

**Cell phone radiation poses a serious biological  
and health risk:**

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## **Cell phone radiation poses a serious biological and health risk:**

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### **The Issue:**

Thousands of people are using cell phones for hours each day. They are exposing a very sensitive organ, their brain, to higher mean intensities than military personnel are exposed to when repairing radar. The military personnel show significant increases in cancer and a wide range of illnesses. Even at the very low mean levels that people experience living within 10 km of radio and TV towers, significant increases in cancer has been observed.

Analogue cell phones emit an analogue modulated RF/MW signal similar to an FM radio or TV signal. The digital cell phones radiate a pulse RF/MW signal similar to radar. Biological and epidemiological effects from EMR exposure across the spectrum show the same or similar effects.

Many people continue to drive while talking on their cell phones. Attention deficit and neurological effects on the user's brain make accidents much more likely.

Very young children and teenagers are becoming regular to heavy users of cell phones while their brains and bodies are in a much more vulnerable state than elderly people. With cancer and neurodegenerative disease latencies of decades, the possible adverse effects will take some time to become evident. By which time it will be too late for thousands of people.

There is growing concern about cell phone interference with cardiac pacemakers. If cell phone signals can interfere with an electronic pacemaker, then it is likely to also interfere with human hearts that are arrhythmically unstable.

### **Biophysical Principles:**

Radiant energy is absorbed into human bodies according to three main processes. The first is the Aerial Effect where bodies and body parts receive and absorb the RF/MW signal with resonant absorption that is a function of the size of the body parts and the wavelength of the RF/MW signal. For an adult male about 1.8 m tall the optimal absorption frequency is close to 70 MHz, Figure 1. This has a wavelength of 4.3m. The body acts like a half-wave dipole interacting strongly with a half wavelength close to the body size. A monkey interacts with a wavelength of 1m and a half wavelength of 0.5m. This is similar to the absorbency of a human child.

The Aerial effect also relates to body parts such as arms and heads. A typical adult head has a width of 15 cm. This is a half wavelength for a 1 GHz microwave signal, close to that used by most cell phones.

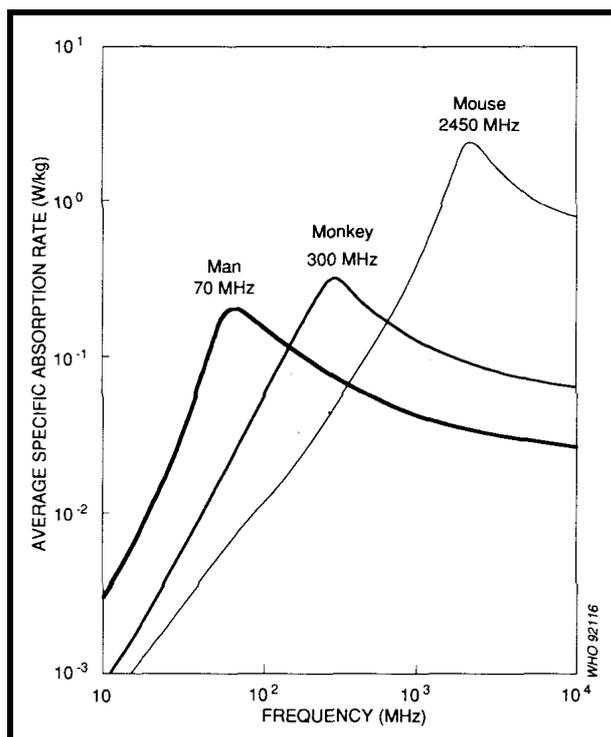


Figure 1: Average SAR for 3 species exposed to  $10 \text{ W/m}^2$  with E vector parallel to the long axis of the body, from Durney et al. (1978).

Cellphone-type radiation is in the 0.9 to 1.8 GHz range, i.e.  $0.9 \times 10^9$  to  $1.8 \times 10^9$  Hz. Hence according to Figure 1 neither children nor adults are close to the optimum absorption rate but babies and infants bodies, whose dimensions lie between "monkey" and "mouse", are close to the optimal absorption for cell phone-type radiation.

A person with a height  $h$  (m), acting as an aerial in an RF electric field  $E$  (V/m) at a carrier frequency  $f$  (MHz), has a current induced in them which flows to earth through their feet, given by, Gandhi et al. (1985):

$$I_h = 0.108 h^2 E f \text{ (mA)}$$

This induced current flows mainly through high water content organs. In flowing to ground the current passes through the ankles. These consist mainly of low conductivity bones and tendons and have an effective cross-sectional area of  $9.5 \text{ cm}^2$  for an adult, despite the actual physical area is of the order of  $40 \text{ cm}^2$ . The formula for  $I_h$  also allows for the effective absorption area of the person, which is somewhat greater than their actual cross-sectional area, because of the attraction of the surrounding field to an earthed conductor. These aerial considerations are more pertinent to whole-body exposures to cell sites.

Cell phone aeriels from digital phones typically occupy the length of the body of the phone and extend a few centimeters out of the top of the phone body. Cellphone radiation for the phone's aerial is quite close to the user's head and can be intense enough to cause a warming sensation.

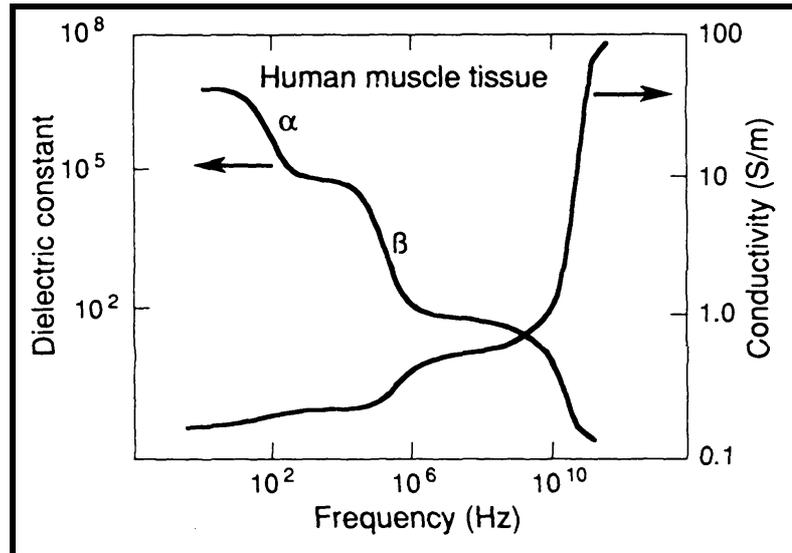


Figure 2: The dielectric constant and conductivity of typical biological tissue as a function of frequency, Schwan (1985).

The second mechanism involves the coupling of the signal to the tissue as the signal penetrates the tissue and interacts with the cells and layers of tissue. This process is related to the dielectric constant and conductivity of the tissue types, which vary significantly with the carrier frequency, Figure 2.

The third biophysical absorption process involves resonant absorption by biological systems in the brain and cells. Resonant absorption occurs when a system with a natural frequency is stimulated by an imposed signal of a similar frequency or harmonic frequency. Radio and TV receivers use both the aerial principle and the resonant absorption principle. The aerial resonantly absorbs the carrier frequency and carries it as an induced current to the receiver. Here a tuned circuit oscillating at the same frequency resonantly absorbs the carrier wave and uses decoding circuitry to extract the encoded message contained in the amplitude, frequency or digital modulation imprinted on the carrier wave.

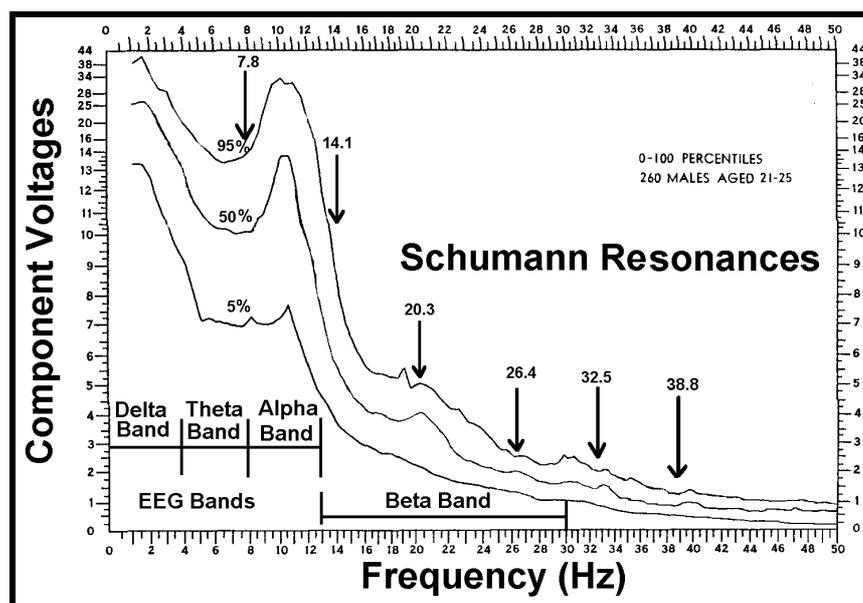


Figure 3: Comparison of the frequency spectra of the human EEG from 260 young males showing the 5%, 50% and 95%ile bands, adapted from Gibbs and Gibbs (1951), and Schumann Resonance peaks, from Polk (1982).

Figures 4 and 5 confirm the relationship shown in Figure 3, using independently derived spectra of the daytime human EEG, Figure 4 and the Schumann Resonance spectrum, Figure 5. The figures have been aligned to have a common horizontal frequency scale.

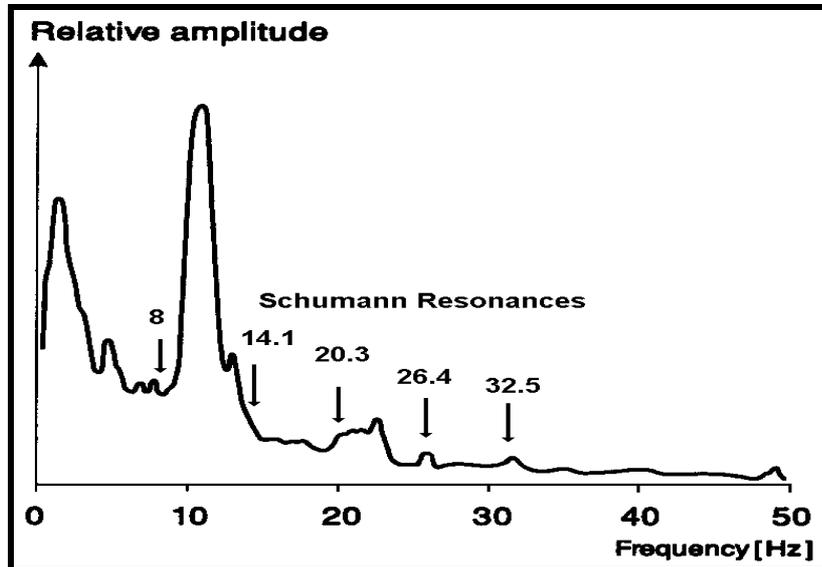


Figure 4: A typical EEG spectrum, with the Schumann Resonance peaks superimposed.

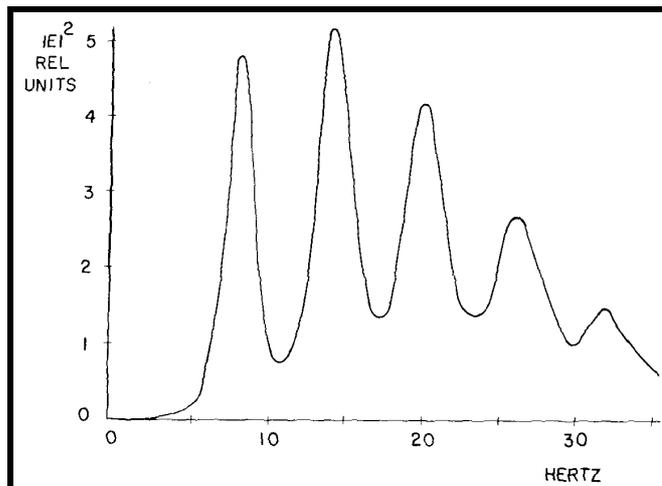


Figure 5: Daytime Schumann Resonance Spectrum, Polk (1982).

Figures 3-5 show that the frequency range of the primary peaks of the Schumann Resonances coincide with the frequency range of the human EEG. Upper Schumann peaks also associated with small peaks in the EEG. This shows a resonant interaction and supports the probability of an actual use by the brain or the Schumann Resonance signal. Figure 6 shows that this occurs in a study showing a significant dose-response correlation between the intensity of the 8-10 Hz Schumann Peak and human reaction times.

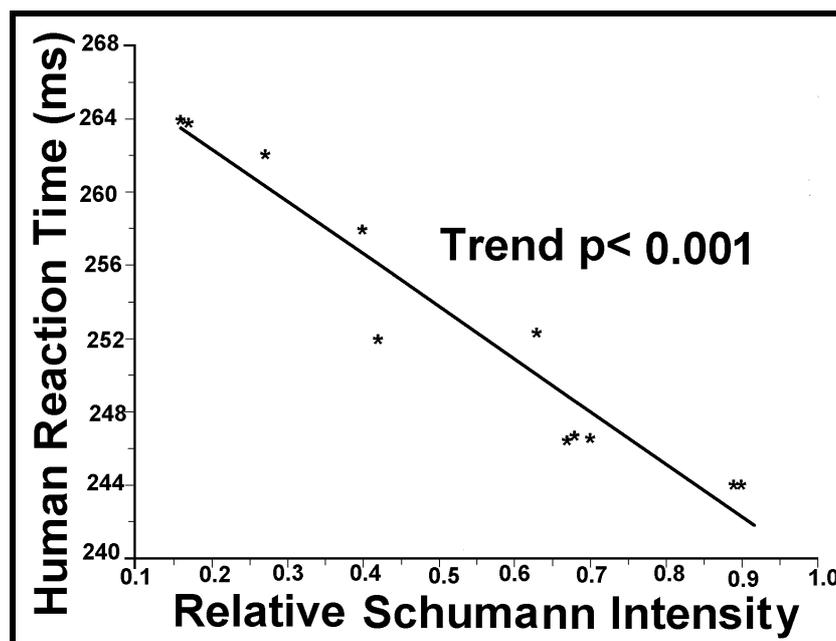


Figure 6: Human reaction times as a function of Schumann Resonance 8-10 Hz Relative Intensity, for 49,500 subjects tested during 18 days in September 1953, at the German Traffic exhibition in Munich. Derived from data in Figure 3 of König (1974b). Trend:  $t = 10.414$ , 2-tailed  $p < 0.001$ .

Cellphone radiation is shown to interact with human EEG patterns and to alter them and to change reaction times. The GSM signal has a pulse frequency of 217 Hz and a modulation at 8.34 Hz. This is in the Schumann Resonance and EEG spectral primary frequency range.

**Effects shown for electromagnetic radiation, especially radio and radar signals, but also electrical occupations:**

Such signals have been shown to:

**Neurological Activity:**

- Alter brain activity, including EEG and reaction times, memory loss, headaches, fatigue and concentration problems, dizziness (the Microwave Syndrome), Gordon (1966), Deroche (1971), Moscovici et al. (1974), Lilienfeld et al. (1978), Shandala et al. (1979), Forman et al. (1982), Frey (1998).
- Impair sleep and learning, Altpeter et al. (1995), Kolodynski and Kolodynska (1996)
- Increase permeability of the blood brain barrier (a mechanism for headache), Frey et al. (1975), Alberts (1977, 1978) and Oscar and Hawkins (1977).
- Alter GABA, Kolomytkin et al. (1994).
- Increase neurodegenerative disease including Alzheimer's Disease, Sobel et al. (1995, 1996), Savitz et al. (1998a,b)

- Highly significant Increased permeability of the blood brain barrier for 915 MHz radiation at SAR =0.016-0.1 (p=0.015) and SAR = 0.1-0.4 (p=0.002); Salford et al. (1994).
- Increase the Suicide Risk, Baris and Armstrong (1990), Perry et al. (1991), Van Wijngaarden et al. (2000).

#### **Cardiological Activity:**

- Alter blood pressure and heart rhythm (heart rate variability) Bortkiewicz et al. (1995, 1996, 1997) and Szmigielski et al. (1998).
- Increases Heart Disease and heart attack mortality, Forman et al. (1986), Hamburger, Logue and Silverman (1983), Savitz et al. (1999)

#### **Immune System Activity:**

- Impairs the immune system Quan et al. (1992), Dmoch and Moszczynski (1998), Bruvere et al. (1998)

#### **Reproductive Activity:**

- Reduces sperm counts in radar exposed military personnel, Weyandt et al. (1996)
- Increases miscarriage and congenital abnormalities, Kallen et al. (1982), Larsen et al. (1991), Ouellet-Hellstrom and Stewart (1993).
- Doubles the incidence of twins in the families of radar exposed personnel, Flaherty (1994).
- Significantly alters the leaf structure of plants exposed to a radar, Magone (1996).
- Significantly reduces the radial growth of pine trees, Balodis et al. (1996).
- Reduced fertility of mice exposed to an RF field (27.12 MHz), Brown-Woodman et al. (1989).
- Increased fetal/embryo lethality in mice exposed to 2.45 GHz microwaves, Nawrot, McRee and Galvin (1985).
- Radio exposures completely cause complete infertility in mice over 3 to 5 generations at mean exposure levels of 1.05 and 0.17 $\mu$ W/cm<sup>2</sup>, respectively, Magras and Xenos (1997).

#### **Genotoxic Activity:**

- Reduce melatonin and alter calcium ions, Abelin (1999), Burch et al. (1997, 1999) Bawin and Adey (1976), Blackman et al. (1988, 1989, 1990).

- Enhances heat shock proteins at extremely low exposure levels in a highly reproducible manner showing that they are not stimulated by heat but in reaction to a 'toxic' protein reaction, Daniells et al. (1998), and down to 0.001W/kg (0.34 $\mu$ W/cm<sup>2</sup>) using 750MHz microwaves, de Pomerai (2000).
- Damages chromosomes. Heller and Teixeira-Pinto (1959), Tonascia and Tonascia (1966), Yao (1982), Garaj-Vrhovac et al. (1990, 1991, 1992, 1993, 1999), Timchenko and Ianchevskaia (1995), Balode (1996), Haider et al. (1994) and Vijayalaxmi et al. (1997) have reported significant chromosome aberrations from RF/MW exposures. In the Mar/Apr 1999 edition of Microwave News it is reported that Drs Tice, Hook and McRee
- Alters DNA, Ali and Behari (1994).
- Breaks DNA strands, Lai and Singh (1995, 1996, 1997).
- Alters gene transcription activity, Phillips et al. (1992, 1993).
- Neoplastically transform cells, Balcer-Kubiczek and Harrison (1991).
- Enhances cell death in a dose response manner for signal intensity and exposure time, Garaj-Vrhovac et al. (1991).
- Enhances cell proliferation in a dose-response manner for exposure time, Mattei et al. (1999).
- Enhances Ornithine Decarboxylase (ODC) activity, a measure of cell proliferation rate, Byus et al. (1988), Litovitz et al. (1997).
- Enhances free radicals, Phelan et al. (1992).
- Increased cancer in rats and mice, Prausnitz and Suskind (1962), Szmigielski et al. (1988) and Chou et al. (1992)

### **Cancer Epidemiology:**

- Increase the incidence of many types of cancer, including leukaemia, brain tumor, testicular cancer, genitourinary and breast cancer, Robinette et al. (1980), Milham (1985, 1988), Szmigielski (1996), Hocking et al. (1996), Dolk et al. (1997 a, b), Beall et al. (1996), Grayson (1996), Thomas et al. (1987), Lilienfeld et al. (1978), Zaret (1989), Davis and Mostofl (1993), Hayes et al. (1990), Tynes et al. (1996), Cantor et al. (1995), and many others.

These biological and health effects are consistent with the biological understanding that brains, hearts and cells are sensitive to electromagnetic signals because they use electromagnetic signals for their regulation, control and natural processes, including those processes monitored by the EEG and ECG. There is overwhelming evidence that EMR is genotoxic, alters cellular ions, neurotransmitters and neurohormones, and interferes with brain and heart signals, and increases cancer.

## **Cell Phone Radiation Research:**

For years the cell phone companies and government authorities have assured us that cell phone are perfectly safe. For example, they claim that the particular set of radiation parameter associated with cell phones are not the same as any other radio signal and therefore earlier research does not apply. They also mount biased review teams who falsely dismiss any results that indicate adverse biological and health effects and the flawed pre-assumption that the only possible effect is tissue heating. There is a very large body of scientific research that challenges this view. Now we have published research, primarily funded by governments and industry that shows that cell phone radiation causes the following effects:

### **Neurological Activity:**

- Alters brain activity including EEG, Von Klitzing (1995), Mann and Roschkle (1996), Krause et al. (2000).
- Disturbs sleep, Mann and Roschkle (1996), Bordely et al. (1999).
- Alters sleep EEG after awake exposure, Huber et al. (2000).
- Alters human reaction times, Preece et al. (1999), Induced potentials, Eulitz et al. (1998), slow brain potentials, Freude et al. (1998), Response and speed of switching attention (need for car driving) significantly worse, Hladky et al. (1999). Altered reaction times and working memory function (positive), Koivisto et al. (2000), Krause et al. (2000).
- Brain cortex interaction as shown by significantly altered human EEG by cellphone radiation, during a 15 minute exposure, Lebedeva et al. (2000).
- Weakens the blood brain barrier ( $p < 0.0001$ ): Persson, B.R.R., Salford, L.G. and Brun, A., 1997.
- A Fifteen minute exposure, increased auditory brainstem response and hearing deficiency in 2 kHz to 10 kHz range, Kellenyi et al. (1999).
- While driving, with 50 minutes per month with a cell phone, a highly significant 5.6-fold increase in accident risk, Violanti et al. (1996); a 2-fold increase in fatal accidents with cell phone in car, Violanti et al. (1998); impairs cognitive load and detection thresholds, Lambie et al. (1999). In a large Canadian study Redelmeier and Tibshirani (1997) the risk of collision when using a cellphone was 4 time higher, RR = 4.3, 95%CI 3.0-6.5. Calls close to the time of collision has RR =4.8 for 5 minutes and RR = 5.9,  $p < 0.001$ , for 15 minutes.
- Significant changes in local temperature, and in physiologic parameters of the CNS and cardiovascular system, Khdnisskii, Moshkarev and Fomenko (1999).
- Causes memory loss, concentration difficulties, fatigue, and headache, in a dose response manner, (Mild et al. (1998)). Headache, discomfort, nausea, Hocking (1998).

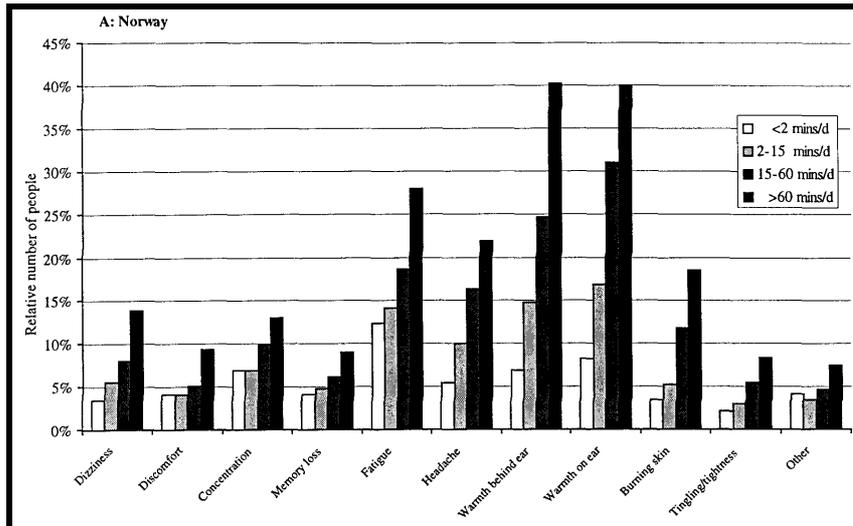


Figure 7: Prevalence of symptoms for Norwegian mobile phone users, mainly analogue, with various categories of length of calling time per day, Mild et al. (1998).

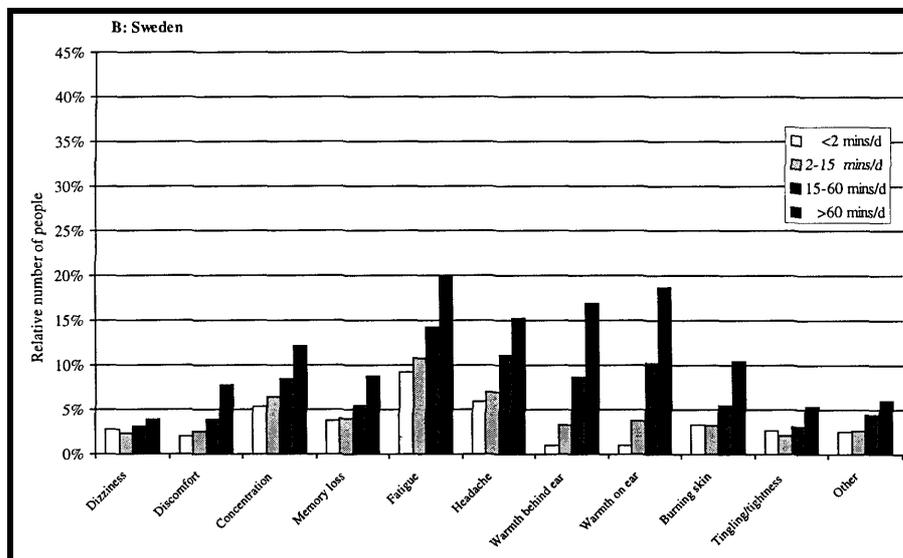


Figure 8: Prevalence of symptoms for Swedish mobile phone users, mainly digital, with various categories of length of calling time per day, Mild et al. (1998).

These are the same symptoms that have frequently been reported as "Microwave Sickness Syndrome" or "Radiofrequency Sickness Syndrome", Baranski and Czerski (1976) and Johnson-Liakouris (1998).

### Cardiac Activity:

- Cardiac pacemaker interference: skipped three beats, Barbaro et al. (1996); showed interference, Hofgartner et al. (1996); significant interference,  $p < 0.05$  Chen et al. (1996); extremely highly significant interference,  $p = 0.0003$ , Naegeli et al. (1996);  $p < 0.0001$ , Altamura et al. (1997); reversible interference, Schlegal et al. (1998); significantly induced electronic noise, Occhetta et al. (1999); various disturbances observed and warnings recommended, Trigano et al. (1999)
- Significantly increases blood pressure, Braune et al. (1998).

### Hormone Activity:

- Reduces the pituitary production of Thyrotropin (Thyroid Stimulating Hormone, TSH):

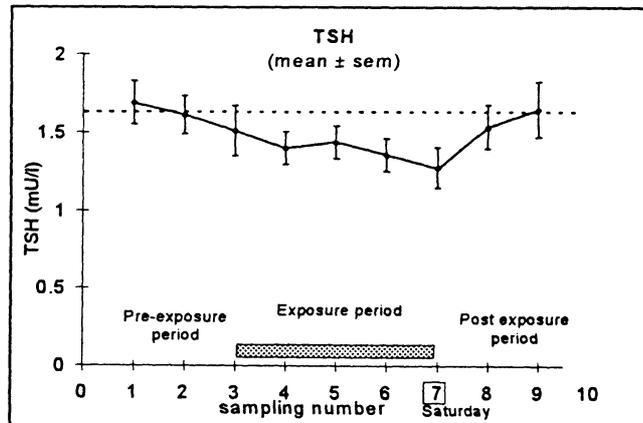


Figure 9: A significant reduction in Thyrotropin (Thyroid Stimulating Hormone) during cell phone use, de Seze et al. (1998).

- Reduces melatonin significantly, Burch et al. (1997, 1998). A GSM cellphone reduces melatonin, but not significantly in a very small sample (N=18) of subjects, de Seze et al. (1999).
- A reported but yet to be published Australian Study, EMRAA News, June 2000, used a Clot Retention Test on blood samples to detect hormonal changes. A group of 30 volunteers used a Nokia 6150 cellphone for 10 minutes on each of two consecutive days. The CRT test showed significant changes in the thyroid, pancreas, ovaries, testes and hormonal balance.

### Reproductive Activity:

- Decreases in sperm counts and smaller tube development in rat testes, Dasdag et al. (1999).
- Increases embryonic mortality of chickens, Youbicier-Simo, Lebecq and Bastide (1998).

### Genotoxic Activity:

- Breaks DNA strands, Verschaeve et al. (1994), Maes et al. (1997), which is still extremely significant  $p < 0.0001$ , at  $0.0024 \text{ W/kg}$  ( $1.2 \mu\text{W/cm}^2$ ), Phillips et al. (1998).
- Produces an up to three-fold increase in chromosome aberrations in a dose response manner from all cell phones tested, Tice, Hook and McRee, reported in Microwave News, March/April 1999. The findings were the same when the experiment was repeated and Dr Tice is quoted as stating: "There's no way you're going to get positive results twice over four different technologies as a chance result."
- Doubles c-fos gene activity (a proto oncogene) for analogue phones and increases it by 41 % for digital phones, Goswami et al. (1999), altered c-jun gene, Ivaschuk et al. (1997), Increased hsp70 messenger RNA, Fritz et al. (1997).

- Increases Tumour Necrosis Factor (TNF), Fesenko et al. (1999).
- Increases ODC activity, Penafiel et al. (1997).
- DNA synthesis and cell proliferation increased after 4 days of 20 min for 3 times/day exposure. Calcium ions were significantly altered, French, Donnellan and McKenzie (1997). Decreased cell proliferation, Kwee and Raskmark (1997), Velizarov, Raskmark and Kwee (1999)
- Doubles the cancer in mice, Repacholi et al. (1997).
- Increases the mortality of mobile phone users compared with portable phone users, RR = 1.38, 95%CI: 1.07-1.79, p=0.013, Rothman et al. (1996).
- Increases human brain tumor rate by 2.5 times (Hardell et al. (1999)). Associated with an angiosarcoma (case study), Hardell (1999)
- Hardell et al. (2000), for analogue phones OR = 2.62, 95%CI: 1.02-6.71, with higher tumour rates at points of highest exposure.
- Significantly increases the incidence of eye cancer (Uveal Melanoma), by between OR = 4.2, 95%CI: 1.2-14.5, and OR = 10.1, 95%CI: 1.1-484.4, Stang et al. (2001).
- United States, Motorola Study Morgan et al. (2000)

High Exposure	RR = 1.07	(0.32-2.66)	n = 3
Moderate Exposure	RR = 1.18	(0.36-2.92)	n = 3
High/Mod vs Low	RR = 1.13	(0.49-2.31)	n = 6

This project underestimated cancer rates by using a high cancer reference group.

- Carlo and Schram (2001) report that in the industry funded WTR (Wireless Technology Research) programme Dr Joseph Roti Roti confirmed the Tice, Hook and McRee research showing that cellphone radiation significantly damaged DNA through observed micronuclei formation.
- Muscat et al. (2000) report elevated brain cancer in cellphone users in the United States, with cerebral tumors occurring more frequently on the side of the head where the mobile phone had been used, (26 vs 15 cases, p=0.06) and for a rare brain cancer, neuroepitheliomatous, OR = 2.1, 95%CI: 0.9-4.7. Mean use of cell phones was 2.5 years for cases and 2.2 years for controls, showing that a small increase in cellphone use (0.3 years) produces a large increase in brain cancer risk.
- Cell phone users in Denmark Johansen et al. (2001)

Duration of digital subscription		<1 yr	1-2yrs	≥3 yrs
Relative to reference group	SIR	0.7	0.9	1.2
Relative to <1 yr group	RR	1.0	1.29	1.71

Other cancers are set out in "Table 2" below. Over 67 % of phone users had used their phones for 2 years or less. The reference group had a higher than average cancer rate than the age range of cell phone users, underestimating the cancer rates. This is shown by Standard Incidence Ratios (SIR) of some groups being as little as 0.6. For example SIR for users for <1 year is 0.7.

**Table 2. Standardized incidence ratios (SIRs) and 95% confidence intervals (CIs) for cancer among 420 095 cellular phone subscribers\* in Denmark, 1982-1996†**

Site of cancer (ICD-7)‡	Men				Women			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
All cancers (140-205)	2876	3327.6	0.86	0.83 to 0.90	515	497.6	1.03	0.95 to 1.13
Brain, nervous system (193)	135	142.8	0.95	0.79 to 1.12	19	18.5	1.03	0.62 to 1.61
Salivary glands (142)	7	9.0	0.78	0.31 to 1.60	0	0.7	---	---
Leukemia (204)	77	79.6	0.97	0.76 to 1.21	7	6.6	1.07	0.43 to 2.20
Other cancers								
Pharynx (145-148)	32	51.5	0.62	0.42 to 0.88	4	1.7	2.43	0.65 to 6.22
Esophagus (150)	42	57.1	0.74	0.53 to 0.99	3	2.0	1.53	0.31 to 4.46
Stomach (151)	63	81.2	0.78	0.60 to 0.99	2	4.5	0.45	0.05 to 1.61
Colon (153)	190	199.4	0.95	0.82 to 1.10	22	22.7	0.97	0.61 to 1.47
Rectum (154)	133	133.1	1.00	0.84 to 1.18	12	10.6	1.13	0.58 to 1.98
Liver (155)	18	29.8	0.60	0.36 to 0.96	2	2.0	1.00	0.11 to 3.61
Pancreas (157)	57	69.1	0.82	0.62 to 1.07	5	6.9	0.73	0.23 to 1.70
Larynx (161)	53	65.3	0.81	0.61 to 1.06	2	1.6	1.24	0.14 to 4.48
Lung (162)	301	460.7	0.65	0.58 to 0.73	34	39.1	0.87	0.60 to 1.22
Breast (170)	5	5.0	0.99	0.32 to 2.32	152	141.3	1.08	0.91 to 1.26
Cervix uteri (171)	---	---	---	---	37	27.5	1.34	0.95 to 1.85
Corpus uteri (172)	---	---	---	---	18	17.6	1.02	0.60 to 1.61
Ovary (175)	---	---	---	---	24	22.0	1.09	0.70 to 1.62
Prostate (177)	159	175.6	0.91	0.77 to 1.06	---	---	---	---
Testis (178)	187	166.6	1.12	0.97 to 1.30	---	---	---	---
Kidney (180)	104	101.3	1.03	0.84 to 1.24	7	6.7	1.04	0.42 to 2.15
Bladder (181)	233	239.3	0.97	0.85 to 1.11	12	9.0	1.34	0.69 to 2.33
Melanoma (190)	123	142.7	0.86	0.72 to 1.03	21	26.3	0.80	0.49 to 1.22
Other skin (191)	567	614.8	0.92	0.85 to 1.00	79	79.1	1.00	0.79 to 1.24
Eye (192)	8	12.4	0.65	0.28 to 1.27	0	1.1	---	---
Thyroid (194)	13	12.9	1.01	0.54 to 1.72	4	4.4	0.92	0.25 to 2.35
Non-Hodgkin's lymphoma (200, 202)	109	116.7	0.93	0.77 to 1.13	11	10.6	1.04	0.52 to 1.86
Hodgkin's lymphoma (201)	27	30.6	0.88	0.58 to 1.29	3	2.6	1.18	0.24 to 3.43
Other and unspecified cancers	233	331.1	0.70	0.62 to 0.80	35	32.7	1.07	0.75 to 1.53

\*Ever use of a cellular telephone (NMT 450, NMT 900, or GSM).  
†Obs = observed; Exp = expected.  
‡ICD-7 = International Classification of Diseases, 7th revision. NMT = Nordic Mobile Telephone System; GSM = General System for Global Telecommunications.

Table two shows that even with little cellphone use, and even with the use of a high cancer reference group, there are several elevated cancers approaching significance: Testicular cancer SIR = 1.12, 95%CI: 0.97-1.30, Cervical cancer, SIR = 1.34, 95%CI: 0.95-1.85, Female Pharynx cancer, SIR 2.43, 95%CI: 0.65-6.22, Esophagus cancer, SIR = 1.53, 95%CI: 0.31-4.46 and female breast cancer, SIR = 1.08, 95%CI: 0.91-1.26.

## Conclusions:

To date over 50 studies have shown adverse biological or human health effects specifically from cell phone radiation. These research results to date clearly show that cell phones and cell phone radiation are a strong risk factor for all of the adverse health effects identified for EMR because they share the same biological mechanisms. The greatest risk is to cell phone users because of the high exposure to their heads and the great sensitivity

of brain tissue and brain processes. DNA damage accelerates cell death in the brain, advancing neurodegenerative diseases and brain cancer. Brain tumour is already an identified risk factor. Cell phones are carried on people's belts and in breast pockets. Hence liver cancer, breast cancer and testicular cancer became probable risk factors.

Altered attention and cognition, as well as the diversion of talking on a phone while driving is a significant risk factor for accidents and fatal accidents.

Some cardiac pacemakers are susceptible to active cell phone signals, recommending keeping cell phones away from hearts and pacemakers.

Because the biological mechanisms are shown and EMR has been observed to significantly increase the following effects, there is extremely strong evidence to conclude that cell phones are a risk factor for breast, liver, testicular and brain cancer. It is also probable that we will observe a very wide range of other effects including cardiac, neurological and reproductive illness and death. Since cell phone radiation cause many cell damages including DNA and chromosome damage, all of these effects will also be caused by cell sites.

Dose-response studies of neurological, cardiac, reproductive and cancer effects in human populations all point to a near zero exposure level of no effect, Cherry (2000). Since cellphone radiation mimics RF/MW radiation effects which mimics ELF biological and health, the adverse effects occur across the spectrum and includes cellphone radiation, with a safe exposure level of zero.

Hence a risk reduction and public health protection based on keeping exposure below a level that doubles the risk, identifies  $0.1 \mu\text{W}/\text{cm}^2$  as the maximum acceptable exposure. This should allow a mean life-time exposure to be less than  $0.01\mu\text{W}/\text{cm}^2$  which is necessary to reduce the risk of neurological effects. The lower level is necessary because of the exquisite sensitivity of the brain.

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