

**Independent academic review of
biological and epidemiological effects of
cellphone radiation**

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22nd September 2002

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Abstract:

The widespread and massively growing rate of usage of mobile phones around the world is leading to having over a billion people using their phones most days. Initially we had bag phones and car phones. Over 10 years ago we moved to portable handsets which originally were analogue phones and now most of the phones are digital. With the phone held against the ear the exposure of the head to modulated or digitally pulsed microwaves from the antenna, is very high. The head is a very sensitive bioelectromagnetic organ. Resonance, absorption and electrical interference are classical biophysics mechanisms. Cherry (2002) shows that natural electromagnetic radiation, the Schumann Resonance signal, when it is modulated by Solar Activity, is associated with modulation of human health effects, including cancer, cardiac, reproductive and neurological diseases and mortality, through the melatonin mechanism. The study also shows that similar elevated health effects are found in occupational studies of electrical workers and physiotherapists exposed to short wave and microwaves. Since the cellphone radiation from within 500m from a cell site, exposes the people's bodies to about a thousand to a million times higher, and the cellphone user's heads to about a billion times higher exposure than the mean Schumann resonance signal, it is scientifically plausible that the same effects will be found from exposure to cellphone radiation. This review confirms that scientific studies show all these effects are associated with exposure to cellphone radiation. It is therefore scientifically plausible that these health effects will be found in populations living within the vicinity of cellphone sites and from using cellphones.

Introduction:

The brain is a very sensitive electromagnetic organ. It has been shown that the brain resonantly detects and reacts to an extremely small, natural, globally available electromagnetic signal, the Schumann Resonance signal, Cherry (2002). When Solar and Geomagnetic Activity varies it alters the Solar Wind, the earth's magnetic field and ionosphere, the intensity of the Schumann Resonance (SR) signal, which changes the melatonin output of the pineal gland in human populations. This is shown to result in a homeostatic mechanism to modulate the rates of a wide range of human health effects including cancer, cardiac, reproductive and neurological diseases and mortality. Cherry (2002) reviewed published occupational epidemiological studies and found that electrical and electronic occupational workers are shown to have elevated and dose-response elevated rates of all these effects. It also found that physiotherapists exposed to shortwaves and microwaves showed dose-response increases in heart disease and miscarriage. These results are highly plausible because both of these groups are regularly exposed to electromagnetic fields over 100,000 times stronger than the mean SR signal's strength, 0.1pW/cm^2 , and $1\text{-}3\text{pT}$.

Dose-response relationships are strongly indicative of a causal link, Hill (1965). Cherry (2002, 2003) show that the Schumann Resonance signal intensity is very strongly correlated with Sunspot Number and Geomagnetic Activity (GMA) indices and therefore Cherry (2002) concludes that the SR signal is the biophysical mechanism that connects Solar/GMA with human health effects, through the melatonin mechanism. The Schumann Resonance signal is an extremely low frequency modulated globally radiating signal whose frequency range matches the frequency range of the electromagnetic rhythms of the human brain.

Biophysics shows that Radiofrequency and Microwave (RF/MW) radiation is much more biologically active than ELF fields, Johnson and Guy (1972), Adey (1988) and Schwan and Foster (1980) and Gandhi (1990). Therefore it is plausible that living in the vicinity of a cell site or with the regular use of a cell phone that the same and similar effects will be also experienced. This who will present a summary of the effects found from radiofrequency and microwave exposures and then we'll review to study is published at specifically involve cellphone radiation to determine the plausible scientifically justified statement about is confirmed or rejected.

The Issue:

This is a very serious issue because the world now has over a billion regular mobile phones users. Every day around the world cell phones are used by many hundreds of millions of people. Most mobile phones are usually held against the head of the user. Mobile phone usage requires the development of an extensive cell site network around most of the developed countries to allow the widespread use of the mobile phones and enhancing widespread exposure to apparently low-level intensity signals. But they are about a million times higher than the SR signal intensity.

It is logical, with the very high exposure of the cellphone user's head, that neurological effects will occur early in some users from acute and repeated exposures. On the other hand, Cancer, Cardiac, Reproductive and Neurological disease and mortality rates (CCRN), being chronic effects, are likely to take decades to be detectable in cellphone users by their rates being higher than the background rates. However, the ubiquitous nature of the technology and cellphone signals from cell sites will make this quite difficult because of its progressive elevation of the background rates. Suicide and miscarriage could well be good bioindicators of the impact of cellphone radiation and indicators of many other health effects because of their relationship to melatonin reduction and genotoxic activity.

Previous RF/MW reviews:

Previous critical reviews of RF/MW effects, for example ICNIRP (1998) and Elwood (1999) conclude that the evidence of carcinogenicity is weak and inconsistent. However both of these reviews ignore the very large body of published studies showing RF/MW induced chromosome aberrations, micronuclei formation and DNA-strand breakage, showing strong evidence of RF/MW induced DNA damage. They also fail to appreciate the whole body far field exposures experienced in most occupational and all residential situations. Therefore it is logical that RF/MW exposure, if it is genotoxic will be associated with a wide range of cancers, not just a single cancer type. The sensitivity of some particular organs and the way in which the induced electric current flows through the strongly conductive (water dominated) and electrical conduction systems of the human body, are likely

explanations for the observation that most frequent RF/MW cancer associations are with leukaemia, lymphoma and brain cancer. Elwood's table 3 shows five independent epidemiological studies of military and occupational RF/MW exposure with elevated cancer rates across many body organs with Leukaemia/Lymphoma, Brain Cancer being most predominant.

However intensely focused signals exposing local organs are also induce local cancer. For example from cellphone usage, ear cancer (Acoustic neurinoma), OR = 3.27 (1.67-6.43), Hardell et al. (2001), eye cancer (Uveal Melanoma), Stang et al, (2000), OR = 10.1 (1.1-484), brain cancer (Astrocytoma), OR=9.00 (1.14-71.0), Hardell et al. (2002b), and testicular cancer from police hand-held radars placed in the officers' lap, RR = 6.9, $p < 0.001$, Davis and Mostofi (1993).

By considering the whole picture of the available evidence a great deal of understanding is obtained by considering the hypothesis that RF/MW radiation is a Ubiquitous Universal Genotoxic Carcinogen. If the hypothesis is true then the global population is exposed to short-wave radio and satellite microwave signals, and urban areas are massively increasingly exposure to RF/MW radiation over the 20th Century, especially since the Second World War.

An explanatory statement for a motion for a resolution in the European Parliament from the 19th March 1992 states: "Thus in the frequency range 100kHz to 300GHz, 50 years ago was scarcely possible to measure $10\text{pW}/\text{cm}^2$ on the ground in our countries. Today, depending on the location, values one million to one thousand million times higher are recorded because of the explosion in telecommunications. In the microwave range, the widespread use of the mobile phone, which involves the installation of the whole network of transmitter antennas over the whole territory of industrialized countries, will also mean increased exposure. Finally, in the case of low frequencies, the multiple users of electricity and the centralization of its production, together with work on screens, are subjecting an increasingly sizeable proportion of the population to high electromagnetic fields."

It is highly likely that massive rising trend of RF/MW exposures has contributed to the observed rising age-adjusted trends in CCRN Effects. It would also predict that cellphone radiation would be associated with enhanced CCRN Effects and continue the rising trend of various community based health effects from the growing base station exposures, brain cancer form cellphone usage and other health effects for "passive" cellphone exposures.

Review of Schumann Resonance Associated Effects:

Because this review is using the context of the natural election in radiation, the Schumann resonance signal, to review the actual and probable effects of cellphone radiation from cell sites and cellphone usage, then is appropriate to present relevant biological mechanisms and human reactions to this extremely small electromagnetic radiation signal.

Acute short-term changes conditioned resonance in a have been associated with human reaction time change, altered blood pressure and reduced melatonin.

Altered reaction time:

Human reaction time experiments in association with ULF frequencies, primarily 3 Hz and 8 to 10 Hz, were carried out in Germany and the United States in the 1950s and 1960s.

Hamer (1965, 1969) showed that moving the frequency from 7.5 to 8.5 Hz and 8.5 to 9.5 Hz significantly altered reaction times with an rms electric field intensity of 3.8 mV/m. König (1974) and his colleagues had recorded the SR signal on chart recorders and so they characterized the signal as a "10 Hz" oscillation, when it contained up to 32-40 Hz oscillations but the 8 Hz and 14 Hz signal dominated. König reviewed the experiments carried out by Hamer and agreed with Hamer that human reaction times are influenced by ELF fields in a predictable way. Both König and Hamer confirmed that the "10 Hz" signal sped up reaction times. A large experiment involving nearly 50,000 members of the public, found that human reaction times were significantly correlated with the intensity of the 8-10 Hz SR signal, König (1974b), Figure 1.

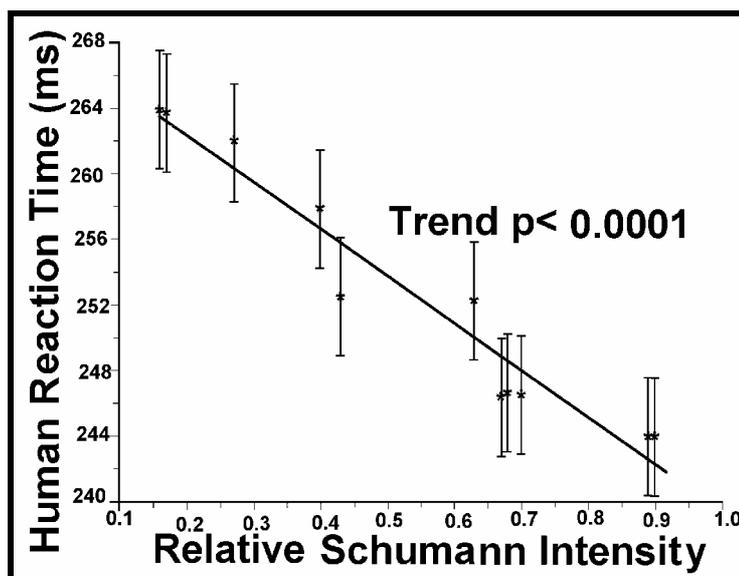


Figure 1: Human reaction times as a function of the 8-10Hz Schumann Resonance relative intensity. Reaction times measured using a light flash and a Morse key, tested during 18 days in September 1953, at the German Traffic exhibition in Munich.

Each point in Figure 1 represents near 4500 subjects, with the mean variance of 3.6 ms shown as error bars. Trend: $t = 10.414$, 2-tailed $p < 0.0001$. Data is derived from Figure 3 of König (1974). The relative intensity is estimated to be in the range 0.6 to 1 pT for the 0-20 Hz band.

Cardiac related biological effects:

A 35-year old cardiologist, with a family history of hypertension and stroke used an electronic blood pressure monitor to record his blood pressure every 15 minutes for 3 years. This revealed a significant periodicity of 27.7 days in systolic and diastolic blood pressure and heart rate, which was coherent with the GMA Kp index, Watanabe et al. (1994). This period is the sun's rotational period and it is the dominant period in the Schumann Resonance daily data spectrum analysis, Cherry (2002).

An Italian study of 447 patients with hypertension also found very significant correlations between systolic and diastolic blood pressure and GMA indices over a 5-year period, Ghione et al. (1998). A multiple correlation with potential confounding factors, such as age and date, confirmed the significant correlation with GMA. Stratifying the days into quiet, disturbed and highly disturbed GMA days always showed significantly higher values in the

highly disturbed days for all blood pressure parameters except systolic night-time pressure. The difference between quiet and highly disturbed GMA days was 6 to 8mm for the 24hr systolic and diastolic blood pressure. The SR signal has the Solar Storm pattern shown by a super imposed epoch analysis, Cherry (2002).

Melatonin reduction:

Seven directly involve correlation of melatonin reduction with GMA variation, Bardasano et al. (1989), Bartsch et al. (1994), Burch et al. (1999b), Rapoport et al. (1997, 1998, 2001), and Weydahl et al. (2001). Burch et al. (1999a,b) measured urinary melatonin metabolite in 149 workers exposed to 60 Hz magnetic fields. Reduced melatonin was correlated with 3-phase conductor exposure, cellphone use and overall magnetic fields, with a dose-response decrease in workers exposed to low light levels. When all of these effects were removed from the data, it also showed a highly significant reduction of melatonin for GMA fields above 35nT, $p < 0.01$. When the data was stratified over 6 GMA levels a very highly significant ($p < 0.005$) dose-response decrease in melatonin from people was found using a Global 36 hr aa-index, Figure 2.

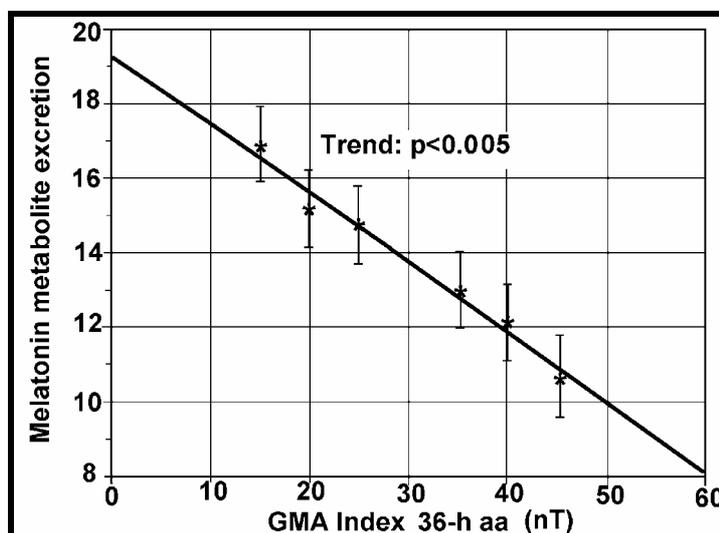


Figure 2: Reduction in the melatonin metabolite 6-OHMS in μg in urine from U.S. electric utility workers, as a function of the 36hr global GMA aa-index, Burch et al. (1999b).

In multiple today's studies and a significant dose response relationships, the solar activity induced variations in the Schumann Resonance signal to a strongly associated with variations in human reaction times, blood pressure changes and reduced Melatonin. These are the biological mechanisms related to neurological response, possible traffic accidents, heart disease and, through the melatonin reduction mechanism, increased rates of cancer, cardiac, reproductive and neurological (CCRN) diseases and mortality.

Review of RF/MW CCRN effects:

Because the CCRN disease and mortality rates are enhanced by the Schumann Resonance signal and are enhanced in electrical workers, it is predicted that the same and similar effects will be found from radiofrequency and microwave radiation exposed populations. Therefore the effects shown for exposure to electromagnetic radiation, especially radio and radar signals, but also electrical occupations, is summarized under the neurological, cardiac, reproductive, genotoxic and cancer studies.

Neurological Activity:

EMF/EMR:

- Alters 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), and Frey (1998).
- Impairs sleep: Altpeter et al. (1995), in a causal manner Abelin (1999), and impairs learning: Kolodynski and Kolodynska (1996)
- Increases permeability of the blood brain barrier (a mechanism for headache), Frey et al. (1975), Alberts (1977, 1978) and Oscar and Hawkins (1977), Alters GABA, Kolomytkin et al. (1994).
- Increases neurodegenerative disease including Alzheimer's Disease, Sobel et al. (1995, 1996), Savitz et al. (1998a,b) and ALS/MND in a significant dose-response manner, Davanipour et al. (1997), Savitz, Checkoway and Loomis (1998) and Johansen (2000).
- 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).
- Increased the Suicide Risk, Baris and Armstrong (1990), Perry et al. (1991), Van Wijngaarden et al. (2000).

Cardiological Activity:

- Alters 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. (1982), 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)
- Increased miscarriage and congenital abnormalities, Kallen et al. (1982), Vaughan et al. (1984), Wertheimer and Leeper (1986), Taskinen et al. (1990), Larsen et al. (1991), Lindbohm et al. (1992), Juutilainen et al. (1993), Evans et al. (1993), Ouellet-Hellstrom and Stewart (1993), Magras and Xenos (1997), Belanger et al. (1997), Lee et al. (2000), Li et al. (2002) and Lee et al. (2002).

- 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 $0.17\mu\text{W}/\text{cm}^2$, respectively, Magras and Xenos (1997).

Genotoxic Activity:

- Reduce melatonin Abelin (1999), Burch et al. (1997, 1999), and alter calcium ions, 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 $0.001\text{W}/\text{kg}$ ($0.34\mu\text{W}/\text{cm}^2$) using 750MHz microwaves, de Pomerai (2000).
- Damages chromosomes and enhances micronuclei formation: Heller and Teixeira-Pinto (1959), Yao (1978, 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), Goldsmith (1997).
- Alters DNA, Sarkar, Sher and Behari (1994).
- Breaks DNA strands, Lai and Singh (1995, 1996, 1997). This is also shown by the actual data in Malyapa et al. (1998a), contrary to the authors' conclusions.
- 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, de 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), Chou et al. (1992) and Vijayalaxmi et al. (1997).

Cancer Epidemiology:

There is a very large body of published papers showing increased cancer in ELF and RF/MW exposed populations in many body organs. For example:

- Increase the incidence of many types of cancer, including leukaemia, brain tumor, testicular cancer, genitourinary and breast cancer, Lilienfeld et al. (1978), Robinette et al. (1980), Thomas et al. (1987), Zaret (1989), Milham (1985, 1985a, 1988, 1996, 2001), Davis and Mostofl (1993), Maskarinec and Cooper (1993), Cantor et al. (1995), Szmigielski (1996), Hocking et al. (1996), Goldsmith (1995, 1997), Dolk et al. (1997 a, b), Beall et al. (1996), Grayson (1996), Hayes et al. (1990), Tynes et al. (1996), Michelozzi et al. (2002) 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.

An important scientific principle is “the absence of evidence has not evidence”. A second important principle is putting the evidence into the appropriate context which allows a scientific hypothesis to be evaluated and possibly confirmed. It has been shown in a very large body of published research that natural electromagnetic radiation, electrical and electronic ELF exposed workers and residents, and radio, TV and radar exposed people and animals, are shown to damage DNA, reduce melatonin, alter cellular calcium ions, and in chronically exposed populations elevate rates of cancer, cardiac, reproductive and neurological health effects and mortality. Cellphone radiation from analogue cellphones is FM modulated microwaves and digital phones are pulsed like radar. Therefore the scientific hypothesis (the prediction) is that all of the biological and health effects found across the EMR spectrum will be produced by cellphone radiation.

Cell Phone Radiation Research:

To evaluate the evidence in the context of this hypothesis the published cellphone radiation-related research will be summarized in the CCRN manner. A key background evaluation is of the biological mechanisms of melatonin reduction, genotoxicity, reaction time change and altered blood pressure or heart rate variability.

Neurological Activity:

- Alters brain activity including EEG, Von Klitzing (1995), Mann and Roschkle (1996), Krause et al. (2000). Brain cortex interaction as shown by significantly altered human EEG by cellphone radiation, during a 15min exposure, Lebedeva 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).
- 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 $RR = 1.3$, $p < 0.001$, for 15 minutes.

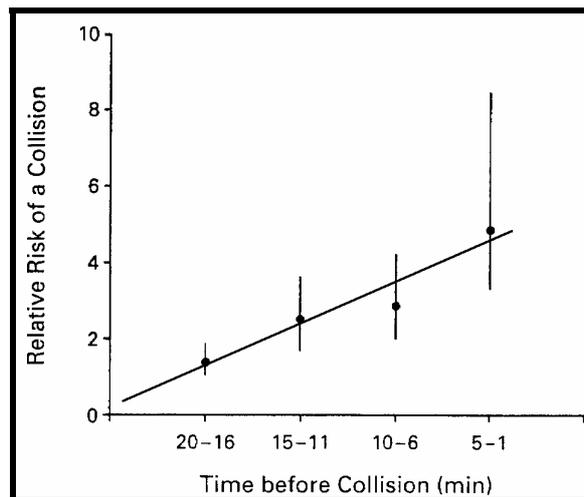


Figure 3: The relative risk of a collision related to the time used a cell phone rises significantly the closer the use of the phone is to the time of the collision, Redelmeier and Tibshirani (1997).

- The United Kingdom study done by the Transport Research Laboratory in behalf of the insurance industry, showed a significant reduction in reaction times from using hands-free cellphones compared with effect of alcohol on drinking. Handheld cellphones were much worse. They included a driving while talking on a cellphone was much worse than drunk driving, TRL (2002).
- 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).

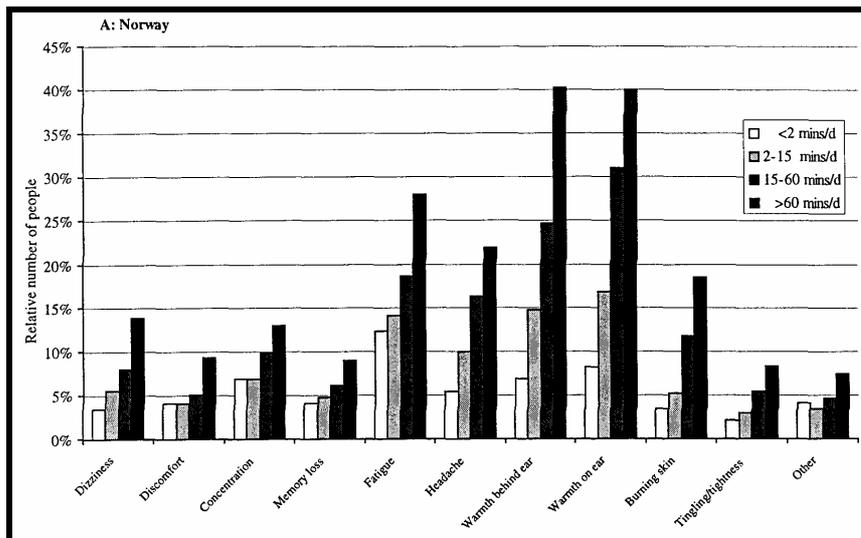


Figure 4: Prevalence of symptoms for Norwegian mobile phone users, mainly analogue, with various categories of length of calling time per day, Mild et al. (1998).

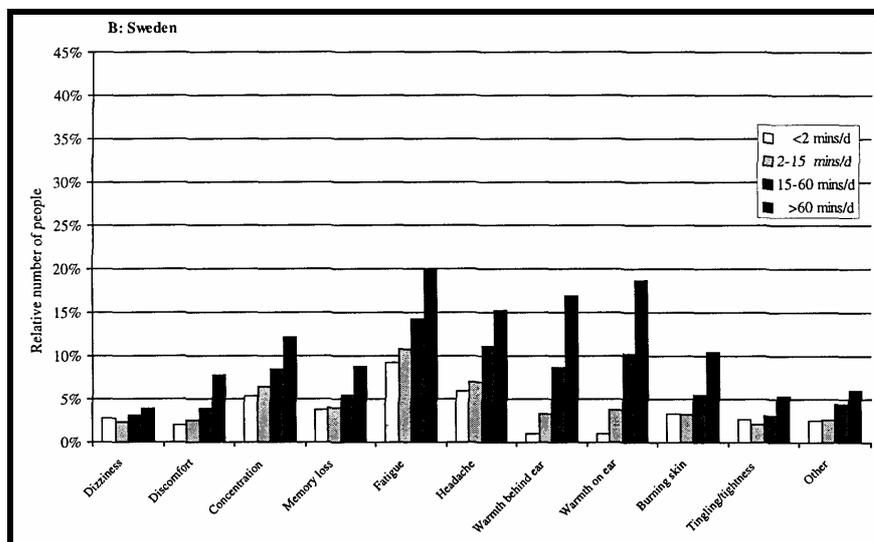


Figure 5: Prevalence of symptoms for Swedish mobile phone users, mainly digital, with various categories of length of calling time per day, Mild et al. (1998).

These are the same symptoms that have frequently been reported as "Microwave Sickness Syndrome" or "Radiofrequency Sickness Syndrome", Baranski and Czernski (1976) and Johnson-Liakouris (1998). These symptoms were found in the personnel at the US embassy in Moscow who were chronically exposed to a very weak radar signal with mean exposure levels typically much lower than $0.1\mu\text{W}/\text{cm}^2$. Therefore they are plausibly associated with living in vicinity of cell sites. This has been confirmed by Santini et al. (2002), who found significantly elevated and many dose-related symptoms, including sleep disturbance, fatigue, memory loss, loss of concentration, nausea, irritability, discomfort, Visual Perturbations, vertigo, loss of appetite, Cardiovascular problems Cutaneous problems, hearing difficulties and visual perturbations. Many of these symptoms are shown above in a dose-response manner from using cellphones, Figures 4 and 5 and from "Microwave Sickness Syndrome". Almost all of the symptoms are associated with reduced Melatonin.

Professor Roger Santini, carried a survey of health effects around cell sites with the following significant results, Santini et al. (2002).

Symptoms	Distances of subjects from cell phone base stations (m)											
	< 10 m		10 to 50 m		50 to 100 m		100 to 200 m		200 to 300 m		> 300 m ...	
	2	3	2	3	2	3	2	3	2	3	2	3
Fatigue	76 *	72 *	63.5 *	50.9 *	60.6	56.6 *	64.2	41.1	66.6 *	43.7	40.7	27.2
Irritability	32.8	23.2 *	41.7 *	25.7 *	47.2 *	44.1 *	25.8	4.1	25	9	18	3.3
Headache	51 *	47.8 *	40 *	26.1 *	40.6 *	36.7 *	60.7 *	31.2 *	19.3	0	15.6	1.8
Nausea	14.5 *	6.9	8.4	3	5.7	3.8	2.4	4.6	0	2.3	2.1	1.1
Loss of appetite	20.4 *	8.3	8	5.5	5	5	6.9	0	4.2	0	3.3	3.3
Sleep Disturbance	41.3 *	57.1 *	41.4 *	57.5 *	46.9 *	58.5 *	45.8 *	50*	33.3	35.5	13.8	21.1
Depression	16.9	26.8 *	21.6	19.7 *	11.6	24 *	16.2	3.1	13.6	2.5	10.3	3.7
Discomfort	28 *	45.4 *	25.2 *	18.9	30.6 *	12.8	15.7 *	0	9.7	5.1	2.4	8.1
Difficulties in concentration	39.3	28.8 *	37.5	16.6	34.2	26.4 *	25	12.5	43.3	5.5	26.7	7.1
Loss of Memory	27.8	25.4 *	29.4	26.6 *	37.1 *	29 *	25	15.6	17.2	11.1	17.9	5.8
Cutaneous problems	18.1 *	17.1 *	6.6	10.8	11.1 *	11.1	13.9 *	7.5	8.7	0	1.2	4.6
Visual Perturbations	14.5	24.3 *	23	13.5	22	7.1	2.5	4.9	15	2.8	13.6	4.1
Hearing Difficulties	33.3 *	17.4	17.7 *	12	8.3	15.5	7.7	7.7	11.6	9.5	5.6	8.7
Vertigo	10	12.5 *	17.3 *	7.5*	9.6	9.6*	12.2	2.7	7.7	5.2	6.2	0
Moving Difficulties	5.6	7.7*	8.2	1.7	3	3	0	0	2	0	2.9	1
Cardiovascular Problems	10.1 *	13 *	15.3 *	9.6	12.3 *	7.4	8.7	0	8.5	6.5	1	3

Table 1 : - Incidence of symptoms as a function of distance from cell phone base stations by 530 people (men and women) as compared to people living more than 300m or not exposed to base stations.

* = Chi Squared test Significance ($p < 0.05$) for exposed subjects compared to those living more than 300m from a base station or not exposed. 2 = "often" and 3 = "very often"

- Santini et al. (2002a) surveyed 161 students and workers in a French engineering school on symptoms experienced during use of digital cellular phones. A significant increase in concentration difficulty was reported by use of both cellular phones and VDT and by users of 1800-MHz (DCS) cellular phones compared to 900-MHz (GSM) phone users. The women using cellular phones significantly complained more often of sleep disturbance than men. Digital cellular phone users also significantly more often complained of discomfort, warmth, and pricking of the ear during phone conversations as a function of calling duration per day and number of calls per day.

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):

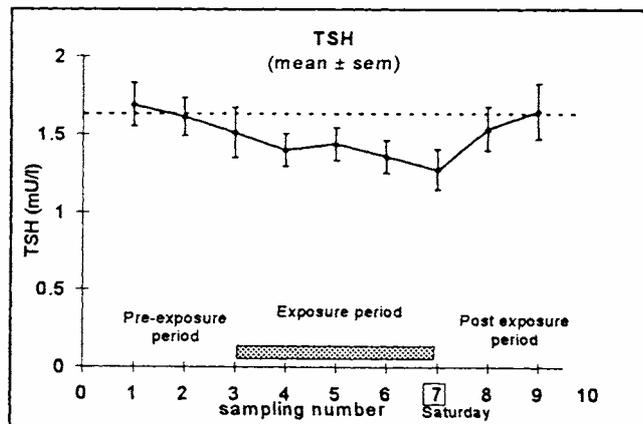


Figure 6: A significant reduction in Thyrotropin (Thyroid Stimulating Hormone) during cell phone use, averaged over 4 weeks, de Seze et al. (1998).

- 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 W/kg ($1.2 \mu\text{W/cm}^2$), Phillips et al. (1998). This is also shown by the actual data in Malyapa et al. (1998b), contrary to the authors' conclusions.
- 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.", formally published, Tice et al. (2002).
- 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 total mortality of from the whole body from Bag Phones users compared with portable hand-held phone users, from 1994, RR = 1.38, 95%CI: 1.07-1.79, $p=0.013$, Rothman et al. (1996). It also shows that the more the Bag Phone was used the higher the mortality rate was.
- Increases human brain tumor rate by 2.5 times, Hardell et al. (1999a). Associated with an Angiosarcoma (case study), Hardell (1999b)
- 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.
- United States, Motorola Study
High Exposure
Morgan et al. (2000)
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 of the general population in 4 states, failing to deal with the Healthy Worker Effect.

- 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 hr/month over 2.8 yrs for cases and 2.2 hr/month for 2.7 years for controls, showing that a small increase in cellphone use (12.7hrs) produces a large increase in brain cancer risk.

Considering the whole incidence of Brain Cancer, 14.1% of the Brain Cancer Case Group, used cellphones compared with 18.0% of the Control Group. The overall brain cancer rate of the Case Group was 13.3% and Control Group was 17.8%. This shows that the high proportion of people who used cellphones get a higher rate of brain cancer close to the proportion of usage, RR = 1.34 (0.98-1.82), $p=0.066$. This also shows the problem of finding a non-exposed control group.

- Pereira and Edwards (2000) describe the first case of nodular fasciitis (benign reactive proliferation of fibroblasts, that closely resembles a sarcoma, near the ear of a 39-yr old, high usage mobile phone user.
- 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.
- 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).

- 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 Johansen et al. "Table 2" below. Over 67 % of all phone users had used their phones for 2 years or less. In the case of digital phone users, 92.7% had used their phones for 2 years or less. The reference group chosen had a higher than average cancer rates than the age range of cell phone users. This leads to a gross underestimate of the relative cancer rates in cell phone users. This is shown by Standard Incidence Ratios (SIR) of some groups being as little as 0.6. For example, the SIR for digital users for <1 year is 0.7.

If the reference group cancer rate is multiplied by 0.6 to make it reasonably comparative for mean cancer rates, then for male brain cancer RR = 1.56, 95%CI: 1.19-2.04, $p=0.001$, $n=135$. For females RR = 1.73, 95%CI: 0.82-3.62, $n=19$. For all people combined, RR = 1.58, 95%CI: 1.23-2.03, $p=0.0003$.

Johansen et al. also had an *a priori* hypothesis that cell phone usage could increase cancer, a one-directional effect, but they used a 2-tailed significance test, which halves the significance level (doubles the p-value). This enabled them to avoid getting any significant results because with this method the confidence interval is wider and keeps the lower limit below 1.0. For example, for "Other and Unspecified brain cancers" SIR = 1.31, 95%CI: 0.98-1.70. Using a 1-tailed test this would have been significant.

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 1.50

*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 a little cellphone use, and even after using a high cancer reference group and a two-tailed test, 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.

- Swedish analogue cell phone study
Brain Cancer:

Hardell et al. (2001)

Overall analogue phone use	OR = 1.26 (1.02-1.56)
Induction period >10 years	OR = 1.77 (1.09-2.86)
Anatomical area relationship (Tumour near aerial)	OR = 2.50 (1.28-4.88)
Acoustic neurinoma	OR = 3.27 (1.67-6.43)

- Swedish analogue cell phone, larger study Hardell et al. (2002a)

In this much larger study, with 1,429 cases and 1,470 controls, the use of analog cell phones for longer than a year was associated with a statistically significant increased risk of brain tumors:

OR=1.26, CI: 1.02-1.56.

For longer latency periods, the risks were higher:

>5 years	OR= 1.35, CI: 1.03-1.77.1
>10 years	OR= 1.77, CI: 1.09-2.86.

For all brain tumors on the side of the head the phone is used:

OR= 2.50, CI: 1.2 8-4.88.

The risk was highest for acoustic neuromas among users of analog phones:

OR= 3.27, CI: 1.67-6.43.

- Swedish analogue cell phone study Hardell et al. (2002b)

This paper addresses the 588 patients with malignant brain tumors (414 Astrocytomas) among the 1,429 cases in the second study.

All Brain Cancer:	Analog phones	OR= 1.13, CI: 0.82-1.56
	Digital phones	OR= 1.11, CI: 0.85-1.45

Astrocytomas:	Analog phones	OR= 1.29, CI: 0.87-1.90
	Digital phones	OR= 1.11, CI: 0.81-1.53

For all brain tumors on the side of the head the phone is used:

All malignant brain tumors:	Analog phone	OR= 1.85, CI: 1.16-2.96
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Astrocytomas:	Analog phone	OR= 1.95, CI: 1.12-3.39.
	Digital phone	OR= 1.59, CI: 0.98-2.58
	Cordless phones	OR= 1.70, CI: 1.06-2.74

For Astrocytomas in the areas of the head close to the phone aerial: based on 12 cases and 5 controls.

OR=9.00, CI: 1.14-71.0

Summary and Conclusions:

To date over 66 studies have shown the same biological mechanisms and/or human health effects specifically from cell phone radiation. They include all of the predicted biological mechanisms, including melatonin reduction, genotoxicity, reaction time change and altered blood pressure or heart rate variability. They also include animal and human health effects of cancer, cardiac and acute neurological problems and driving accidents

and mortality. For the reproductive diseases there is an absence of studies but the biological mechanisms for miscarriage, congenital malformation etc, melatonin reduction and genotoxicity, are already shown in multiple studies.

Therefore there is large, sound and robust evidence that Cellphone radiation from the phones and cell sites are producing elevated rates of cancer, cardiac, reproductive and neurological diseases and mortality.

For years the cell phone companies and government authorities have assured us that cell phones 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. And integration of a large body of evidence here strongly challenges these claims. There is direct evidence that both cellphones and cell sites are causing elevated rates of serious health problems. 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.

Very young children and teenagers are becoming regular 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.

However a third serious risk factor is for the hundreds of millions of people learning within about 500 m of cell sites, because they are experiencing reduced melatonin increased rates of DNA damage, no safe threshold level. Although these residential exposures are quite low intensity compared to the standard levels, based on avoiding tissue heating, they are over a million times higher than the natural (SR) signals that are known to reduce melatonin and have been shown to cause serious health effects, Cherry (2002).

Altered attention and cognition, reaction time and memory, as well as the diversion of talking on a phone while driving, is a significant risk factor for accidents and fatal accidents. There should be legislative moved to prohibit the use of cellphone while driving.

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

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.

Protection of public health will only be achieved by accepting this evidence interpretation, and setting very low allowable exposure standards to minimize exposures, using $0.1\mu\text{W}/\text{cm}^2$ 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 acute neurological, cardiac and reproductive effects and chronic cancer, cardiac and neurological disease and mortality rates. The lower level is necessary because of the

exquisite electro-sensitivity of the brain and the vital importance of protecting the natural electromagnetic activity of the brain and heart from interference and damage. This is especially important for cellphones. Even cellphones can be produced and used in such a way that this protective standard is met.

Very much lower mean exposures can be achieved by using the smart, efficient and safer technology approach. Cellular telephone handsets can be shielded like a "Faraday Cage" which significantly reduces the exposure of the user from the signals generated within the handsets. Aerials can be designed to produce directional transmitting signals that are focused into a narrow beam, away from the user's head and body. Fiber-optic cable hands-free kits offer significantly reduced microwave exposures of the head and ear. All this technology is available through registered patents. Reduced mean exposure levels from cell sites can be obtained from planning strategy is that locate the sites away from where people live or work and especially schools and hospitals. The highest exposures are produced within 100 m of the antenna site by the antenna's side-lobes. A horizontal sheet or mesh of metal, located immediately below the antenna itself, can reflect the side-lobes stop them from being radiated down to the ground near the tower.

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