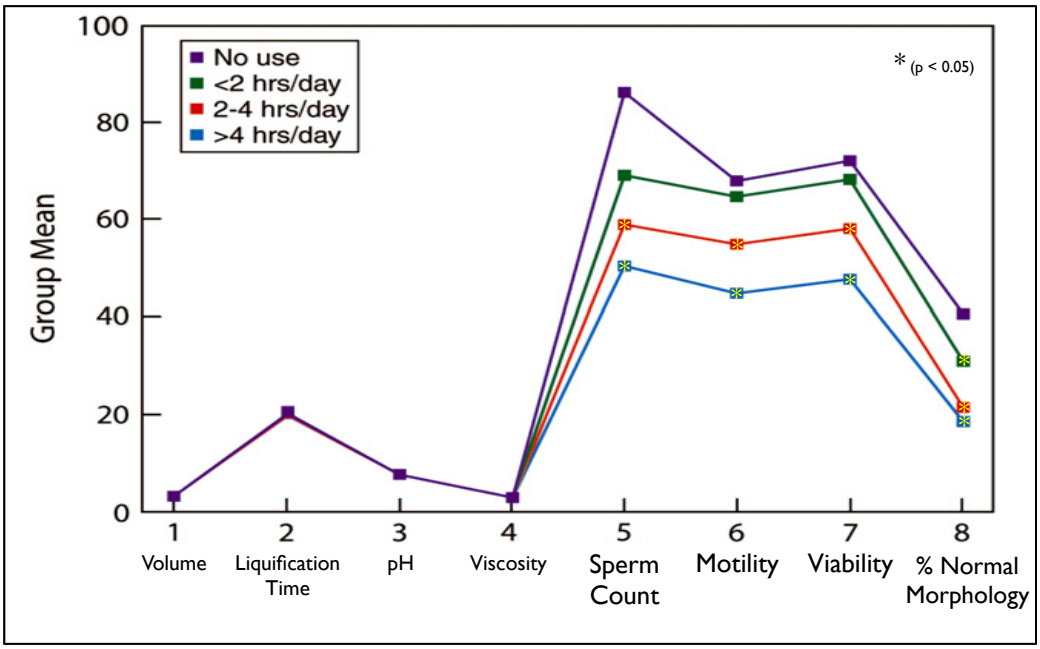
Semen analysis performed on 371 men at a university clinic.

Health questionnaire included query of cell phone use habits.

(Y axis = values in %)

Fejes I, Zavaczki Z, Szollosi J et al. Is there a relationship between cell phone use and semen quality? *Arch Androl* (2005); 51(5):385-393.

Cell Phone Use Degrades Sperm Quality in Vivo



Three hundred sixty-one men undergoing infertility evaluation were divided into four groups according to their active cell phone use:

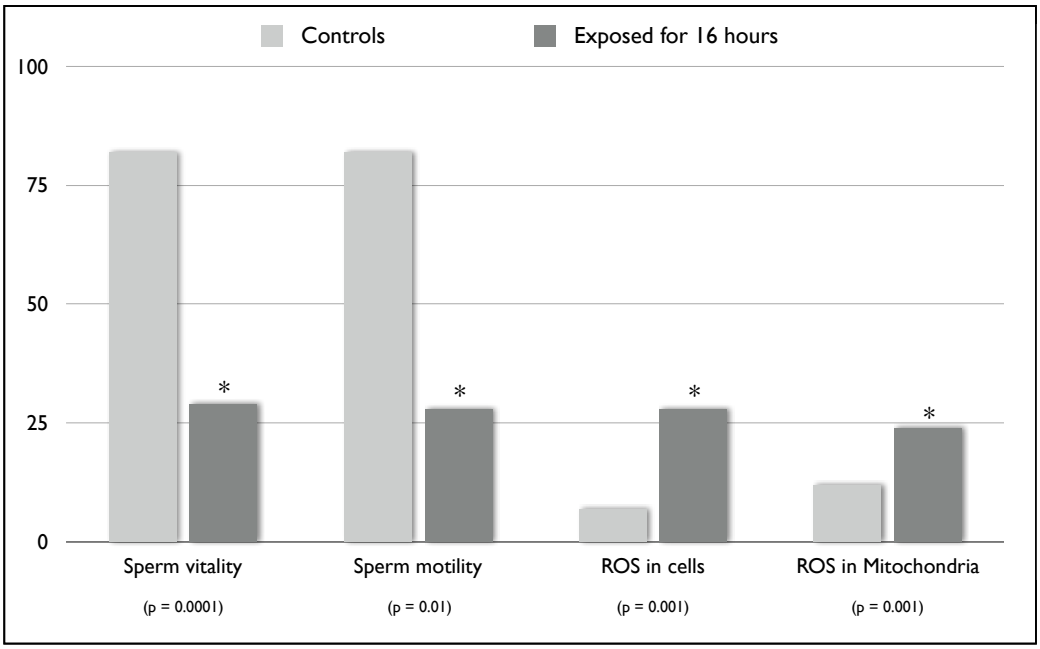
group A: no use; group B: <2 h/day; group C: 2–4 h/day; and group D: >4 h/day.

With greater than two hours a day of reported talk time, significant reduction in **sperm count, motility, viability, and % normal morphology** were observed.

[One can assume that with texting rather than talking, the data might be even worse . . . as the phone antenna will be closer to the testes.]

Agarwal A, Deepinder F, Sharma RK, Ranga G, Li J. Effect of cell phone usage on semen analysis in men attending infertility clinic: an observational study. *Fertil Steril* (2008); 89(1):124-128.

Isothermal Exposure to 1.8 GHz RF Damages Sperm



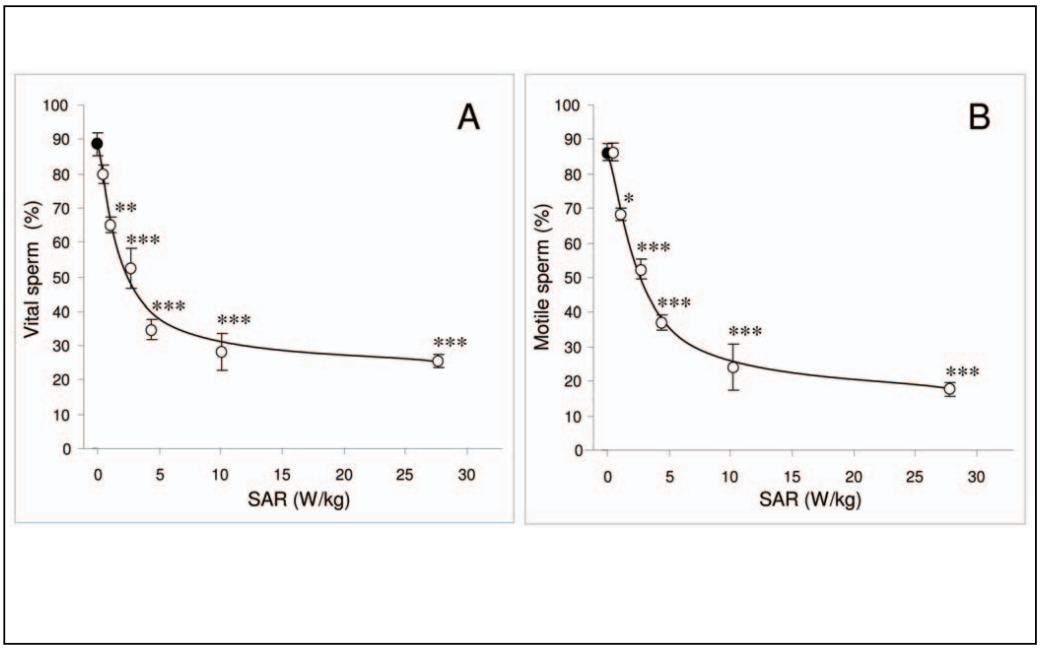
Sperm exposed for 16 hours in vitro to 1.8 GHz (SAR = 27.5 W/kg) @ 21ºC (**isothermal conditions**).

Sperm damage correlates with increased free radical (ROS) production.

Values in %.

De Iuliis GN, Newey RJ, King BV, Aitken RJ. Mobile phone radiation induces reactive oxygen species production and DNA damage in human spermatozoa in vitro. *PLoS One* (2009); 4(7):e6446 (1-9).

1.8 GHz RF Degrades Sperm Quality In Vitro



1.8 GHz RF at various intensities for 16 hours @ 21ºC

This is an isothermal exposure

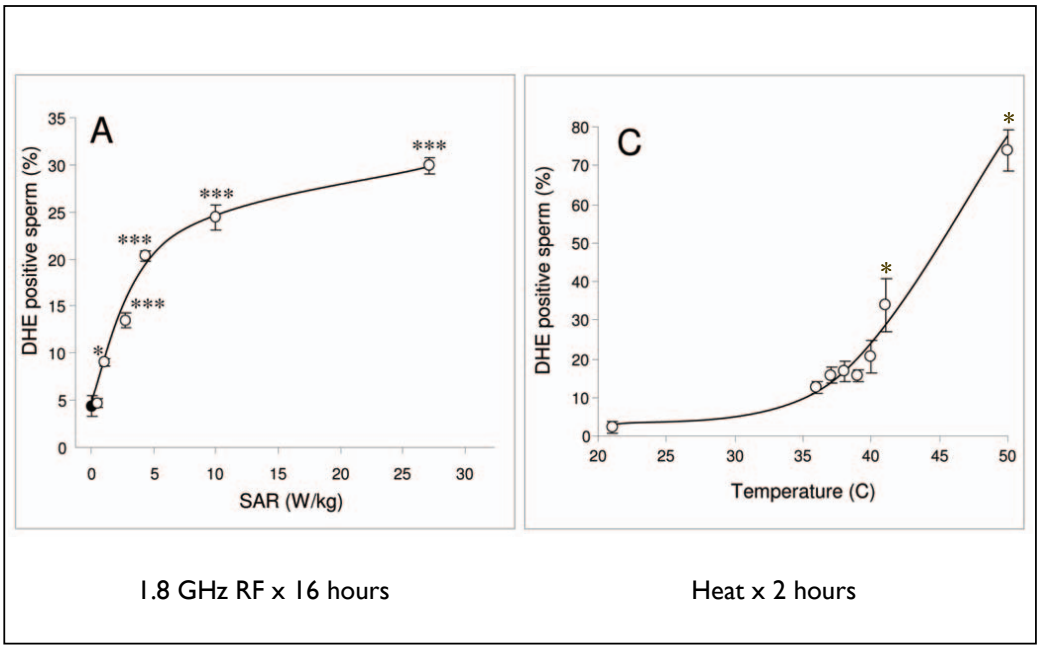
Sperm vitality and motility are significantly detraded at SAR = 1 W/kg and above

Figure 2. RF-EMR exposure reduces motility and vitality of human spermatozoa, in an SAR dependent manner. Percoll-purified spermatozoa (5 x 10^6 cells) were suspended in 1 ml BWW in a 35 mm Petri dish and placed within the waveguide while control cells (closed circles) were placed outside the waveguide. Cells in the waveguide were exposed to 1.8 GHz RF-EMR at SAR levels of 0.4, 1.0 2.8 4.3 10.1 and 27.5 W/kg (open circles) for 16 h at 21uC. Both vitality and motility were reduced in a dose dependent manner.

A, Vitality was significantly reduced at a SAR of 1.0 W/kg from 89% ±3% to 65% ±1% (**p,0.01).

B, Motility was also significantly reduced at a SAR of 1.0 W/kg from 86% ±2% to 68% ±2% (*p,0.05). All results are based on 4 independent samples.

ROS Production – RF versus Thermal



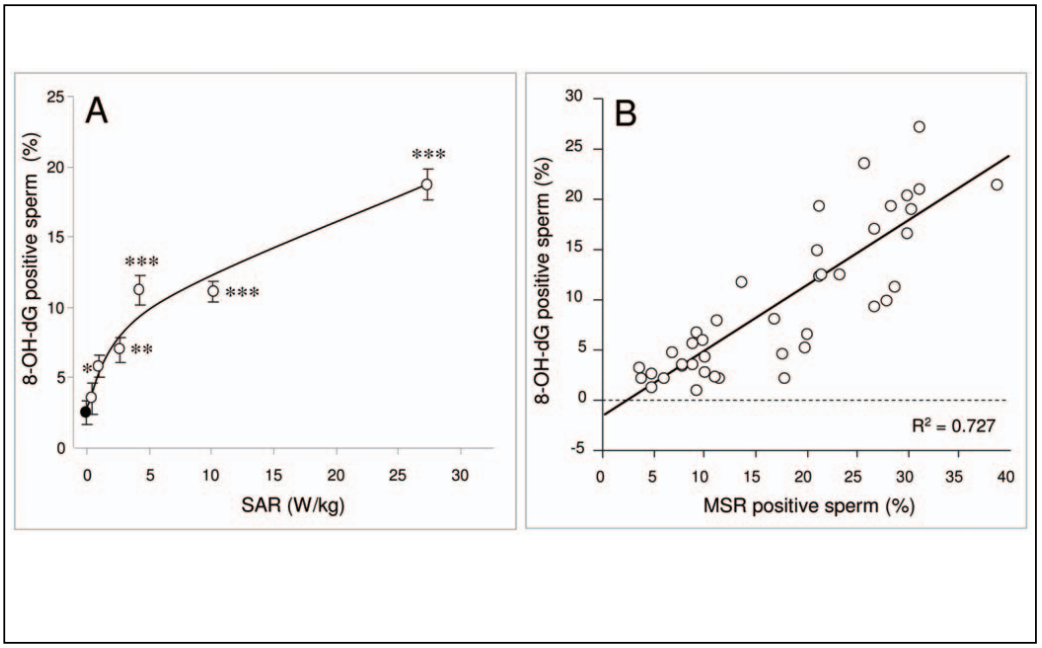
A. ROS generation (DHE response) was significantly increased from control levels after exposure to 1.0 W/kg (*p, 0.05) and above (***p,0.001).

C. In order to control for thermal effects, the impact of temperature of cellular ROS generation was monitored; a significant increase in ROS generation was observed as temperatures rose above 40°C (p,0.001).

Figure 3. RF-EMR induces ROS generation in human spermatozoa, in an SAR-dependent manner unrelated to thermal effects.

De Iuliis GN, Newey RJ, King BV, Aitken RJ. Mobile phone radiation induces reactive oxygen species production and DNA damage in human spermatozoa in vitro. *PLoS One* (2009); 4(7):e6446 (1-9).

Oxidative Damage To Sperm DNA From 1.8 GHz RF Exposure



1.8 GHz RF x 16 hours @ 21°C isothermal.

A) As the power levels were increased, the amount of oxidative DNA damage expressed also increased.

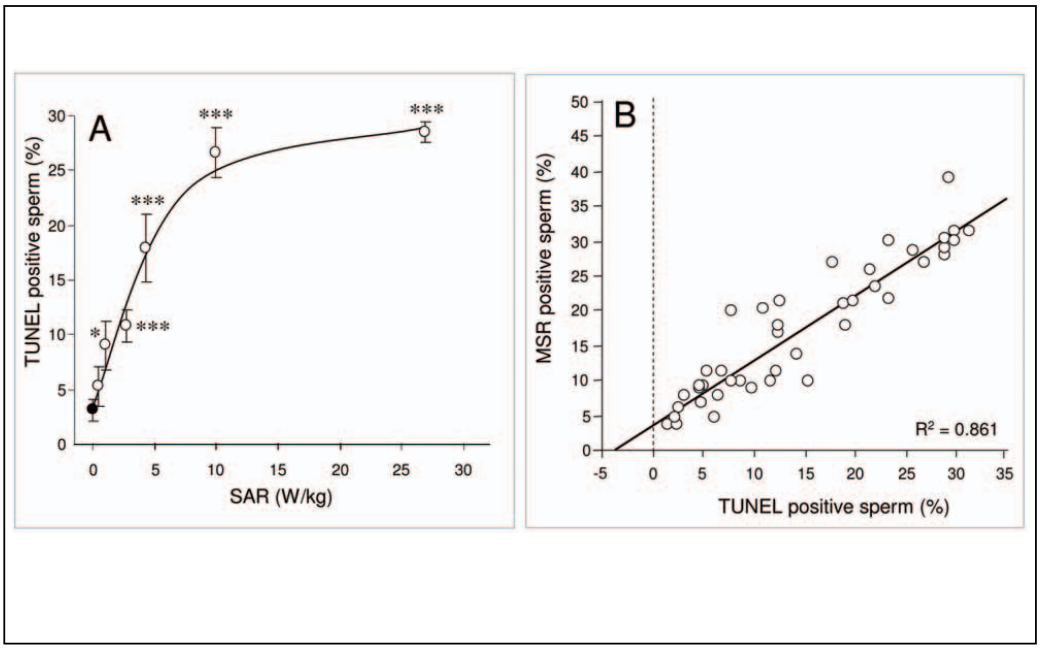
A significant amount of oxidative DNA damage was observed in cells exposed to 2.8 W/kg (*p,0.05) RF-EMR and above (**p,0.01; ***p,0.001).

B) The levels of 8-OH-dG expression were positively correlated with the levels of ROS generation by the mitochondria (R2 = 0.727).

Figure 4. RF-EMR induces oxidative DNA damage in human spermatozoa.

De Iuliis GN, Newey RJ, King BV, Aitken RJ. Mobile phone radiation induces reactive oxygen species production and DNA damage in human spermatozoa in vitro. *PLoS One* (2009); 4(7):e6446 (1-9).

RF Damages Sperm by Increasing Oxidative Stress



A) Significant levels of DNA fragmentation was observed in exposed spermatozoa at 2.8 W/kg (*p,0.05) and above (***p,0.001).

B) DNA fragmentation was positively correlated with ROS production by the mitochondria as monitored by MSR. (R2 = 0.861).

Figure 5. RF-EMR induces DNA fragmentation in human spermatozoa.

De Iuliis GN, Newey RJ, King BV, Aitken RJ. Mobile phone radiation induces reactive oxygen species production and DNA damage in human spermatozoa in vitro. *PLoS One* (2009); 4(7):e6446 (1-9).

Sperm Damage From Laptop WiFi

Motile spermatozoa in semen were incubated at room temperature,

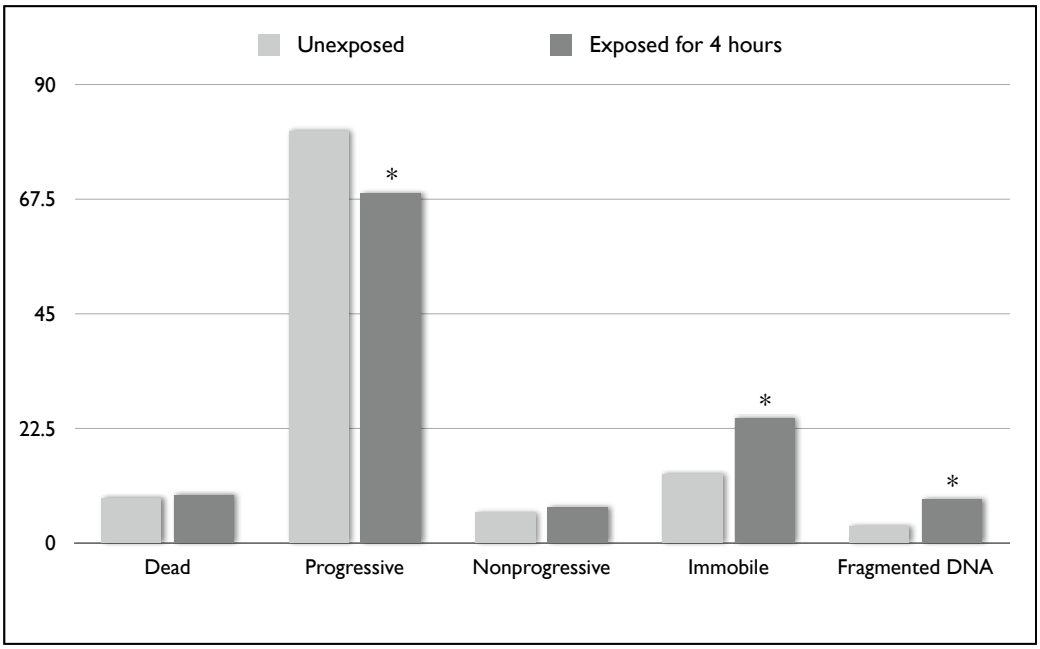
3 cm below laptop computer (e.g. lap distance)

4 hours of exposure.

Control incubated in similar conditions, without presence of the computer.

Avendano C, Mata A, Sanchez Sarmiento CA, Doncel GF. Use of laptop computers connected to internet through Wi-Fi decreases human sperm motility and increases sperm DNA fragmentation. *Fertil Steril* (2012); 97(1):39-45.

Sperm Damage From Laptop WiFi



Power density ranged 0.45 to 1.05 μW/cm^2

[This is roughly **1000 times less than the FCC exposure limit** of 1000 μW/cm^2]

Avendano C, Mata A, Sanchez Sarmiento CA, Doncel GF. Use of laptop computers connected to internet through Wi-Fi decreases human sperm motility and increases sperm DNA fragmentation. *Fertil Steril* (2012); 97(1):39-45.

Cell Phones and Risk of Brain Tumor

INTERPHONE Study 2010

Published by Oxford University Press on behalf of the International Epidemiological Association
International Journal of Epidemiology 2010;**39**:675–694
doi:10.1093/ije/dyq079

THEME: CANCER

Brain tumour risk in relation to mobile telephone use: results of the INTERPHONE international case–control study

The INTERPHONE Study Group*

Corresponding author. Elisabeth Cardis; CREAL, Doctor Aiguader 88, 08003 Barcelona, Spain. E-mail: ecardis@creal.cat
*List of members of this study group is available in the Appendix.

Accepted 8 March 2010

Background The rapid increase in mobile telephone use has generated concern about possible health risks related to radiofrequency electromagnetic fields from this technology.

Methods An interview-based case–control study with 2708 glioma and 2409 meningioma cases and matched controls was conducted in 13 countries using a common protocol.

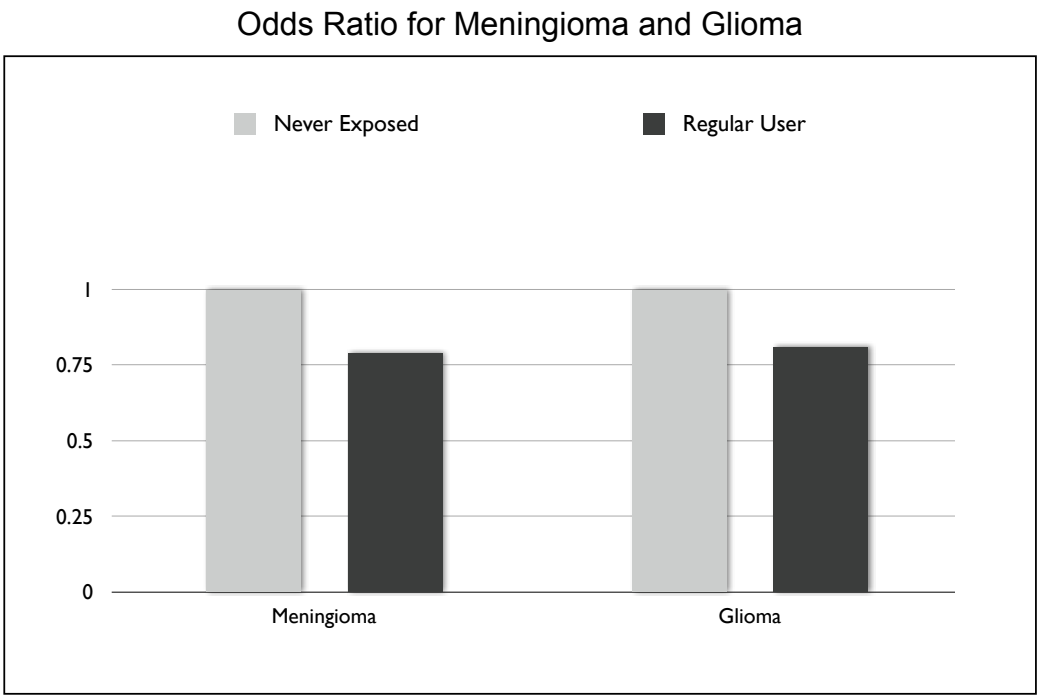
Large case-control study at multiple centers.

Funded in significant part by the telecommunications industry.

INTERPHONE Study 2010

Conclusions Overall, no increase in risk of glioma or meningioma was observed with use of mobile phones.

From the authors' published conclusions.



In the 2010 Interphone Study combined analysis of data for all levels of exposure found that "regular cell phone users" were less likely to have brain tumors than non-users.

This is what was reported in the media about this study.

A reduced odds ratio (OR) related to ever having been a regular mobile phone user was seen for glioma [OR 0.81; 95% confidence interval (CI) 0.70–0.94] and meningioma (OR 0.79; 95% CI 0.68–0.91)

INTERPHONE Study Group. Brain tumour risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. *Int J Epidemiol* (2010); 39(3):675-694.

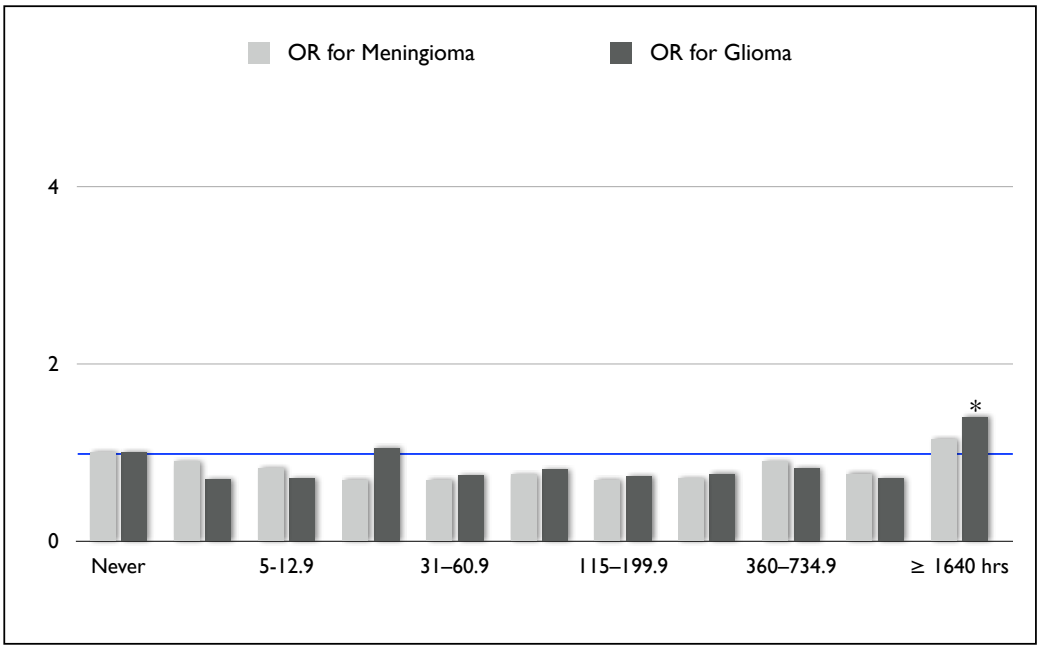
INTERPHONE Study 2010 – Definition of “Risk”

if the subject had ever been a regular user of a mobile phone (had an average of at least one call per week for a period of ⩾6 months).[26]

However, “regular use” was defined as a minimum of one call for week for at least 6 months.

In otherwords, anyone who had made at least 26 cell phone calls in their lifetime was categorized as a “regular user” and placed in the risk group.

Odds Ratio for Meningioma and Glioma with Cell Phone Use



Cumulative call time without hands-free devices, **divided into deciles**.

Blue line is Odds Ratio of 1.0 (equal to control group).

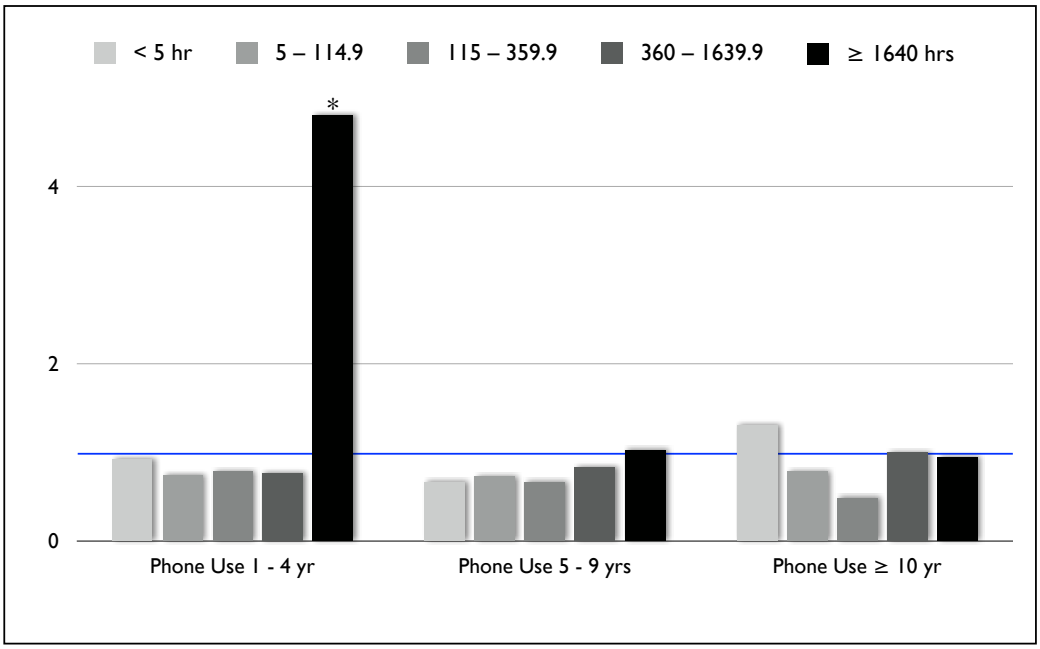
Half of the subjects in the study had less than 115 hours of lifetime exposure.

Note that a significantly higher risk for glioma was seen with more than 1640 hours of exposure.

OR for glioma = 1.40 [95% CI = (1.03–1.89)]

From Table 2: INTERPHONE Study Group. Brain tumour risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. *Int J Epidemiol* (2010); 39(3):675-694.

Odds Ratio for Meningioma with Cell Phone Use



Charted data from the Interphone study for risk of meningioma.

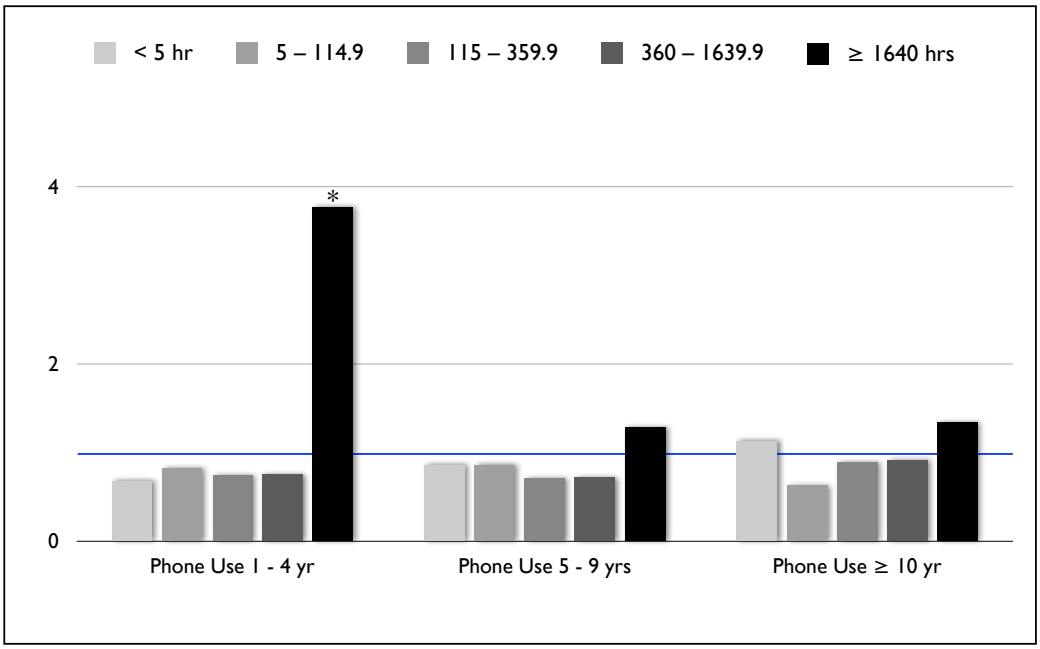
With ≥1640 hrs exposure in 1 – 4 years, OR = 4.80 [95% CI = (1.49–15.4)]

1640 hours in 4 years = 7.9 hrs/wk

(range in cohort was 8 – 30 hrs/wk, which the authors discounted as "implausable values of use" in their summary of results)

From Table 3: INTERPHONE Study Group. Brain tumour risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. *Int J Epidemiol* (2010); 39(3):675-694.

Odds Ratio for Glioma with Cell Phone Use



Charted data from INTERPHONE study group, glioma risk.

Stratified by cumulative call time (without hands/free devices).

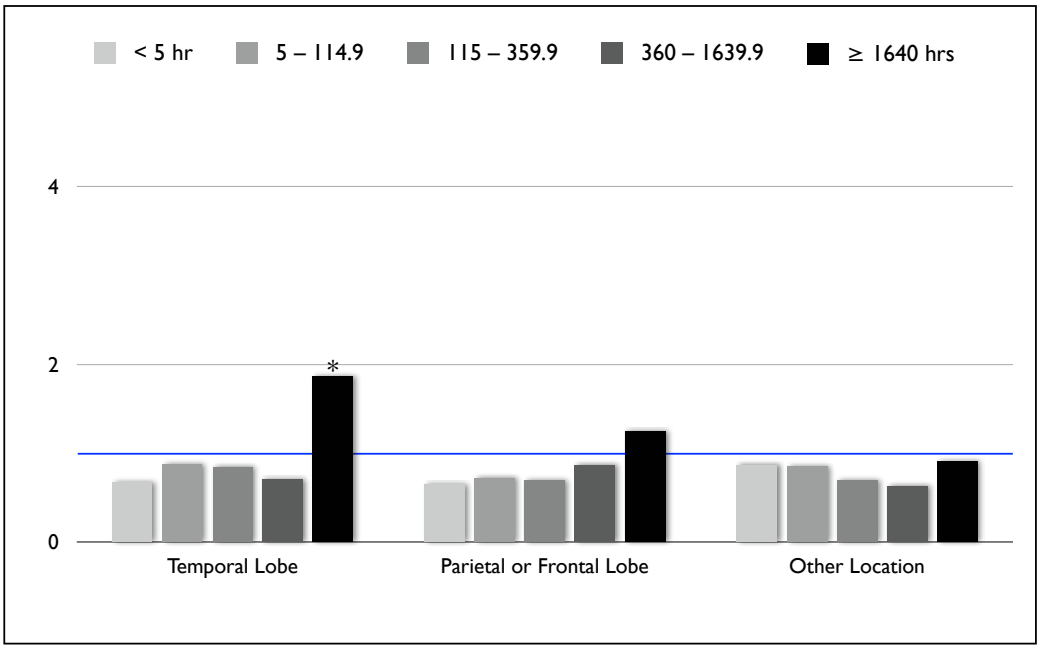
Also stratified by years of use.

With ≥1640 hrs exposure in 1 – 4 years, OR for Glioma = 3.77 [95% CI = (1.25–11.4)]

1640 hours in 4 years = 7.9 hrs/wk (range in cohort was 8 – 30 hrs/wk)

The authors rejected their own findings on glioma, stating that this level of reported cell phone use was "implausable".

From Table 3: INTERPHONE Study Group. Brain tumour risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. *Int J Epidemiol* (2010); 39(3):675-694.



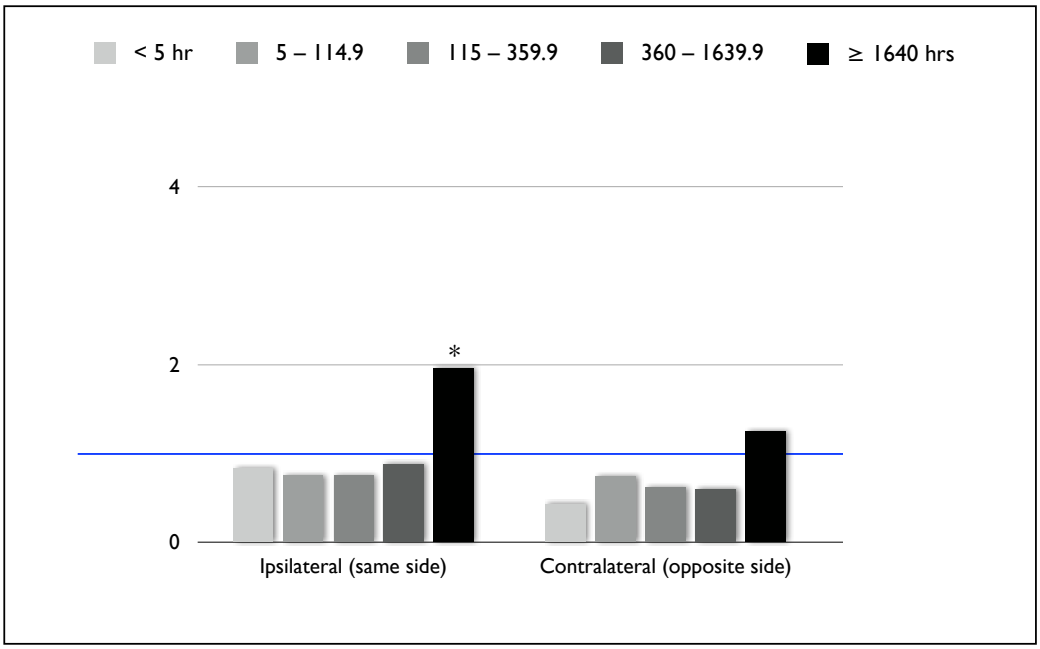
Glioma risk by **location in the brain**.

Also stratified by **cumulative call time**.

Temporal lobe (With ≥1640 hrs exposure, OR = 1.87 [95% CI = (1.09–3.22)]

From Table 4: INTERPHONE Study Group. Brain tumour risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. *Int J Epidemiol* (2010); 39(3):675-694.

Interestingly, the study did report its statistics stratified by total time of reported use, and the top decile (greater than 1640 hours use over a ten year interval, averaging out as greater than 3 hours a week) had an increased risk of certain tumors. Individuals who accrued that greater than 1650 hours of use over a 1 to 4 year interval (ranging from 8 to over 30 hours a week) had a markedly higher odds ratio of meningioma (OR 4.80) or glioma (OR 3.27).

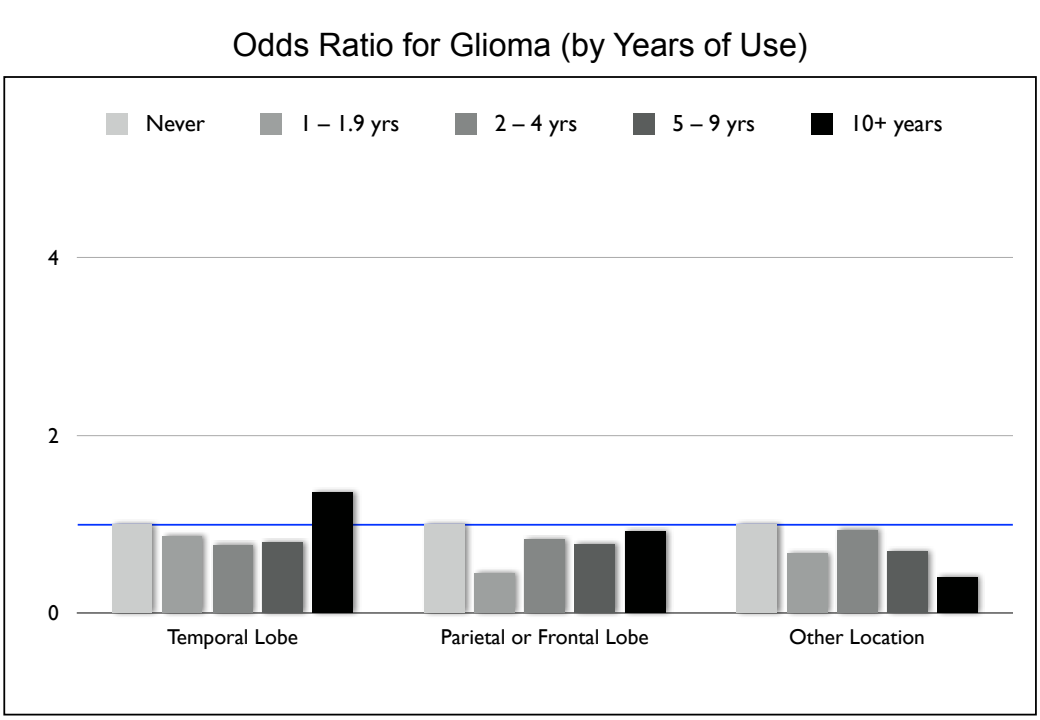


Glioma risk by **side of head they habitually held the phone**.

Also stratified by **cumulative call time**.

(With ≥1640 hrs exposure, Ipsilateral OR = 1.96 [95% CI = (1.22–3.22)]

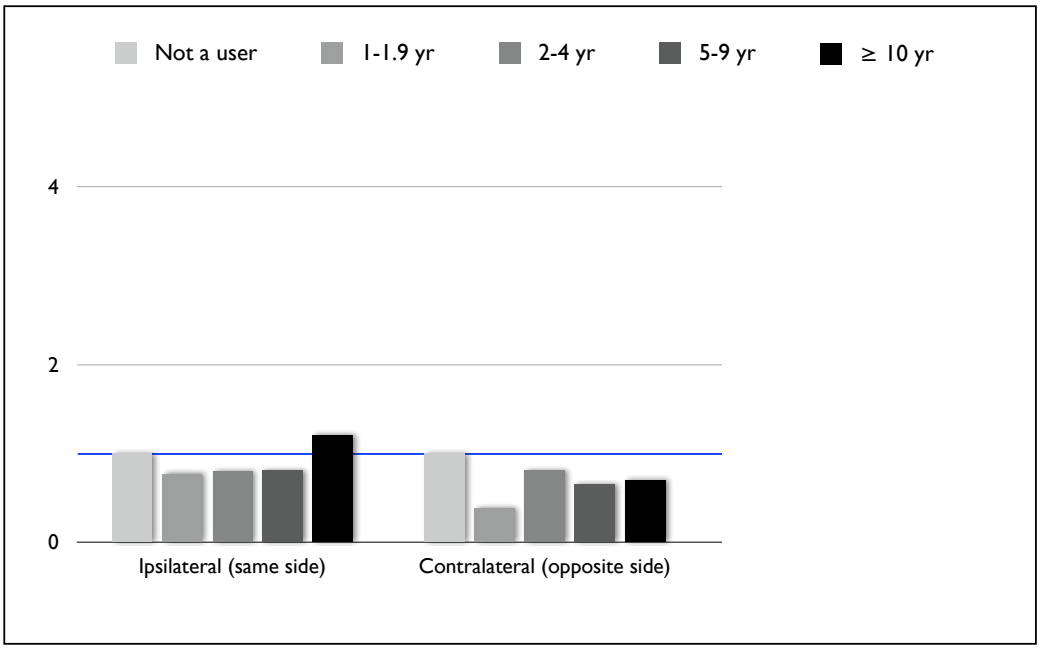
From Table 5: INTERPHONE Study Group. Brain tumour risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. *Int J Epidemiol* (2010); 39(3):675-694.



Stratified by **years of exposure**.

1640 hours in 10+ years ~ > 3 hrs/wk
1640 hours in 4 years = 7.9 hrs/wk (range in cohort was 8 – 30 hrs/wk)

INTERPHONE Study Group. Brain tumour risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. *Int J Epidemiol* (2010); 39(3):675-694.



Glioma risk by **side of head they habitually held the phone**.
Also stratified by **cumulative call time**.

1640 hours in 10+ years ~ > 3 hrs/wk

INTERPHONE Study Group. Brain tumour risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. *Int J Epidemiol* (2010); 39(3):675-694.

INTERPHONE Study 2011

Acoustic neuroma risk in relation to mobile telephone use: Results of the INTERPHONE international case–control study

The INTERPHONE Study Group[*,1]

ARTICLE INFO

Article history:
Received 13 April 2011
Received in revised form 9 May 2011
Accepted 10 May 2011
Available online 23 August 2011

Keywords:
Acoustic neuroma
Vestibular schwannoma
Brain tumour
Mobile phones
Radiofrequency electromagnetic fields
Epidemiology

ABSTRACT

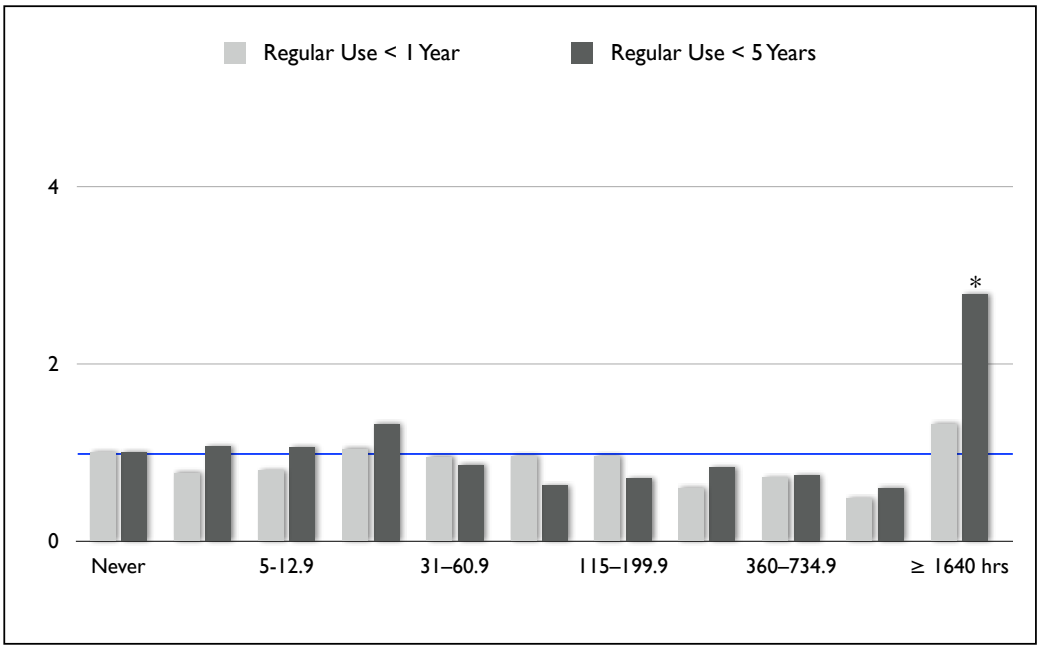
Background: The rapid increase in mobile telephone use has generated concern about possible health risks of radiofrequency electromagnetic fields from these devices. *Methods:* A case–control study of 1105 patients with newly diagnosed acoustic neuroma (vestibular schwannoma) and 2145 controls was conducted in 13 countries using a common protocol. Past mobile phone use was assessed by personal interview. In the primary analysis, exposure time was censored at one year before the reference date (date of diagnosis for cases and date of diagnosis of the matched case for controls); analyses censoring exposure at five years before the reference date were also done to allow for a possible longer latent period. *Results:* The odds ratio (OR) of acoustic neuroma with ever having been a regular mobile phone user was 0.85 (95% confidence interval 0.69–1.04). The OR for ≥10 years after first regular mobile phone use was 0.76 (0.52–1.11). There was no trend of increasing ORs with increasing cumulative call time or cumulative number of calls, with the lowest OR (0.48 (0.30–0.78)) observed in the 9th decile of cumulative call time. In the 10th decile (≥1640 h) of cumulative call time, the OR was 1.32 (0.88–1.97); there were, however, implausible values of reported use in those with ≥1640 h of accumulated mobile phone use. With censoring at 5 years before the reference date the OR for ≥10 years after first regular mobile phone use was 0.83 (0.58–1.19) and for ≥1640 h of cumulative call time it was 2.79 (1.51–5.16), but again with no trend in the lower nine deciles and with the lowest OR in the 9th decile. In general, ORs were not greater in subjects who reported usual phone use on the same side of the head as their tumour than in those who reported it on the opposite side, but it was greater in those in the 10th decile of cumulative hours of use. *Conclusions:* There was no increase in risk of acoustic neuroma with ever regular use of a mobile phone or for users who began regular use 10 years or more before the reference date. Elevated odds ratios observed at the highest level of cumulative call time could be due to chance, reporting bias or a causal effect. As acoustic neuroma is usually a slowly growing tumour, the interval between introduction of mobile phones and occurrence of the tumour might have been too short to observe an effect, if there is one.

2011 INTERPHONE study of acoustic neuroma

Funded in significant part by the telecommunications industry.

Cardis E, Schüz J. Acoustic neuroma risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. *Cancer Epidemiol* (2011); 35(5):453-464.

Odds Ratio for Acoustic Neuroma with Cell Phone Use



From 2011 INTERPHONE study of acoustic neuroma, Table 2.

This study was also funded in major part by the telecommunications industry.

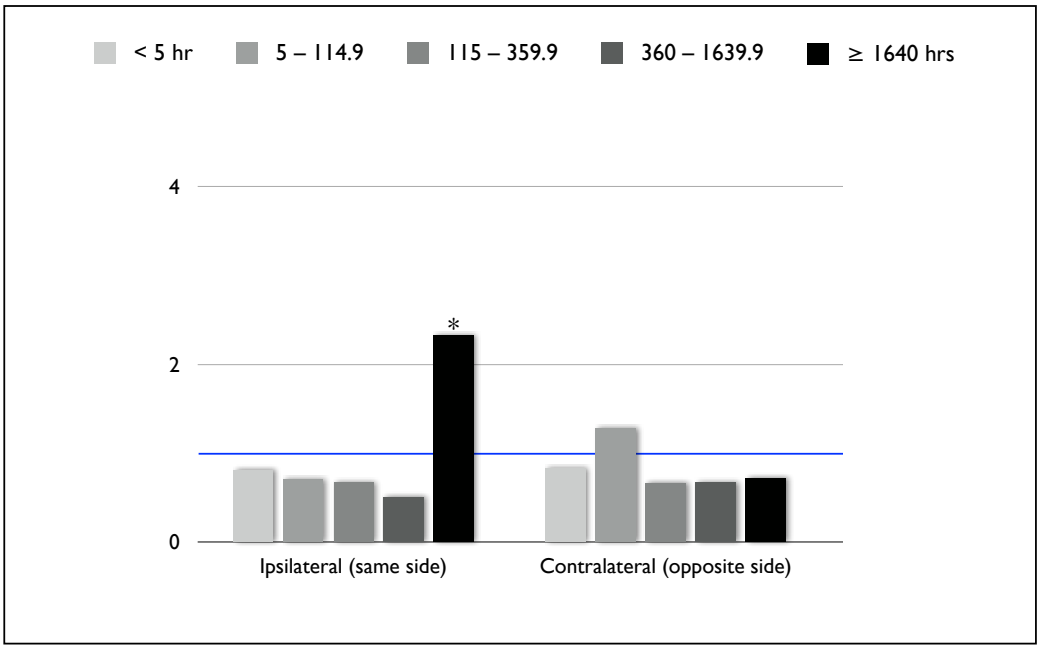
In their conclusion, the authors stated that this data showed **"no trend of increasing risk with increasing cumulative call time"**

They discounted their findings for the highest decile of exposure.

But with ≥1640 hrs exposure in 1 – 5 years of exposure, **OR = 2.79 [95% CI = (1.51–5.16)]**

From Table 2: Cardis E, Schüz J. Acoustic neuroma risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. *Cancer Epidemiol* (2011); 35(5):453-464.

Acoustic Neuroma Risk (< 1 year of cell phone use)



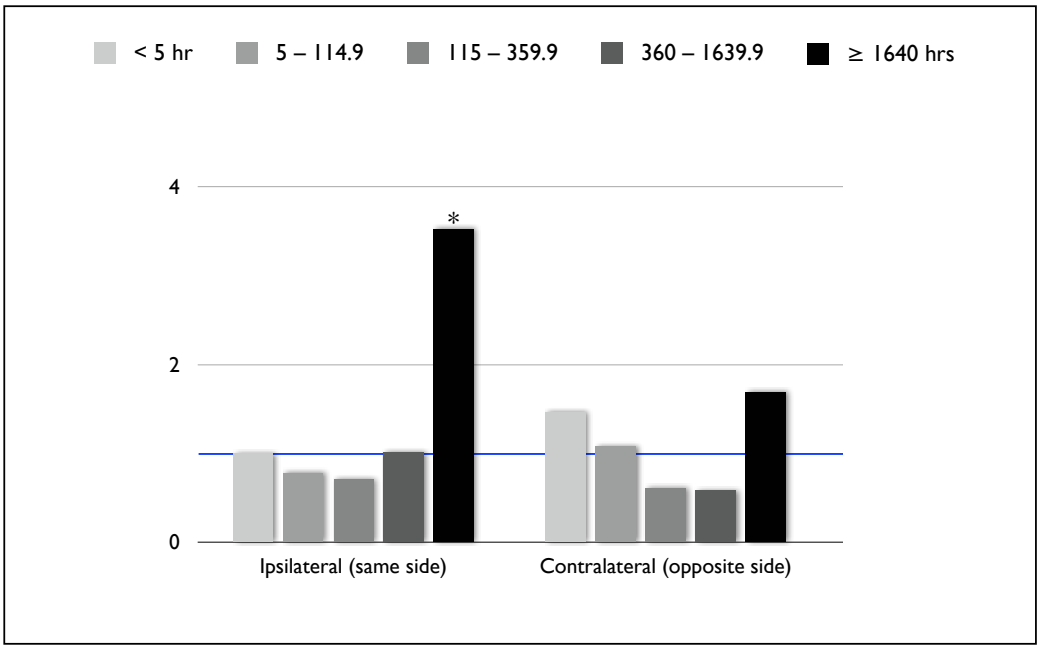
In the high use group, risk of acoustic neuroma was significantly higher on the side of the head where the subject habitually held the cell phone.

1640 hours in 1 year = 4.5 hours a day = 31.5 hours/week

With ≥1640 hrs exposure, ipsilateral tumor Odds Ratio = 2.33 [95% CI = (1.23–4.40)]

From Table 3: Cardis E, Schüz J. Acoustic neuroma risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. *Cancer Epidemiol* (2011); 35(5):453-464.

Acoustic Neuroma Risk (< 5 years of cell phone use)



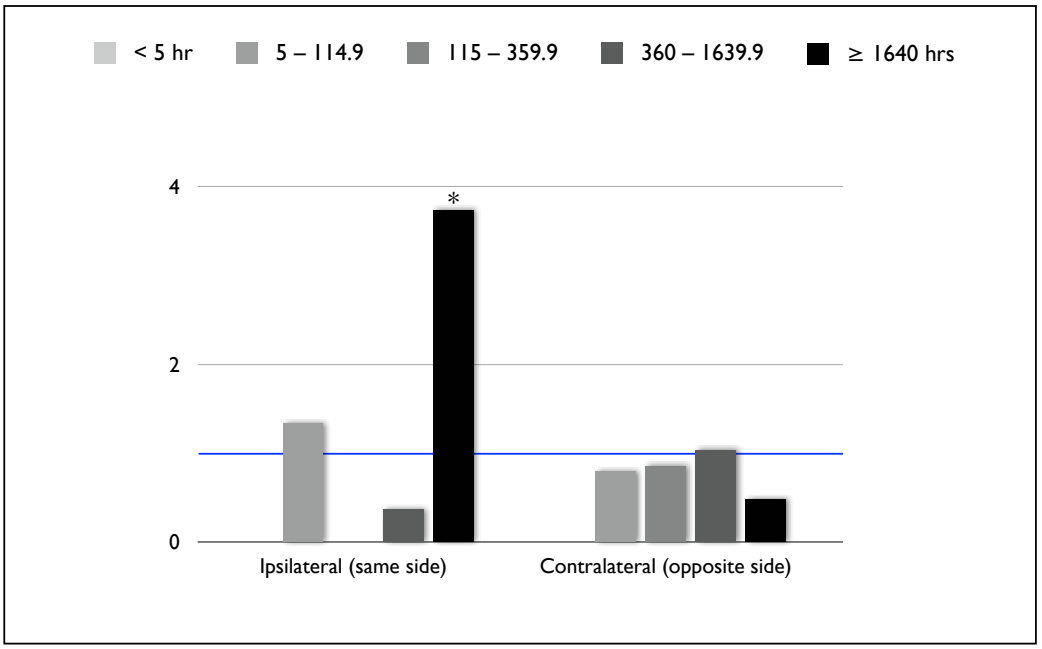
Risk increased with increased years of exposure.

1640 hours in 5 years = 0.9 hours a day = 6.3 hours/week

With ≥1640 hrs exposure, ipsilateral tumor Odds Ratio = 3.53 [95% CI = (1.59–7.82)]

From Table 3: Cardis E, Schüz J. Acoustic neuroma risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. *Cancer Epidemiol* (2011); 35(5):453-464.

Acoustic Neuroma Risk (≥ 10 years of cell phone use)



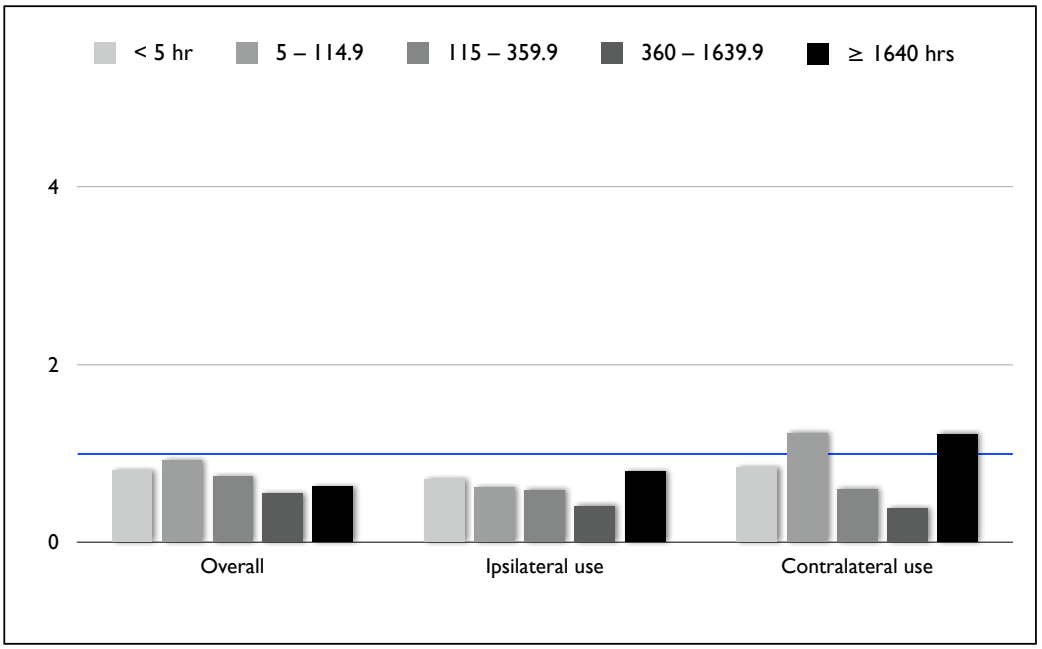
Higher risk with ten or more years of exposure.

1640 hours in 10 years = less than half an hour a day. = 3.2 hours/week = 0.45 hours a day

With ≥1640 hrs exposure, ipsilateral tumor Odds Ratio = 3.74 [95% CI = (1.58–8.83)]

From Table 4: Cardis E, Schüz J. Acoustic neuroma risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. *Cancer Epidemiol* (2011); 35(5):453-464.

Acoustic Neuroma Risk with 1 to 4 Years of Cell Phone Use

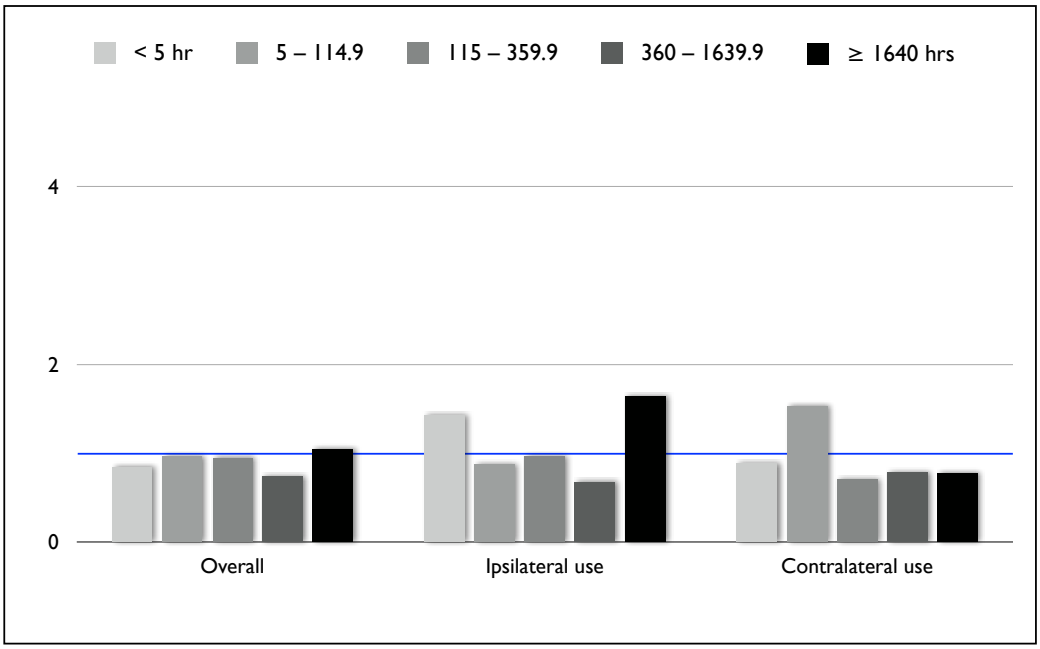


2011 INTERPHONE study of acoustic neuroma

From Table 4: Short, medium, long-term accumulation of >1640 hours.

Cardis E, Schüz J. Acoustic neuroma risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. *Cancer Epidemiol* (2011); 35(5):453-464.

Acoustic Neuroma Risk with 5 to 9 Years of Cell Phone Use

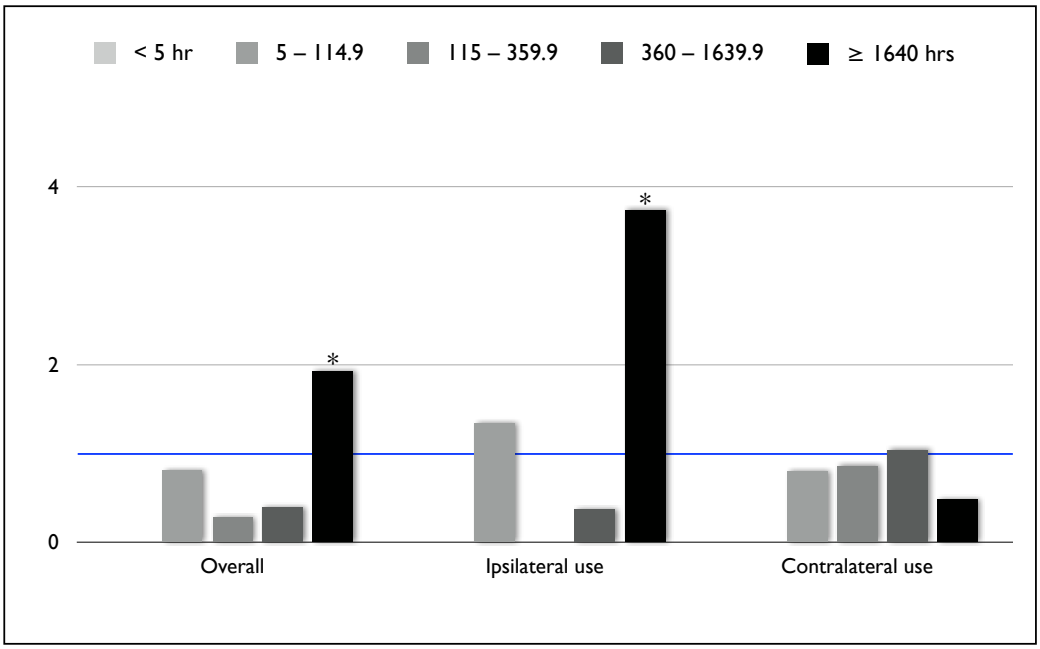


2011 INTERPHONE study of acoustic neuroma

From Table 4: Short, medium, long-term accumulation of >1640 hours.

Cardis E, Schüz J. Acoustic neuroma risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. *Cancer Epidemiol* (2011); 35(5):453-464.

Acoustic Neuroma Risk with 10 + Years of Cell Phone Use



2011 INTERPHONE study of acoustic neuroma

From Table 4: Short, medium, long-term accumulation of ≥1640 hours.

Cardis E, Schüz J. Acoustic neuroma risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. *Cancer Epidemiol* (2011); 35(5):453-464.

INTERPHONE Study 2011

PRESS RELEASE

Risk of brain tumours in relation to estimated RF dose from mobile phones: results from five Interphone countries

E Cardis,[1] B K Armstrong,[2] J D Bowman,[3] G G Giles,[4,5] M Hours,[6] D Krewski,[7] M McBride,[8] M E Parent,[9] S Sadetzki,[10,11] A Woodward,[12] J Brown,[2] A Chetrit,[10] J Figuerola,[1] C Hoffmann,[11,13] A Jarus-Hakak,[10] L Montestruq,[6] L Nadon,[9] L Richardson,[14] R Villegas,[1] M Vrijheid[1]

For numbered affiliations see end of article.

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Accepted 20 May 2011
Published Online First
9 June 2011

ABSTRACT
Objectives The objective of this study was to examine the associations of brain tumours with radio frequency (RF) fields from mobile phones.
Methods Patients with brain tumour from the Australian, Canadian, French, Israeli and New Zealand components of the Interphone Study, whose tumours were localised by neuroradiologists, were analysed. Controls were matched on age, sex and region and allocated the 'tumour location' of their matched case. Analyses included 553 glioma and 676 meningioma cases and 1762 and 1911 controls, respectively. RF dose was estimated as total cumulative specific energy (TCSE; J/kg) absorbed at the tumour's estimated centre taking into account multiple RF exposure determinants.
Results ORs with ever having been a regular mobile phone user were 0.93 (95% CI 0.73 to 1.18) for glioma and 0.80 (95% CI 0.66 to 0.96) for meningioma. ORs for glioma were below 1 in the first four quintiles of TCSE

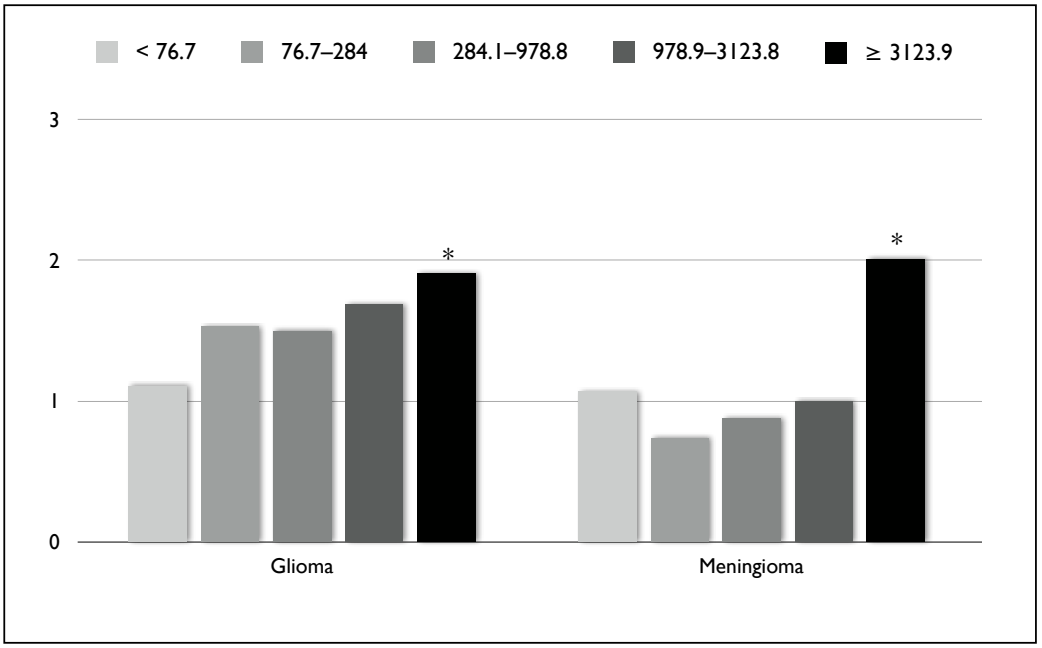
What this paper adds

- Previous epidemiological studies of mobile phone use and brain cancer risk have used information on mobile phone use as a proxy measure of exposure to radio frequency fields from mobile phones.
- Most studies have not observed increased ORs in relation to ever having been a mobile phone user. There were suggestions, however, of an increased risk of glioma in long-term and heavy users, though biases and errors prevent a causal interpretation.
- The relationship between radio frequency energy absorbed at the tumour location and mobile phone use history is complex. In addition to amount of use, it depends on phone type, network properties, conditions of use and

Interphone latest study 2011

Cardis E, Armstrong BK, Bowman JD et al. Risk of brain tumours in relation to estimated RF dose from mobile phones: results from five Interphone countries. *Occup Environ Med* (2011); 68(9):631-640.

Odds Ratio for Brain Tumor (7+ years of cell phone use)



Stratified by Total Cumulative Energy Exposure (joules/kilogram)

From Table 3: Cardis E, Armstrong BK, Bowman JD et al. Risk of brain tumours in relation to estimated RF dose from mobile phones: results from five Interphone countries. *Occup Environ Med* (2011); 68(9):631-640.

INTERPHONE Study 2011

Our results suggest that there may be an increase in risk of glioma in the most exposed area of the brain among long-term and heavy users of mobile phones. These results are uncertain (in light of the uncertainties associated with tumour centre localisation, radio frequency dose estimation and sample size) and require replication before they can be taken to indicate a cause eeffect relationship.

From the conclusions of the 2001 INTERPHONE study (industry-financed).

Study authors finally admitted that their data showed increase risk of glioma, but said that this finding required replication before being taken as a cause and effect relationship.

This despite the fact that this finding was already a replication of their previously published data, and had also been confirmed several times in the published data of the Hardell group in Sweden.

Danish Study 2011

BBC NEWS

HEALTH

20 October 2011 Last updated at 21:11 ET

Mobile phone brain cancer link rejected

By Nick Triggle
Health correspondent, BBC News

Further research has been published suggesting there is no link between mobile phones and brain cancer.

The risk mobiles present has been much debated over the past 20 years as use of the phones has soared.

Danish study: Proclaimed as evidence that cell phones are safe.

420, 095 subscribers in the cohort — who had subcriptions by 1994/95.

Exposure is judged by presence of a cell phone contract, no record of actual usage.

200,507 corporate users excluded — **and placed in the control group**.

2550 juveniles excluded — **and placed in the control group**.

Frei P, Poulsen AH, Johansen C, Olsen JH, Steding-Jessen M, Schuz J. Use of mobile phones and risk of brain tumours: update of Danish cohort study. *BMJ* (2011); 343(d6387).

Danish Study 2011

Danish study: Proclaimed as evidence that cell phones are safe.

420, 095 subscribers in the cohort — who had subcriptions by 1994/95. Exposure is judged by presence of a cell phone contract, no record of actual usage.
200,507 corporate users excluded — and placed in the control group.
2550 juveniles excluded — and placed in the control group.
Half the subjects in the 2009 Johansen et al study had less than two years of cell phone use.

Second publication: Schuz 2006
Only 61% of subscribers reported making or receiving at least 1 call a week in prior six months
All users who began subscription after 1995 were put in the "unexposed" reference population.

Third publication Shuz et al 2011
Same study group
Control group 2.9 million Danes

Fourth publication: Frei et all 2011 BMJ
~ 42% of initial cohort excluded (and placed in control group).
Also in the control group — the 85% of Danes that got a cell phone contract between 1995 and 2004.

"Number of subscription years" is used as a surrogate for actual hours of usage.
18-29 year old excluded

Cohort established by grants from Danish telcom companies. Sources of funding of the International Epidemiology Institute (Rockville, MD, USA) have never been declared.

In this study, the control group was contaminated with so many cell phone users that the results of the study were essentially meaningless. Two reviews stating this fact were published in the same issue of BMJ, along with the Frie study.

Frei P, Poulsen AH, Johansen C, Olsen JH, Steding-Jessen M, Schuz J. Use of mobile phones and risk of brain tumours: update of Danish cohort study. *BMJ* (2011); 343(d6387.

Philips A, Lamburn G. Updated study contains poor science and should be disregarded. *BMJ* (2011); 343(d7899; author reply d7912).

Soderqvist F, Carlberg M, Hardell L. Review of four publications on the Danish cohort study on mobile phone subscribers and risk of brain tumors. *Rev Environ Health* (2012); 27(1):51-58.

Studies from the Hardell Group in Sweden

INTERNATIONAL JOURNAL OF ONCOLOGY 38: 1465-1474, 2011

Pooled analysis of case-control studies on malignant brain tumours and the use of mobile and cordless phones including living and deceased subjects

LENNART HARDELL[1], MICHAEL CARLBERG[1] and KJELL HANSSON MILD[2]

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Received December 6, 2010; Accepted January 20, 2011

DOI: 10.3892/ijo.2011.947

Abstract. We studied the association between use of mobile and cordless phones and malignant brain tumours. Pooled analysis was performed of two case-control studies on patients with malignant brain tumours diagnosed during 1997-2003 and matched controls alive at the time of study inclusion and one case-control study on deceased patients and controls diagnosed during the same time period. Cases and controls or relatives to deceased subjects were interviewed using a structured questionnaire. Replies were obtained for 1,251 (85%) cases and 2,438 (84%) controls. The risk increased with

emissions from wireless devices such as mobile phone base stations, broadcast transmission towers, pagers and personal digital assistants, wireless networks and other sources of RF radiation (1).

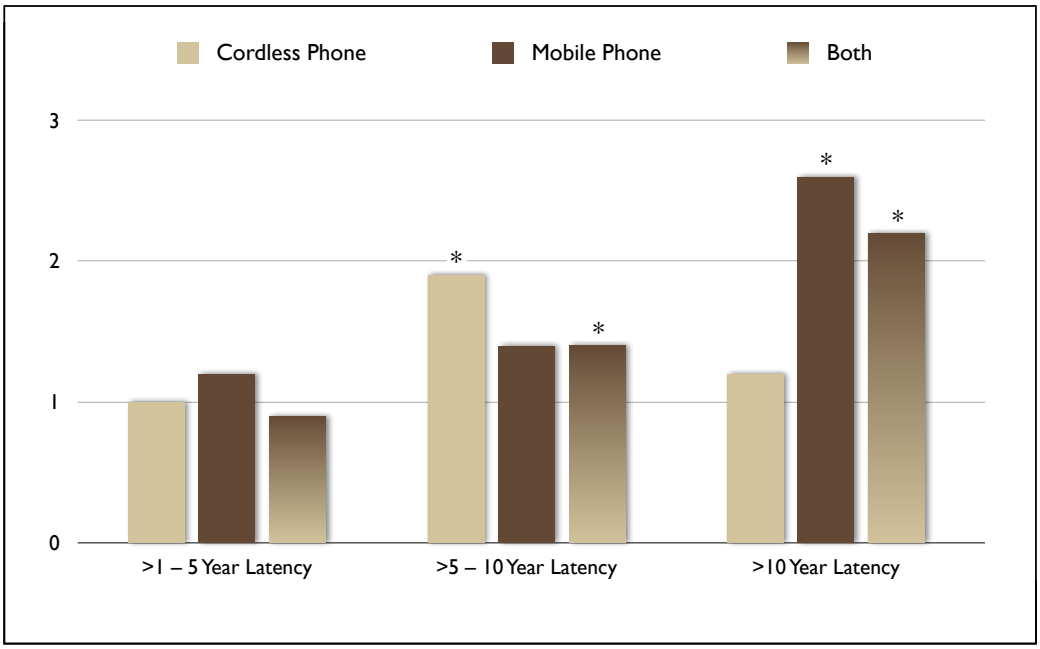
The brain is the target organ of the body with highest near field exposure to microwaves during use of a handheld wireless phone. Thus, fear of an increased risk for brain tumours from RF fields emitted from mobile phones has dominated the debate the last decade. Of equal importance is use of the desktop cordless phones

The most reliable research on the tumor risks of cell phones has been performed by the Hardell group in Sweden.

This group does not receive funding from the cell phone industry.

This is the only group that has controlled for use of in-home cordless phones as well as cell phones [which makes their data more reliable].

Hardell L, Carlberg M, Hansson Mild K. Pooled analysis of case-control studies on malignant brain tumours and the use of mobile and cordless phones including living and deceased subjects. *Int J Oncol* (2011b); 38(5):1465-1474.



Orient to the bar graph.

Hardell group -- current summary

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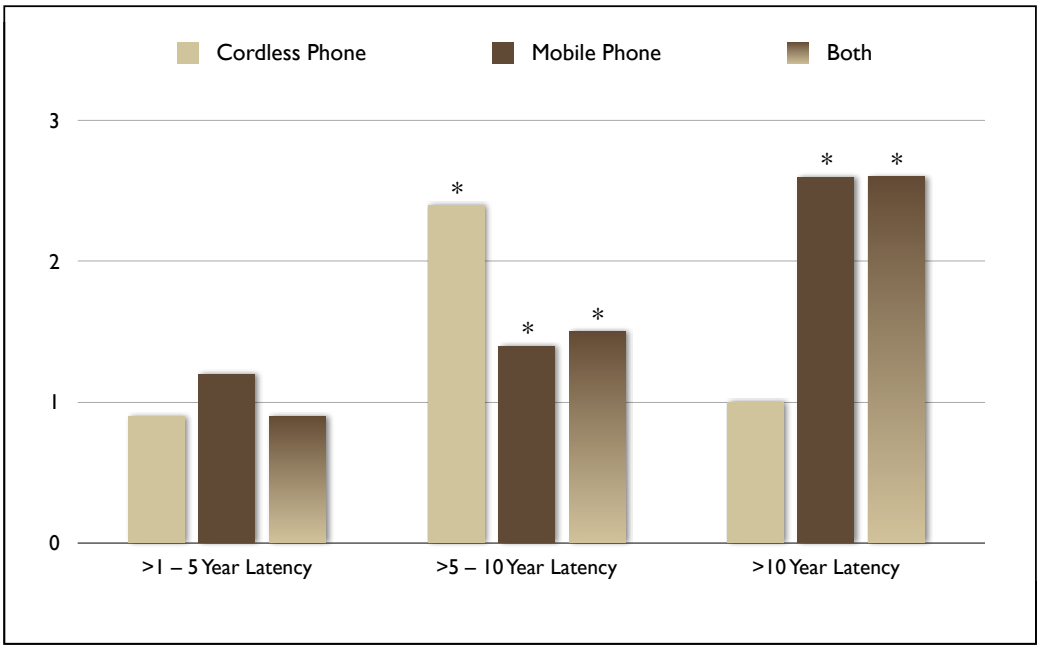

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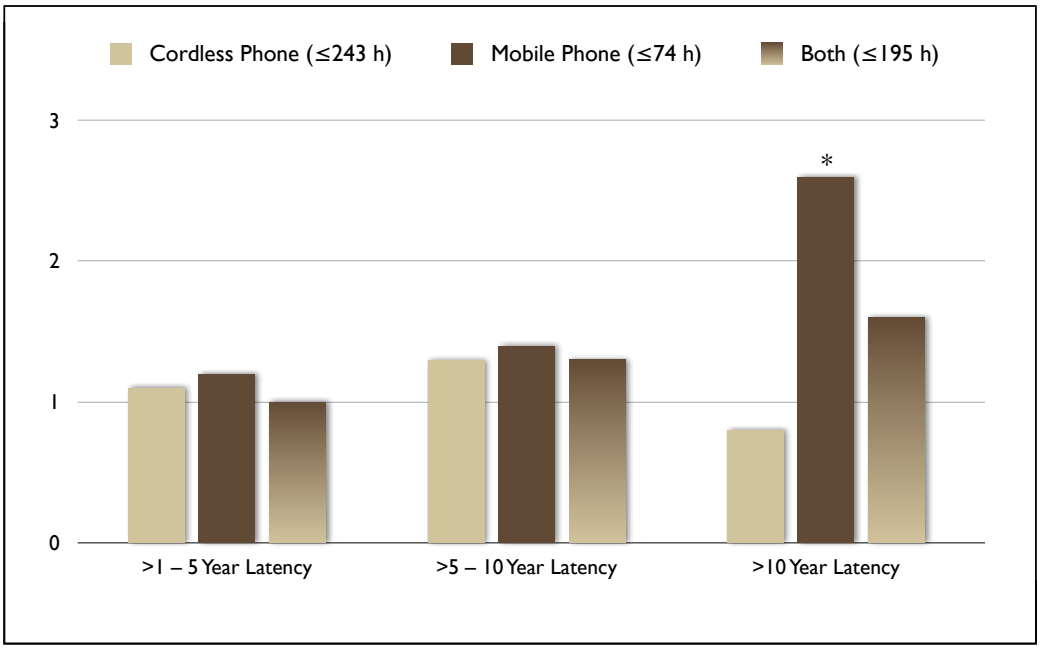

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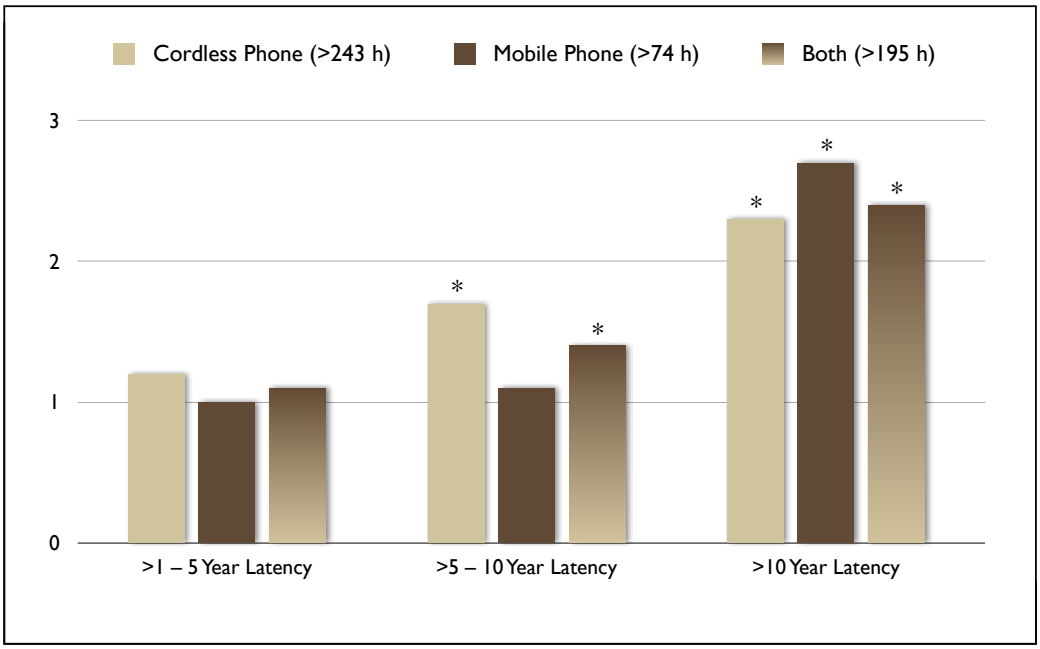

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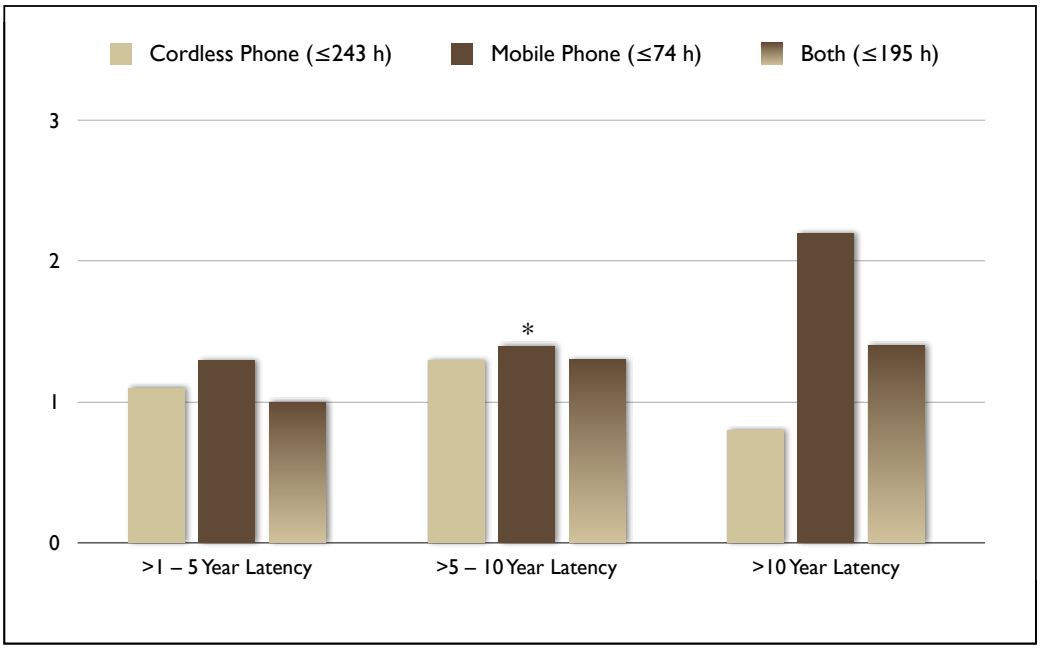

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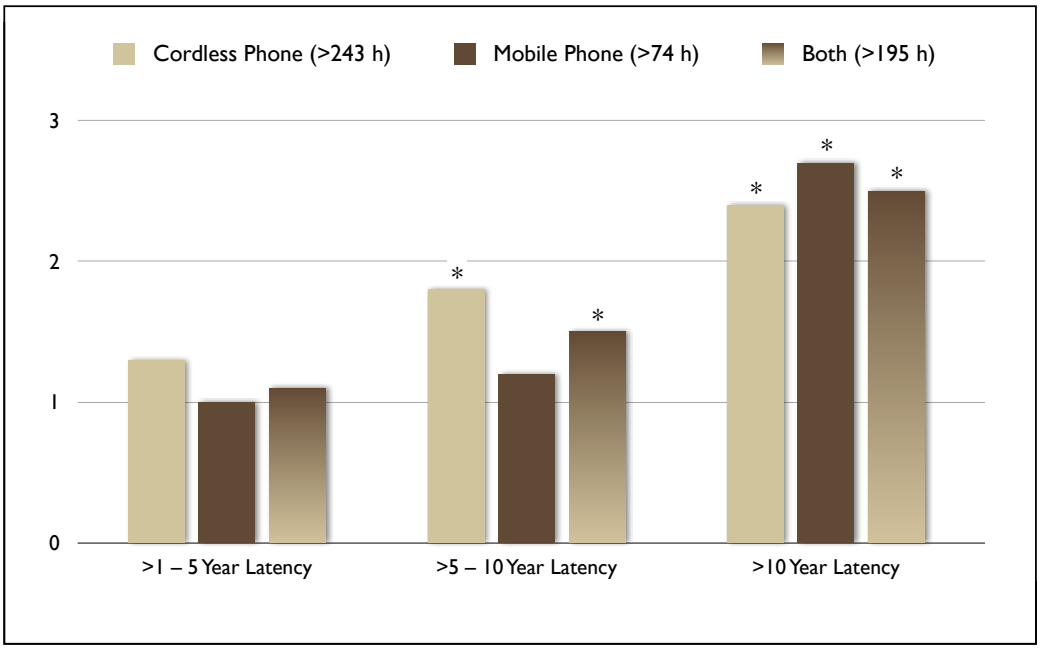

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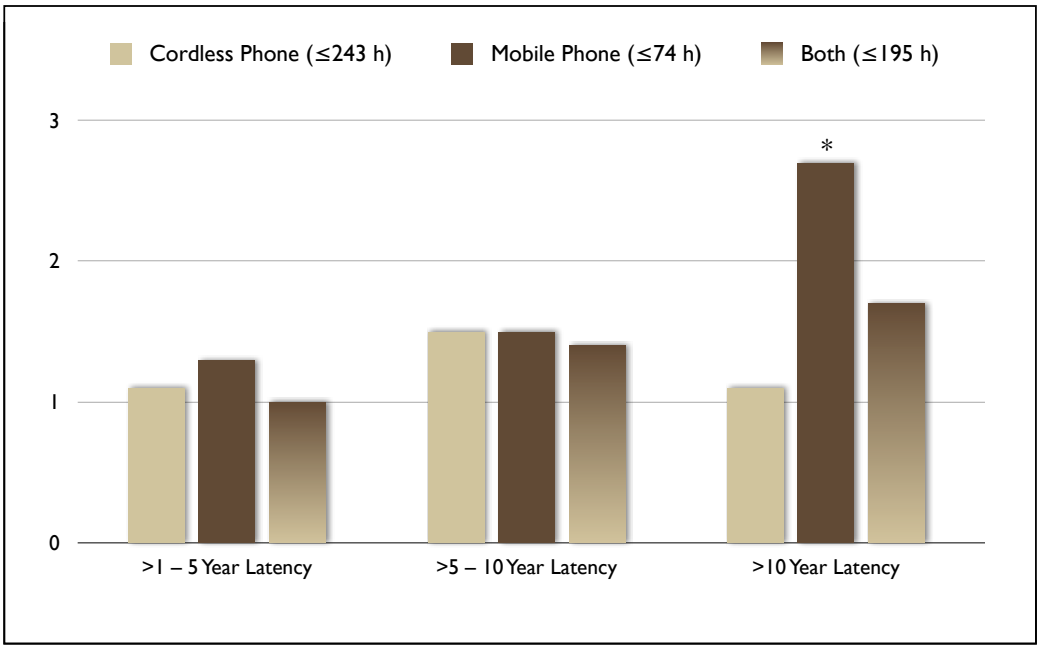
Risk of Astrocytoma (Usage Below Median)



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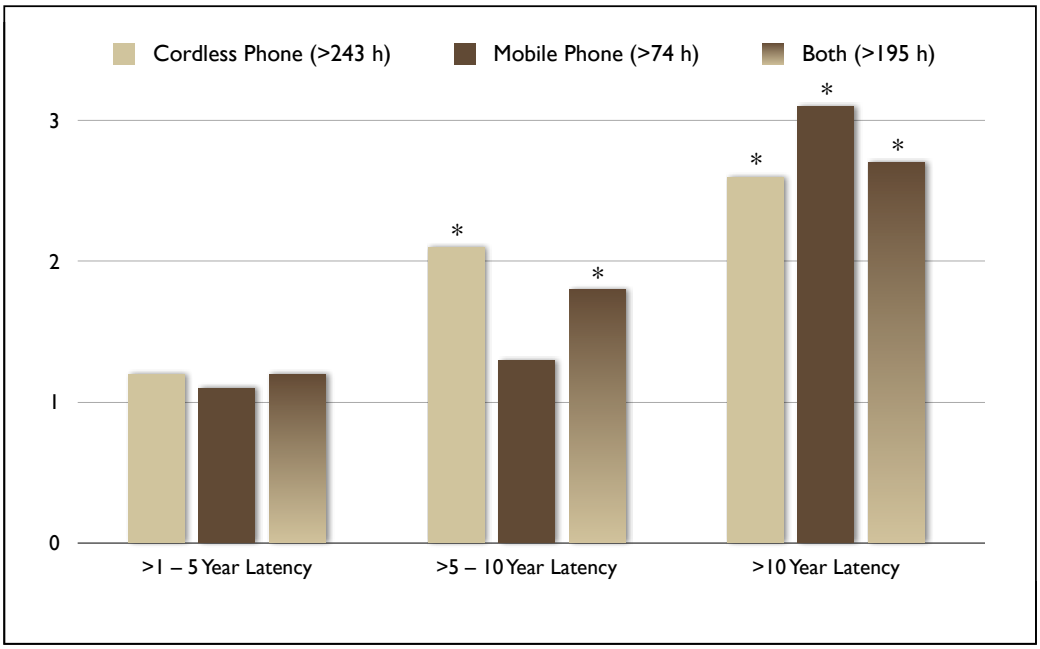

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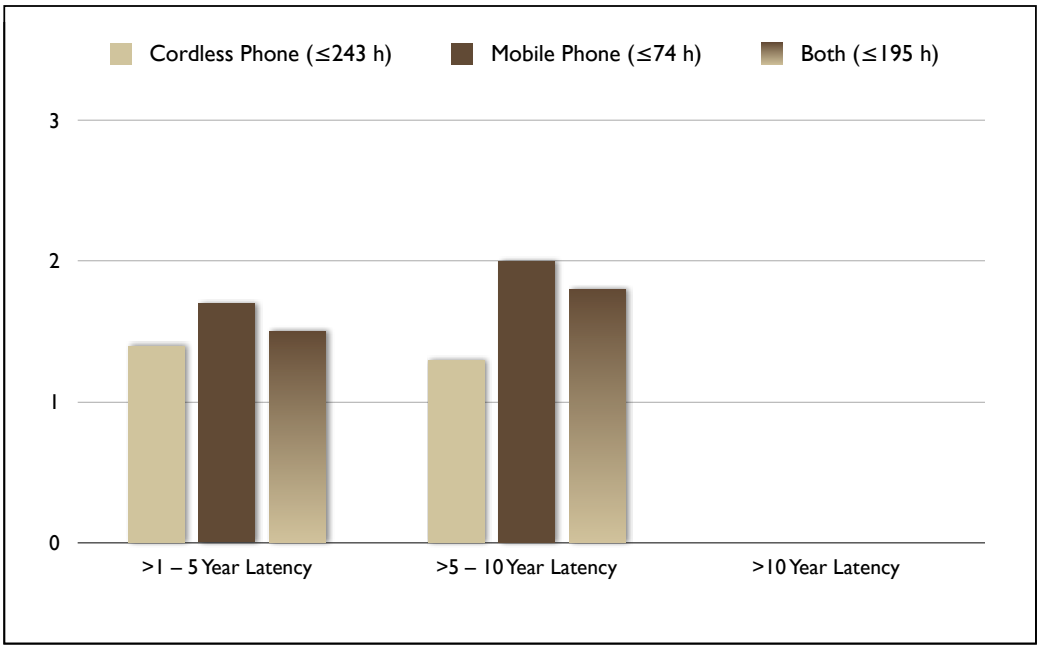
Risk of Oligodendroglioma (Usage Below Median)



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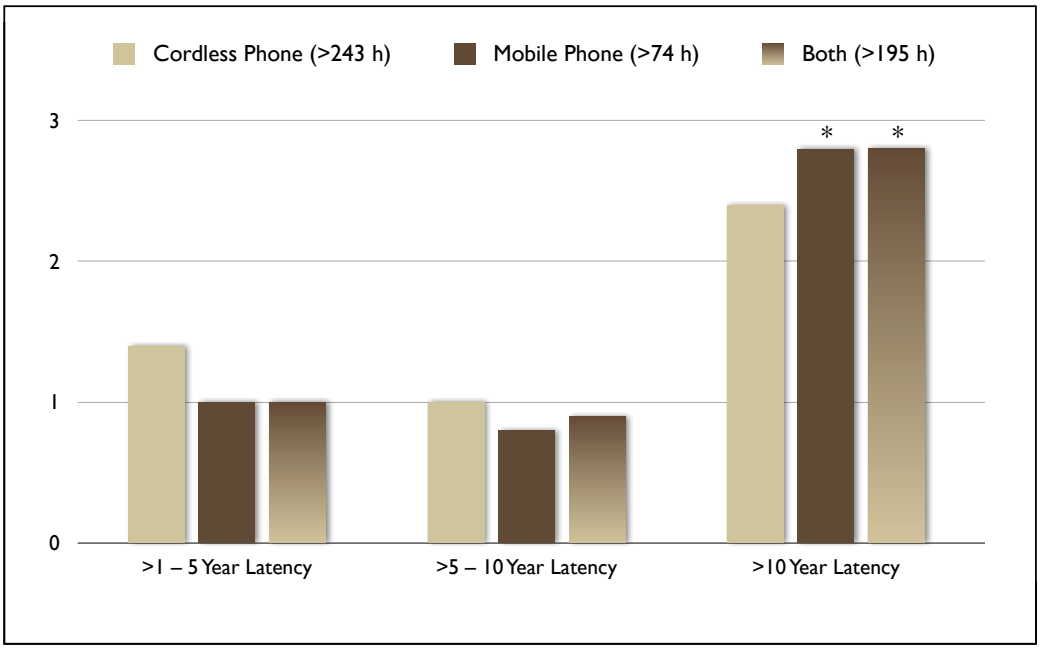

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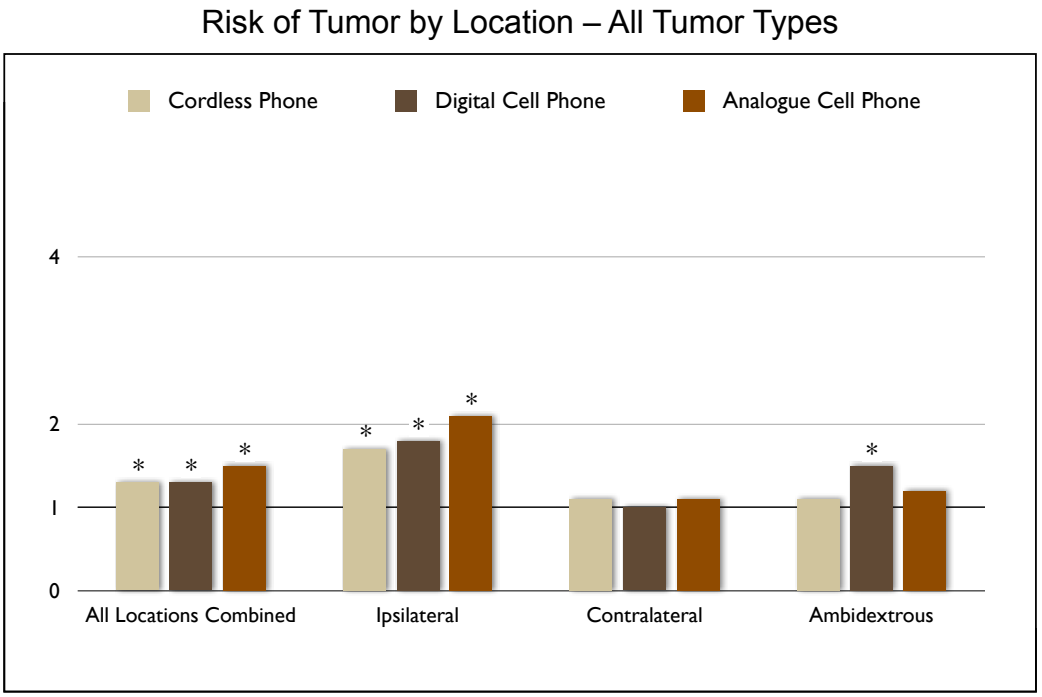

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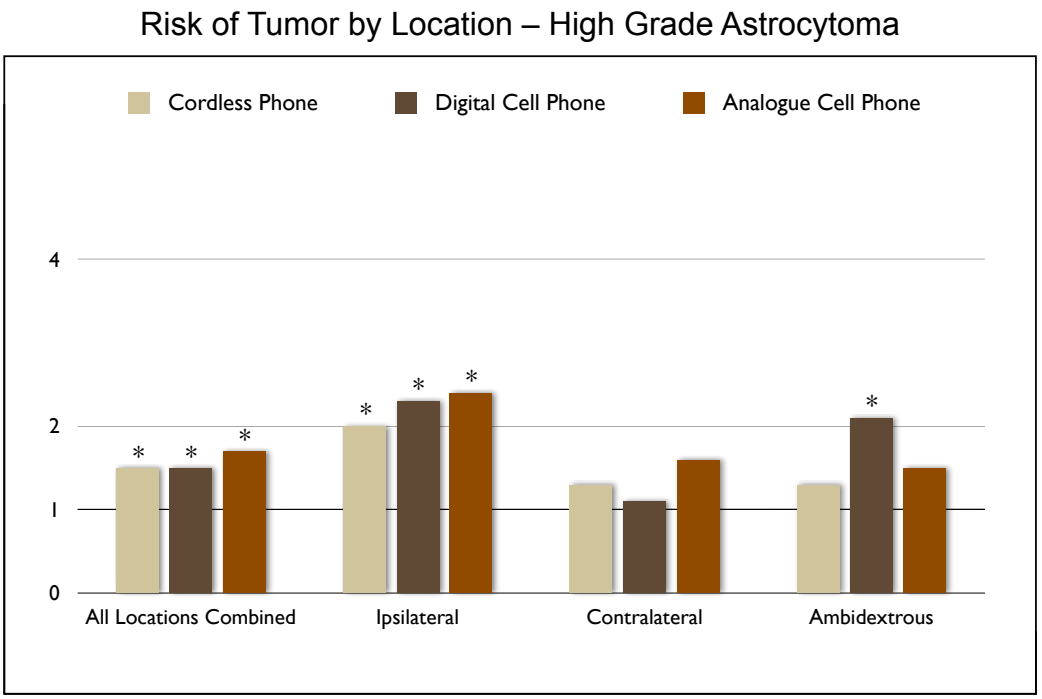

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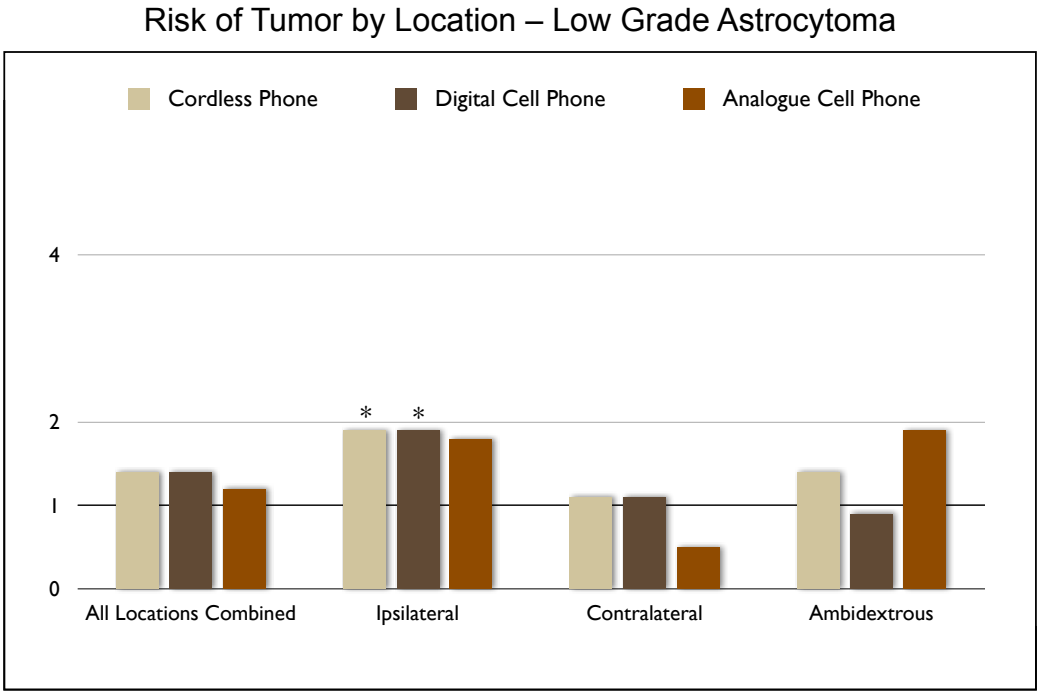

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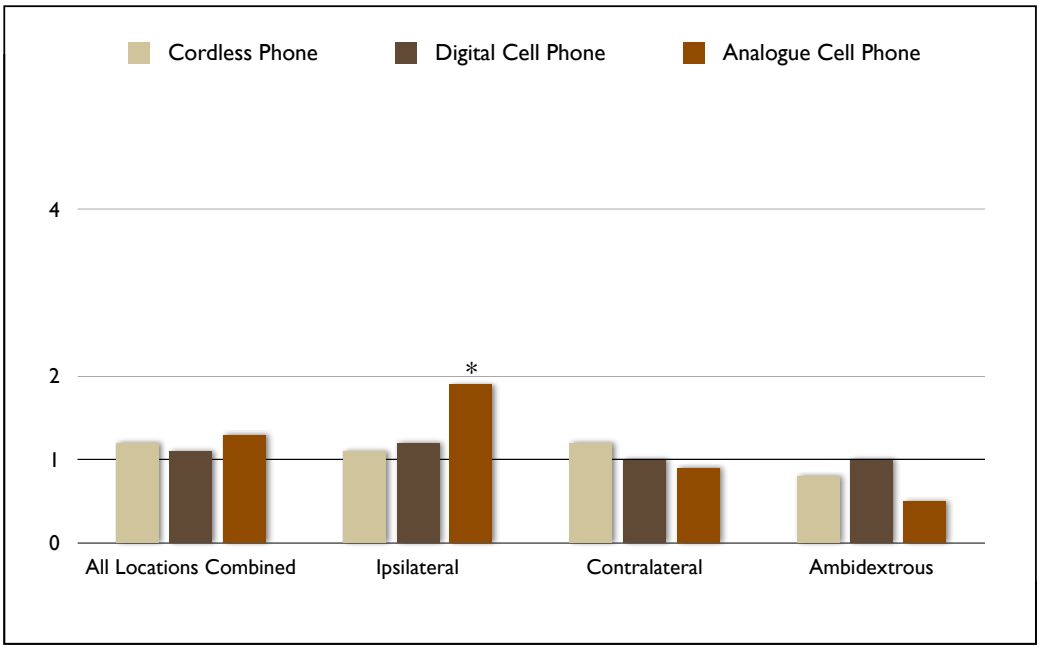

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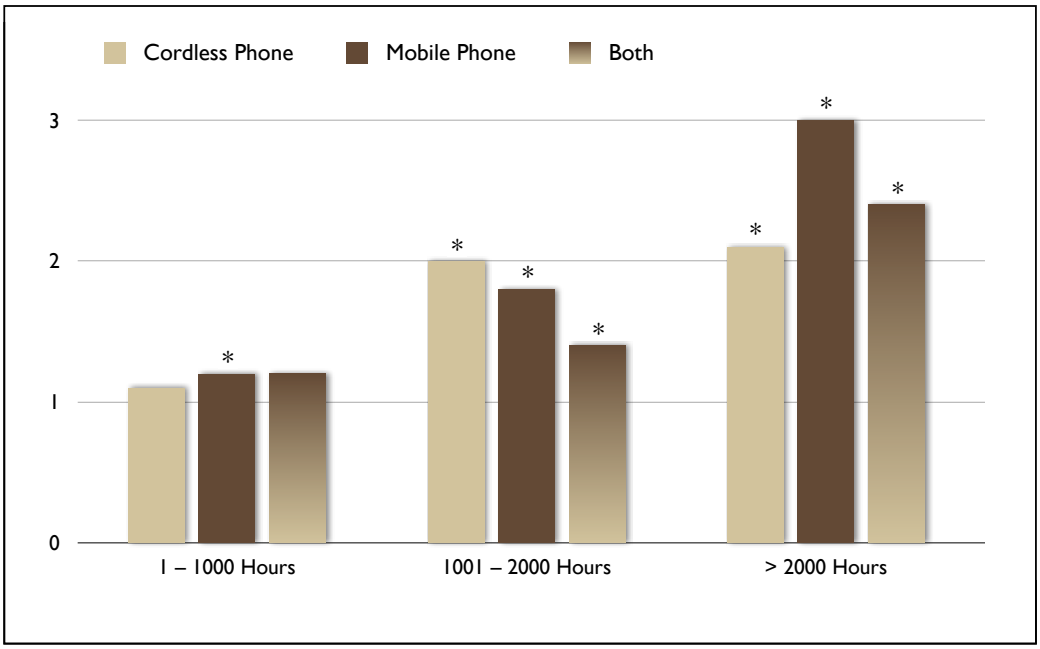
Tumor Risk by Cumulative Hours of Use – Any Brain Cancer



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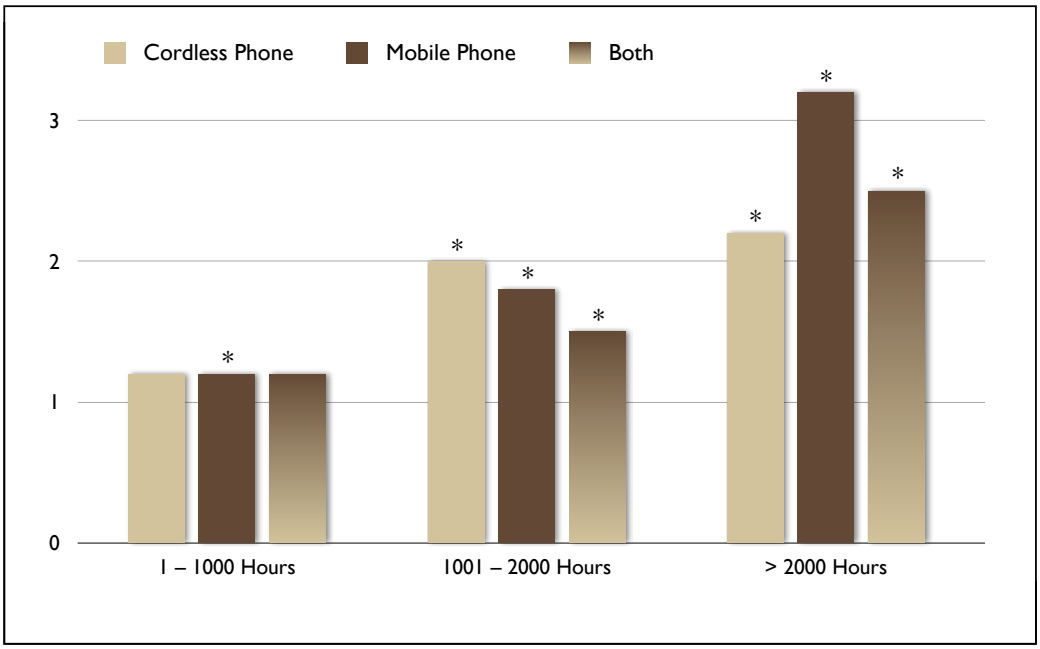
Tumor Risk by Cumulative Hours of Use – Glioma



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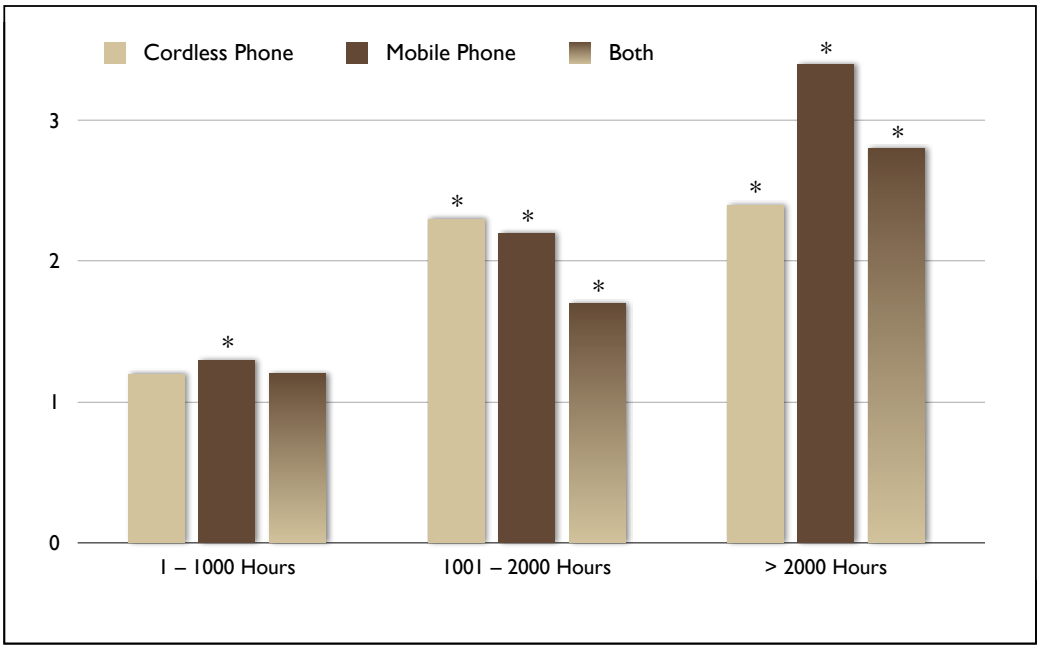
Tumor Risk by Cumulative Hours of Use – Astrocytoma



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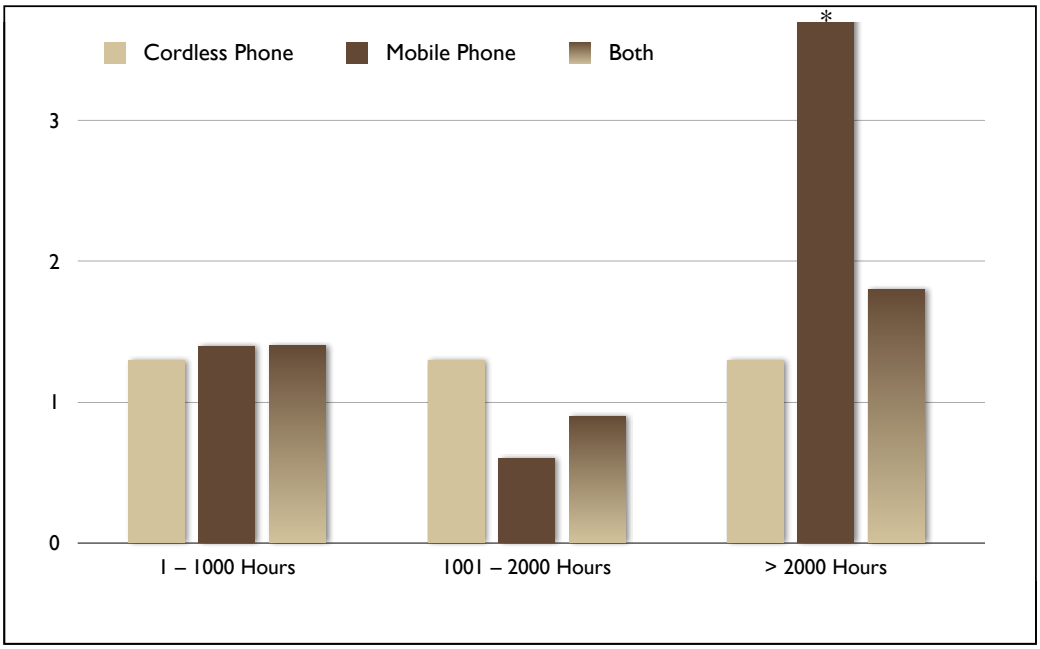
Tumor Risk by Cumulative Hours of Use – Oligodendroglioma



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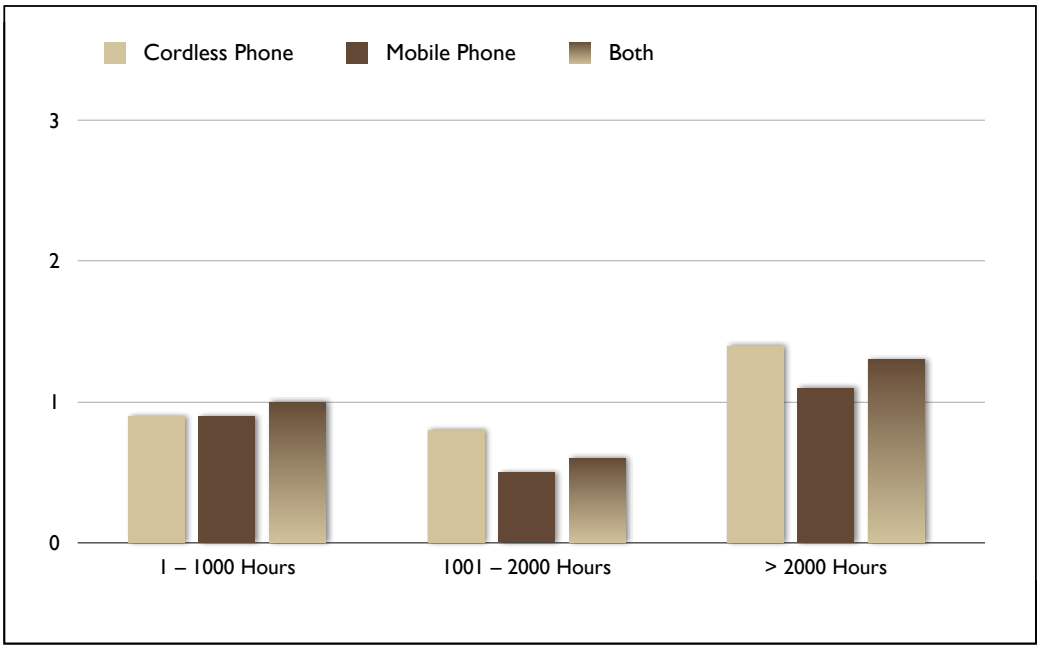
Tumor Risk by Cumulative Hours of Use – Other/Mixed Glioma



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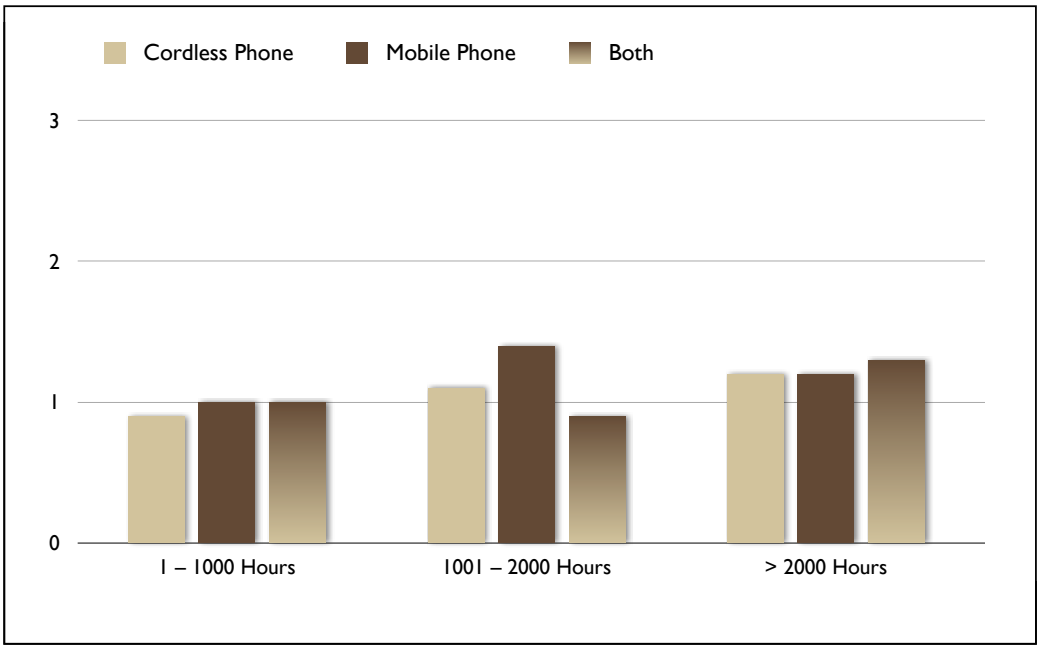
Tumor Risk by Cumulative Hours of Use – Other Brain Malignancy



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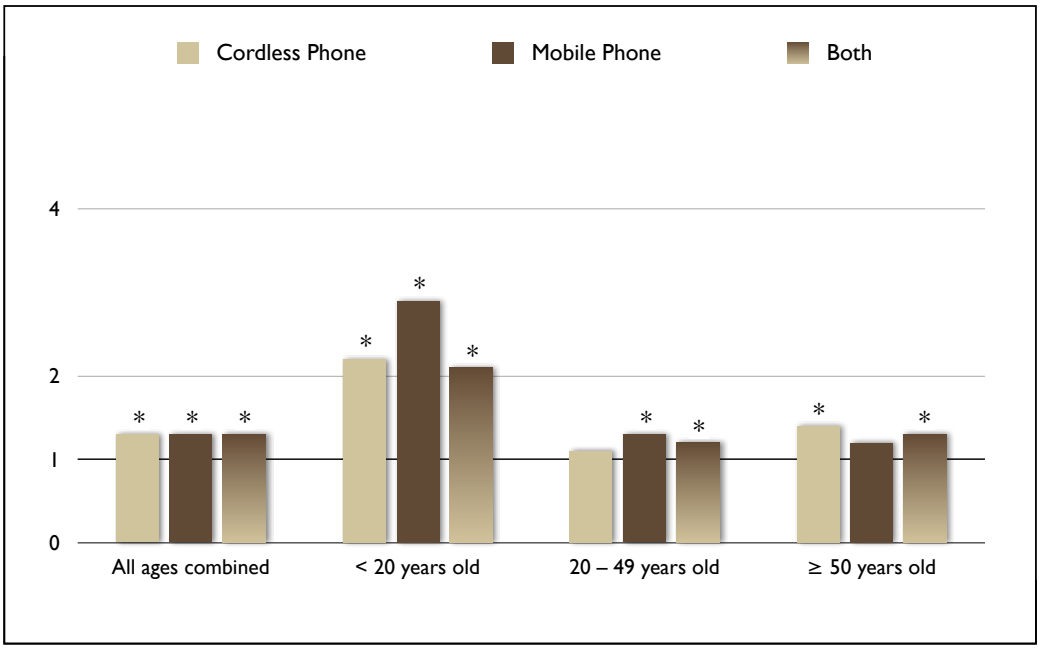
Tumor Risk by Age of First Use – Any Brain Cancer



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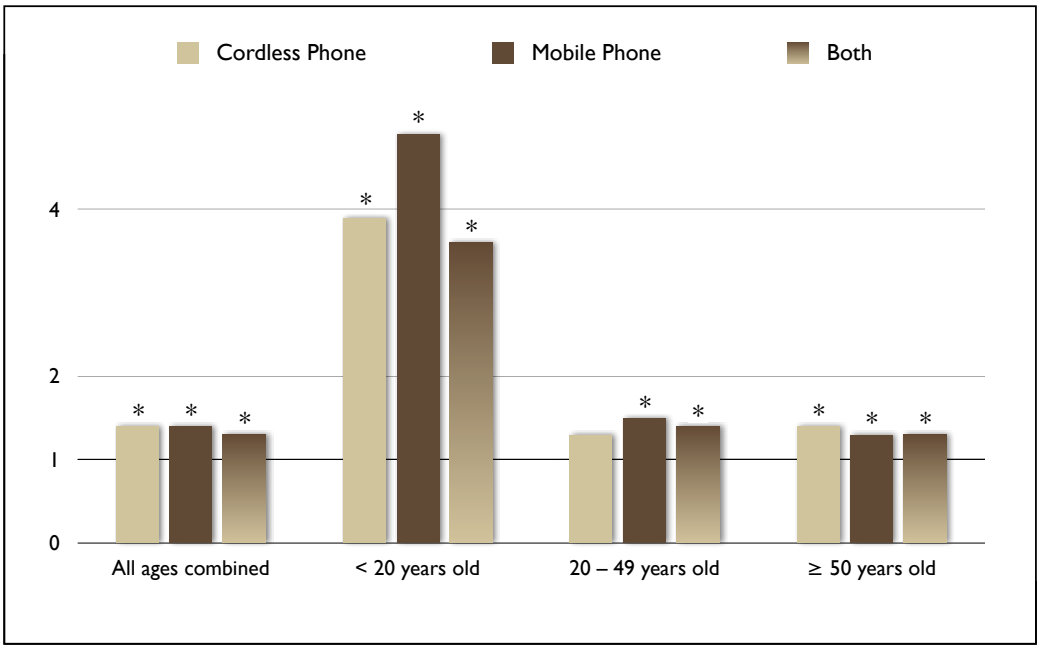

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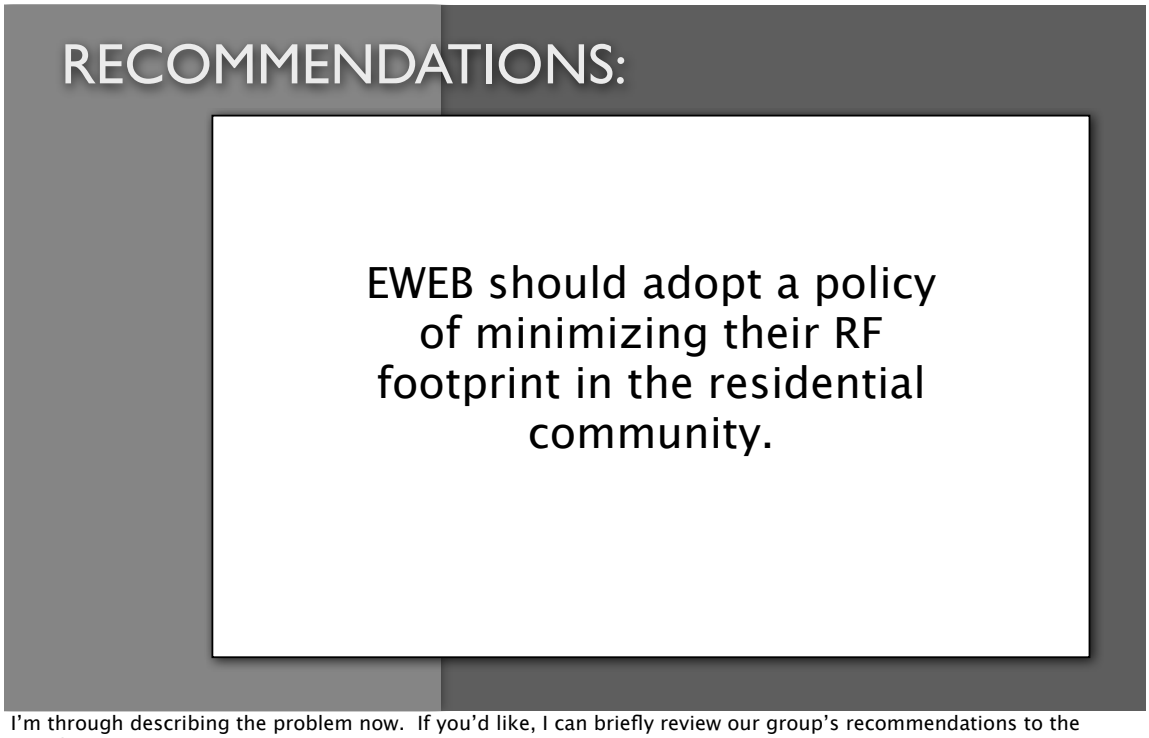


I'm through describing the problem now. If you'd like, I can briefly review our group's recommendations to the Board.

If EWEB chooses to go ahead with RF smart meters, the solution is to use these tools in a safer way.

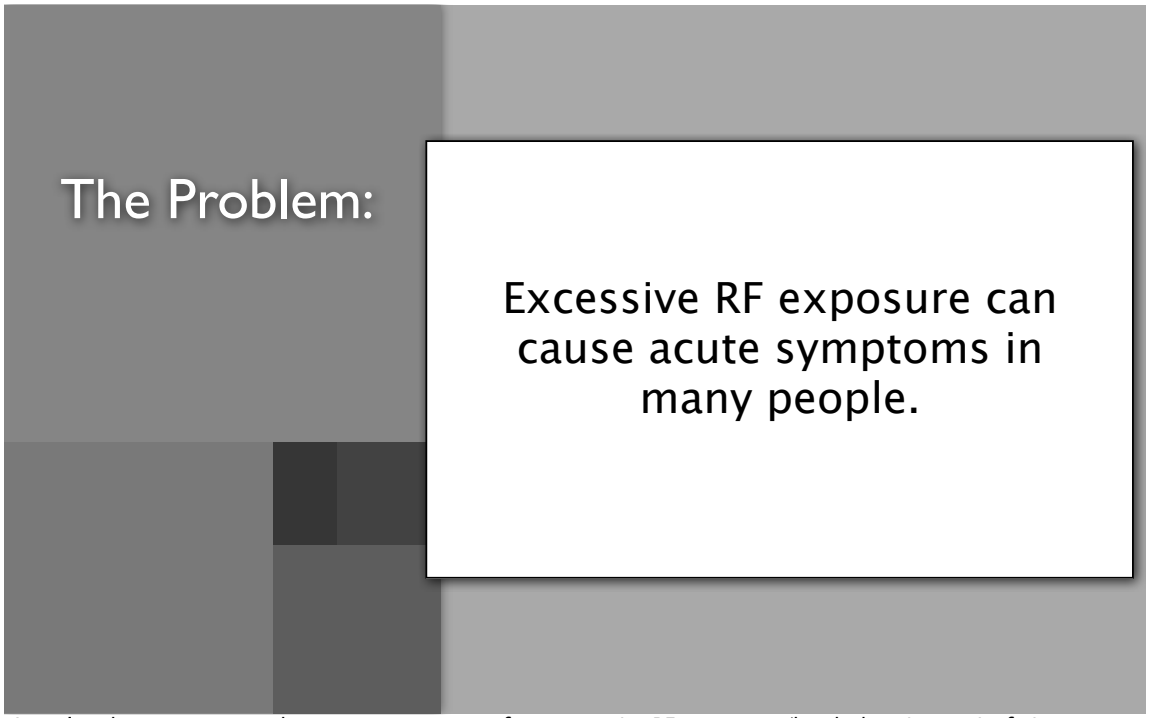
Design the system to truly minimize the amount of RF signal that is being produced.

Most engineering choices in AMI have not been designed with these goals in mind.

The industry has devoted more energy to denying risk than it has to designing systems that are "smart" enough to minimize that risk.

But our group thinks that it could be possible to take a prudent approach and still get the job done.

What can EWEB do to actually "work the problem"? Let's summarize the situation:



As we've shown, some people get acute symptoms from excessive RF exposures (headaches, insomnia, fatigue, vertigo, tinnitus, other symptoms of EHS).

People like this exist in Eugene.

How many people might this be in our town?

Based on existing research, a conservative guess might be 3 to 5% of the population.

3% of 150,000 people is 4,500 people.

The Problem:

Excessive RF exposure can also cause severe chronic problems.

Chronic RF exposure increases oxidative stress in living systems.

Increased cancer and male infertility are only two of many problems potentially caused by chronic elevation of oxidative stress.

Allowing an "opt out" is not a practical solution.

Customers should certainly have the option of "opting out" of having a meter on their house.

But we do not feel that an "opt out" policy is a solution to the public health problem.

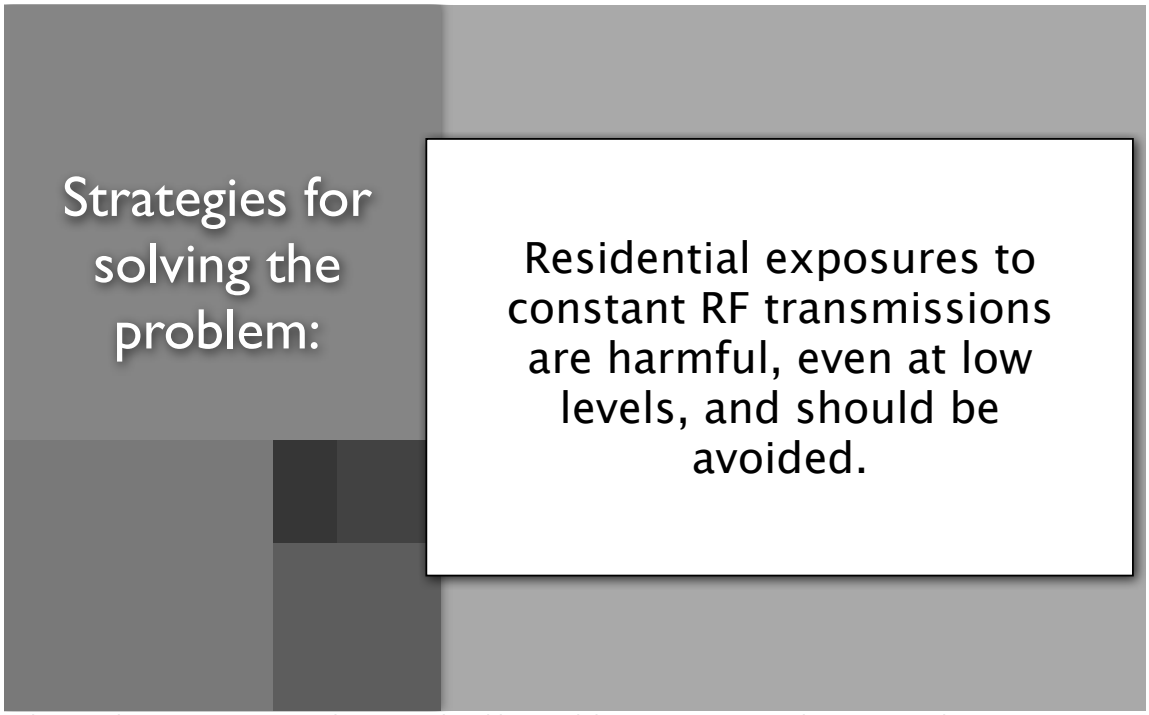
You can't "opt out" of all the meters on the wall of your rental apartment complex. Or the ones on the wall of the complex right across the alley from your apartment.

You can't "opt out" of exposure to your neighbor's meter, that is ten feet away from your bedroom window.

You can't "opt out" of exposure to the meter on the other side of your bedroom wall if you are a baby in a crib.

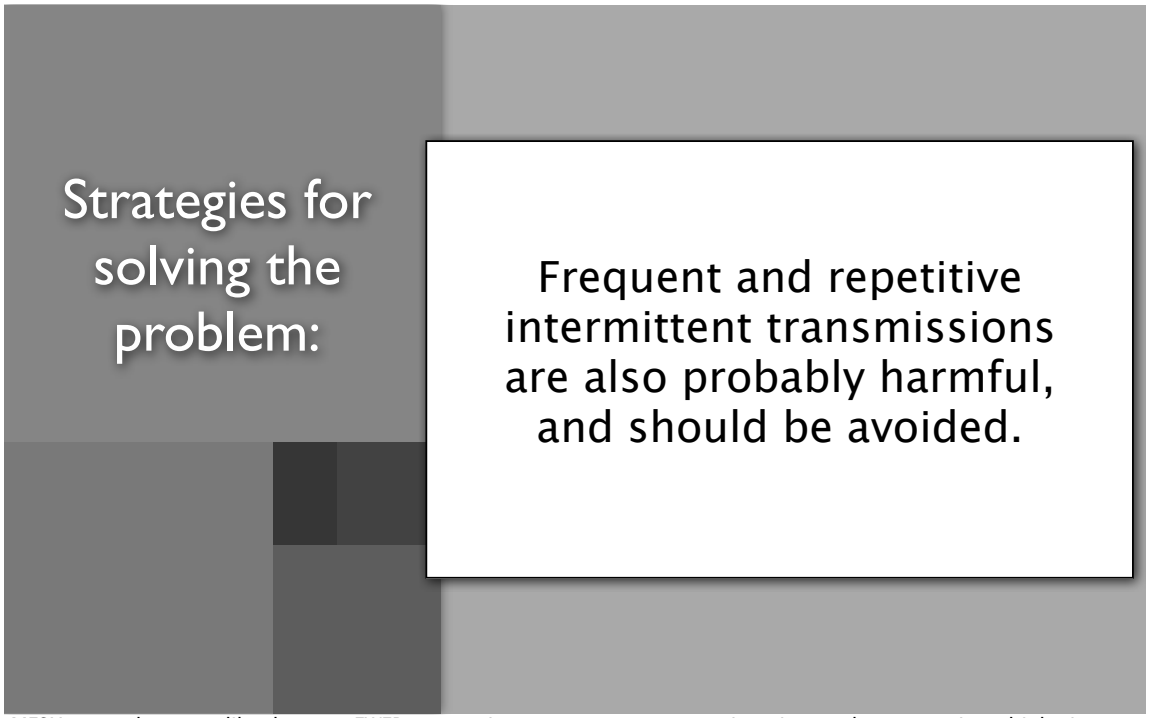
You can't "opt out" of exposure to transmissions from the radio tower 100 meters from your house.

An "opt out" doesn't protect people who DON'T opt out, if a health hazard is being produced.



A better solution is to recognize the potential problem, and design a system to truly minimize risk, by reducing transmissions to a functional minimum.

Constant transmissions can and should be avoided.



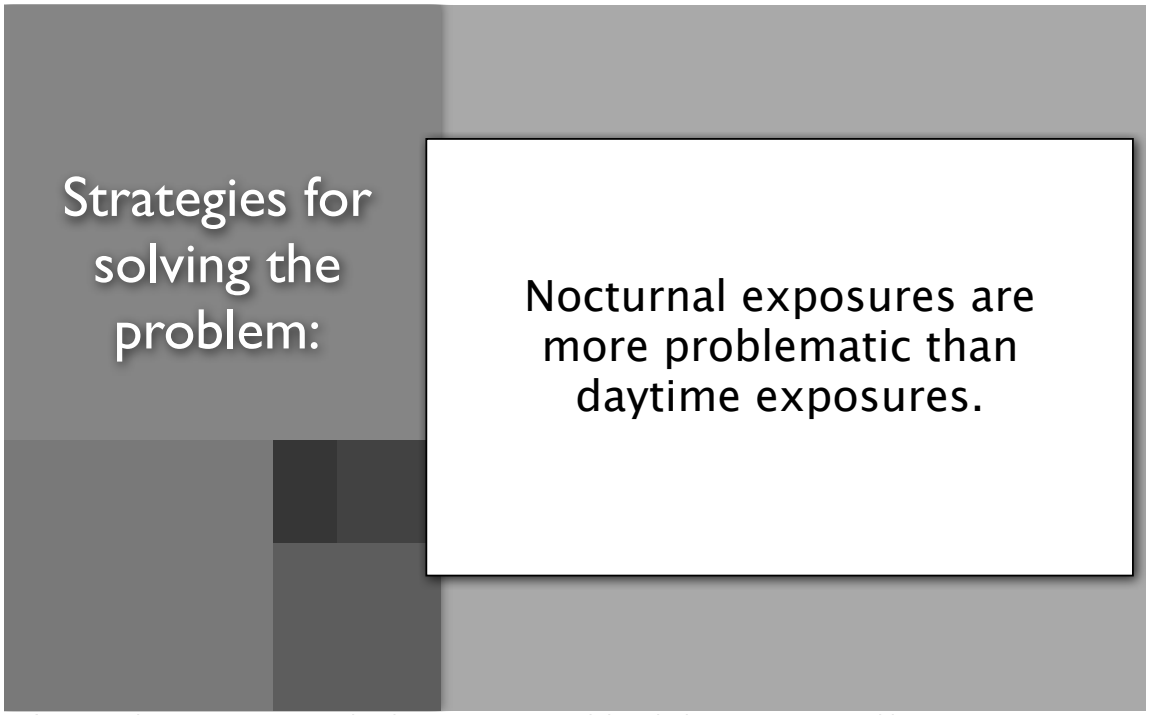
MESH network meters like the ones EWEB was testing a year ago are a case in point, as they transmit multiple times a minute. **EWEB staff should be applauded for steering away from that technology.**

Our group thinks that the MESH technology in the in-home "Zigbee" network is also likely to be harmful to the public. It is lower powered, but contemporary research shows that chronic low power RF exposures can have serious consequences.

It would be a mistake for EWEB to get married to this technology, and invest many millions of dollars in an infrastructure that will become less and less acceptable to the public down the line.

The solution here (for the smaller percentage of your customers who may want to share this functionality in the future) might be to **explore a broadband communication option** that allows them to remotely adjust their thermostat over the internet, rather than via the smart meter network.

80% of the households in our area have broadband at the present time.



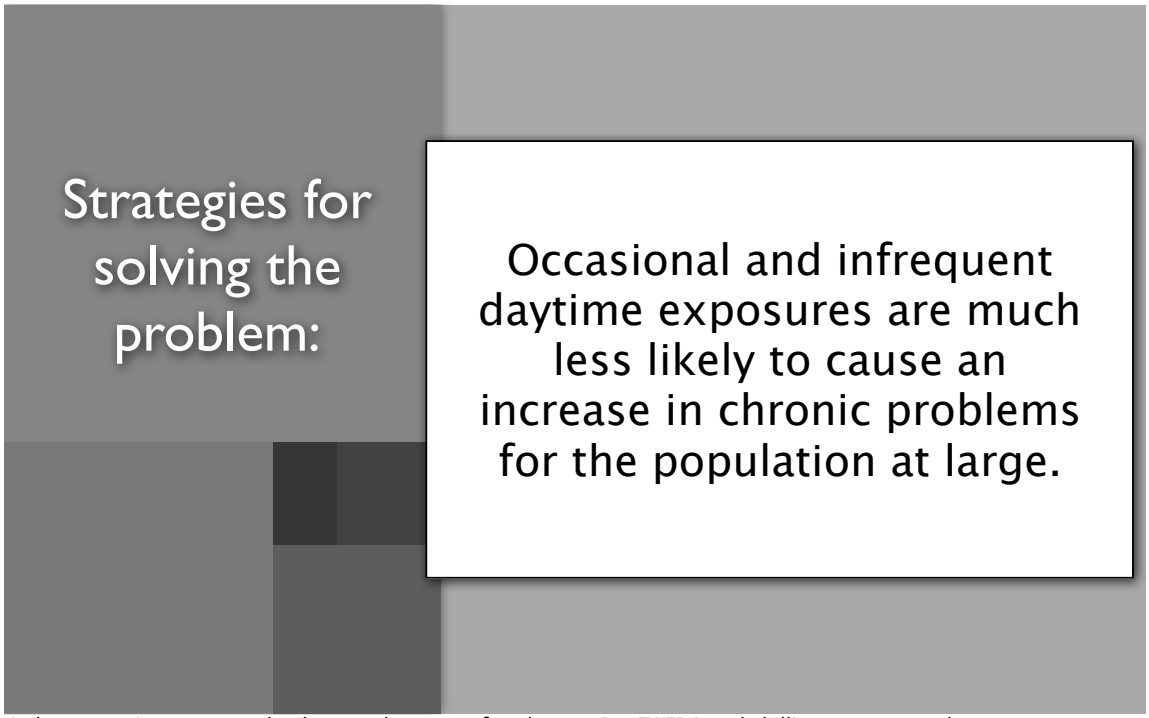
RF's potential to suppress nocturnal melatonin secretion and disturb sleep is a serious problem.

Chronic suppression of melatonin can increase incidence of breast cancer and some other cancers.

The best solution is to avoid nocturnal RF transmissions.

Fortunately, EWEB doesn't need real-time access to billing data. So **it shouldn't be necessary to upload usage data at night.**

A broadband remote control option would eliminate the need for tower -> meter communications at night.



Industry routines are to upload usage data every four hours. But EWEB is only billing once a month.

The solution here is to upload usage data much less frequently.

If you can fit all the Beatles albums plus Bach's Mass in B Minor on an iPod, it should be possible to design a smart meter protocol that only requires an upload once every two weeks, or less frequently.

This is the direction the industry needs to go in.

EWEB should explore this issue with their vendors, and push for this sort of functionality in any system that they purchase.

Strategies for solving the problem:

Occasional and infrequent daytime exposures may still provoke acute symptoms in a portion of the population.

People with EHS will be likely to react acutely to intermittent exposures in their residential neighborhoods, even if these exposures are infrequent.

Part of addressing this problem is to upload data as infrequently as possible.

A data upload by the system once every two weeks might not be a significant release in exposure burden to this part of the population, where a data upload every four hours could be expected to have significant adverse consequences on their quality of life.

Infrequent transmissions at predictable times might be much easier for these people to deal with.

They will certainly want to opt out of having a meter on their house.

Other steps might also be found to mitigate residential exposures for these members of the population, if RF communications are to be used by EWEB.

Finding a "smart" way to move forward:

We're all trying to work towards the benefit of our community and our environment.

The AMI program is an attempt to reduce EWEB's carbon footprint, aid in energy conservation, and enable more effective utilization of renewable energy sources down the line.

These are laudable goals.

The key thing here is to avoid solving one problem with tools that create a new one.

If EWEB is really "smart" about how we use "smart meters", the advisory group thinks that it should be possible to find a way to make it work without harming the community.

This will require a progressive approach that looks at some new ways to approach the engineering problem.