Radiofrequency EMFs and Health Risks

This article is separated into 8 sections, each of which can be individually downloaded. It is a 'work in progress' incorporating new information whenever time permits.

Section 1

Introduction

1. Introduction; RF broadcast transmitters (radio & TV); DAB transmitters; radar; mobile phone masts; Internet of Things (IoT); safety zones; Lloyd's of London insurance refusal

2. The research – General; addiction; autism; behaviour changes; blood-brain barrier; blood changes; blood pressure; bone and muscle development; brain activity; cancer; Non-Hodgkin's lymphoma; cellular changes; central nervous system; cognitive changes; dementia; diabetes; DNA; emotional effects; epilepsy; eyes; headaches; hearing

3. The research – heart; effects on heart pacemakers; immune system; kidney effects; lifespan; limb changes in utero; liver damage; medical interference; microwave therapy; multiple sclerosis; neurological changes; effects on the nose; occupational exposure, including pulsed RF; oxidative stress; pain; psychiatric symptoms; skin effects; effects on sleep; spine; spleen and thymus; synergistic effects; thyroid effects; other biological changes; protection; the need for precaution with respect to children; synergistic effects; campaigning organisations

4. General reproductive effects; Radiofrequency (microwave) (RF) exposure and reproductive effects; Mobile phones or phone-type exposure and male sperm; Radiofrequency exposure and effects on female reproduction; Radiofrequency exposure and effects during pregnancy

5. Driving – car systems; tracking vehicles; when your car lock doesn't work; driverless vehicles; road trains; charging electric vehicles; mobile phones; motorbikes; speed limiting devices; traffic control sensors; other in-car devices; interference with electric vehicles

6. Animals; birds and bats; tadpoles; fishes; insects; ants; bees; cockroaches; flies; effects on plants

7. References – 595 references

8. Appendix; table of symptoms, by study; Santini 2002; Freiburger Appell 2002; Navarro 2003; Oberfeld 2004; open letter to Edmund Stoiber, President of Bavaria; Balmori 2005; Hutter 2006; Abdel-Rassoul 2007; Preece 2005; UK Parent-Teacher study 2000; Bortkiewicz 2004; Eger 2004; Wolf & Wolf 2004;

Eberhardt 2008; Augner 2010; Alazawi 2011; Santini 2003; Eger & Jahn 2010; Singh 2016; Kato & Johansson 2012; Gomez-Perretta 2013; Bortkiewicz 2012

Introduction

People first became exposed to man-made radiofrequency radiation in the 20th century. It was initially used by the military for radar. Studies of radar and flight-traffic controllers, found biological changes, but these personnel were exposed to much higher levels than the general public are now exposed to. Garaj-Vrhovac (2011) found that pulsed microwaves experienced by personnel working on marine radar could be the cause of genetic and cell alterations and that oxidative stress could be one of the possible mechanisms of DNA and cell damage. The frequencies studied included 3 GHz and 5.5 GHz, which are now used for WiFi transmissions. Part of a crew on a Norwegian naval ship was exposed to the radar waves for approximately 7 minutes from an American destroyer during an incident at sea in August 2012. Their symptoms developed days or weeks after the radar exposure (Moen 2013).

RF radiation was also used as a cold-war weapon. The US embassy in Moscow was exposed to chronic radiation by Soviet radar between 1958 to 1988. Amongst the exposed staff, there were several leukaemia cases, benign and malignant tumours, depression, irritability, memory loss, difficulty in concentrating, allergic skin problems and reproductive problems. Chromosomal abnormality tests showed that there were substantially increased frequencies of mutation in 18 out of 36 individuals (Liakouris 1998).

Radar emissions in peace-time have been mainly centred on airports and seaports, with some Ministry of Defence establishments adding to local environmental exposure.

The major exposure to the general public from pulsed microwaves comes from mobile phones, the transmitting infrastructure (mobile phone base stations or masts), wireless appliances and 'blue tooth' equipment (in homes, schools, workplaces, cars, etc.), wireless computing in schools, homes and work places, and the expanding roll-out of wireless communication giving laptop users access to the Internet whilst 'on the move'. This accessibility is rapidly extending to planes, trains, most cities and towns, and expanding into more remote rural areas. Satellite and balloon technology are also being developed to enable more rural users to benefit from this new technology. A study by Tomitsch (2010) showed that the highest exposure to RF in homes came from DECT base stations and mobile phone masts. Breckenkamp (2012) also found that the major sources of exposure to RF in 1,348 German bedrooms were cordless phones (DECT standard) and wireless LAN/blue tooth contributing about 82% of total exposure. A follow up study by Tomitsch & Dechant (2015) found an overall increase in residential RF exposure between 2006 and 2012, especially for UMTS (3G) and wLANs. There was a higher total RF-EMFs in urban than in rural areas.

Bolte & Eikelboom (2012) found that the highest environmental exposure to RF (excluding mobile phone calls MADE by people in the survey) come from received calls from a mobile phone (37.5%), from cordless DECT phones and their base units (31.7%) and from mobile phone base stations (12.7%). The exposure to mobile phone base stations increased with the percentage of urban ground use, which is an indication for high people density. The highest mean exposure relates to the activities with high people density, such as travelling by public transport, visiting social events, pubs or shopping malls.

The mean total exposure largely depends on phone calls of a high exposure level and short duration. These calls lead to potentially high contrasts as well in exposure levels between sessions of the same activity as between persons, thus posing a challenge for personal exposure prediction.

The technology is novel in human experience and any effects are most likely to be long-term. The important thing to bear in mind with regard to exposure is not the level compared with the allowed guidelines, but the level compared with what we have been exposed to in human evolutionary terms.

Most early health research work focused on occupational exposure of military personnel and some on the effects of weaponry. The first significant report by Sadcikova describing occupational 'microwave sickness' appeared in 1974. The symptoms included fatigue, headaches, palpitations, insomnia, skin symptoms, impotence and altered blood pressure.

Berg (2006) found a slight increase in risk of meningiomas and gliomas as a result of occupational exposure.

Radio and TV station operators were studied and it was found that radiofrequency radiation contributed to adverse effects on the cardiovascular system (Vangelova 2006). It has been felt important to monitor field levels workers are exposed to, so that they can plan work on masts so that the maximum permissible EMF dose is not exceeded in any shift (Masiak 2007).

In many cases, *medical tests (including blood pictures and biochemistry) showed no significant abnormalities.* The symptoms often persisted for several months, even years, after the exposure, and some of the people who had been exposed were never able to regain the level of good health they had experienced beforehand. Some exposures resulted in severe anxiety necessitating short term sedation and even admission to hospital. Psychological problems and emotional instability persisted for up to a year. Some symptoms, especially headaches were made worse as a result of direct sunlight or body warming.

Although many of the occupational studies were investigating accidental exposures to higher levels of radiofrequency radiation than were usual, and much higher than the current levels that the general public are allowed to be exposed to, it is interesting (and concerning) to note:

- The similarity of symptoms in these studies, with those looking at much lower levels of microwave radiation in the environment, such as the sort of levels near mobile phone base stations (see below)
- The difficulty of finding *any* biological markers that can account for the reported health effects, which adds to the problem of diagnosis
- The often long-term persistence of the symptoms, including psychological ones
- The fact that full health is often not recovered after exposure

What the research clearly demonstrates is that body tissues respond to electromagnetic fields at very low levels indeed, and the environment can change levels of exposure quite dramatically depending on whether they are reflective or otherwise (Vermeeren 2010). The RF field levels experienced by surgeons using electro surgery units was investigated. The time exposed was reported to be higher than was actually the case and the cables connecting electrodes with the generator at a distance of 15 cm met the requirements of the Polish permissible exposure limits (Karpowicz 2013).

The response is non-linear for both frequency and power. That is:-

- biological systems may react at some low power levels and not others
- they may not react at all to high levels. Experiments on nematodes show that they respond adversely to lower levels and at higher levels they do not exhibit the same degree of stress (Daniells 1998).
- they may react very differently to different frequencies

We believe that, rather than there being a general threshold below which no ill-health symptoms occur, ***people are very variable, having their own individual thresholds that can, in an increasing minority of the population, be exceeded at low levels of exposure.*** Many people, although they form a minority of the population, exhibit hypersensitive responses to many different stimulants (penicillin, peanuts, etc.) (Baliatsas 2016).

Different parts of the body absorb radiofrequency energy differently. It depends to a large extent on the water content of the tissue, so blood, skin, muscle, brain and peripheral nerves absorb more than fat and bone. It is likely that the effect is cumulative rather than purely instantaneous, and that cascade effects (where one reaction triggers one or more other effects in cells or systems), from gene expression to protein modification to cellular ion transport are all affected. It is probable that these molecular and cellular cascade effects help to explain the wide range of symptoms that characterise electrical hypersensitivity and that simplified provocation trials under laboratory conditions do not necessarily reveal a linear predictable response among people claiming to be sensitive. This does not prove that their experiences in their normal environment are 'all in the mind'. It simply indicates that complex electromagnetic environments where there may be other factors complicating people's exposure (e.g cordless phones, wLAN systems, etc.) are not easily replicated in the laboratory.

Where there are multiple exposures, the outcomes are not necessarily predictable. A relatively recent review by Mild & Mattson (2010) of the work done by the Bioelectromagnetics group at the Catholic University of America (CUA), maybe gives hope to those who are affected by radiofrequency sources, who may find protection in unusual ways. Mild & Mattson concluded that *"biological effects can be found after exposure to low-level ELF and RF electromagnetic fields, and when effects are observed, applying an ELF magnetic noise field inhibits the effects." "In all cases where the noise field has been applied to prevent an observed effect, it has been successful in eliminating the effect."*

The International Agency for Research on Cancer (IARC) in 2011 classified all RF-EMFs (30 Kkz – 300 GHz) as a 2B carcinogen. They accepted that there are significant differences between the emission levels of different emitters, but chose to make no distinctions between them. In March 2012, Robert A Baan, the Responsible Officer for Monograph 102 on RF-EMF said *"Because the exposure levels for many of these other devices and exposure situations are so much lower then the exposure to someone who has a functioning cell phone against her/his ear, the risk will be considerably less* ***(although the hazard still exists)****.*

The Advisory Group on Non-ionising Radiation (AGNIR) 2012 report forms the basis of official advice on the safety of radiofrequency (RF) electromagnetic fields in the United Kingdom and has been relied upon by health protection agencies around the world. The review by Starkey (2016) describes incorrect and misleading statements from within the AGNIR report, omissions and conflict of interest, which make it unsuitable for health risk assessment. The executive summary and overall conclusions did not accurately reflect the scientific evidence available. Independence is needed from the International Commission on Non-Ionizing Radiation Protection (ICNIRP), the group that set the exposure guidelines being assessed.

The rationale, put forward mostly by physicists and accepted by many health agencies, is that, "since NIR does not have enough energy to dislodge electrons, it is unable to cause cancer." This argument is based on a flawed assumption and uses the model of ionizing radiation (IR) to explain NIR, which is inappropriate. Evidence of free-radical damage has been repeatedly documented among humans, animals, plants and microorganisms for extremely low frequency (ELF) electromagnetic fields (EMF) and for radio frequency (RF) radiation, none of which are ionizing. NIR interferes with the oxidative repair mechanisms resulting in oxidative stress, damage to cellular components including DNA, and damage to cellular processes leading to cancer (Havas 2017).

Selected Quotations from scientists who signed the international EMF Scientist appeal (May 2015). Those who signed the appeal have published between them more than 2,000 peer-reviewed research papers on electromagnetic fields.

Dr Don Maisch, Australia

"We are now entering the era of 'The Internet of Things' (IoT) where all our appliances will be Wi-Fi enabled, endlessly communicating with each other and us through so-called smart devices. This 'brave new world' dictates that human exposure to radiofrequency radiation must greatly increase in order to accommodate the technology. This is a planned world being created by technocrats totally ignorant of the reality of our biology."

Dr Magda Havas, Canada

"Putting Wi-Fi in schools; allowing cordless phones that radiate constantly to be manufactured; placing wireless baby monitors near an infant, using a wireless tablet, smart phone or computer while pregnant; holding a cell phone next to the head and keeping a cell phone in a bra or hip pocket or under a pillow; placing cell phone antennas near homes, schools and on hospitals; metering electricity, water and gas with wireless smart meters and designing smart appliances for the home will be viewed by future generations as dumb technology generated by greed for a population that is largely ignorant of the consequences."

Dr Lebrecht von Klitzing, Germany

"Continued exposure to WiFi in Germany has deleterious effects on the cardiovascular system."

Professor Kavindra Kesari, India

"No action has been taken despite our awareness of the harmful impact of electro-pollution due to political interference."

Dr Daniel Favre, Switzerland

"Active mobile phone handsets and signals from masts have a dramatic impact on the behaviour of honeybees and could be contributing to the decline of honeybees around the world."

Dr Martin Blank, USA

"International exposure guidelines for electromagnetic fields must be strengthened to reflect the reality of their impact on our bodies, especially on our DNA."

RF Broadcast transmitters

When discussing the health effects from RF transmitters such as mobile phone masts, the industry often denies that there could be a problem, saying that we have had radio and TV broadcasting for a long time, without reported health problems. This is not strictly true as you can see from several studies, some of which we report below.

Residents on Lookout Mountain, a residential community that contains numerous radio and TV transmitters that broadcast to the entire Denver metropolitan area, had statistically significant increases in the number of white blood cells that are immune system markers (such as T cells and lymphocytes). This study was a follow up to previous findings, in July 2004, that there were a higher number of residents with brain tumours than would be expected in the area. Ha 2007 found a link with increased childhood leukaemia incidence. In an earlier paper, Ha (2003) found a significant increase in the incidences of leukaemia and brain cancer in the vicinity of AM radio transmitters. Park (2004) found higher mortality rates for all cancers and leukaemias, especially

among young adults aged under 30 years, in areas near AM radio broadcasting towers. Hocking & Gordon (2003) had found that those children with leukaemia living less that 4 kilometres from a TV transmitter had a lower survival rate than those living further away.

Electromagnetic fields from radio-television broadcasting stations in Italy were found to reduce immune system function and increase anxiety (Boscolo 2006).

Huttunen (2009) found that about a third of people reacted to RF standing waves with spontaneous hand movements. It is clear that there are relatively crude biological effects, so it is hardly surprising that more subtle effects may be happening.

DAB transmitters

More people seem to react to the new digital radio and TV transmitters than did to the older analogue systems. As far as we know there has been no specific research into it, but it is a growing concern. The connection between FM radiation and skin cancer could be at least partially explained by the results of a study by Hallberg (2016, 2016b); which showed a strong association between cancer risk and the use of horizontally polarized FM broadcasting radiation, whereas vertical polarization seemed to cause no health effects. The Digital Radio Working Group (DRWG) says that by 2015, less than half of all radio listening could be via traditional FM or AM sets. It says that if DAB broadcasts reach enough of the country by then, a switch to digital would be possible by 2017. Motorists are being particularly slow at changing to DAB receivers.

When digital TV transmitters are switched on their power output increases from 30kW to 500kW. The analogue transmitters, which broadcast at higher power than the current digital ones, are generally being switched off when Digital TV transmission is activated. However, as some TVs are still unable to receive digital signal in some places the transmitters are working in tandem.

In 2009, the modulation pattern for digital transmission was changed; possibly making the signal more 'pulsey' which could affect people who are sensitive to RF signals.

Radar

A study by Burlaka (2014) showed that qualitative and quantitative disturbances in electron transport chain (ETC) of mitochondria registered at permitted energy load for the staff of radar stations.

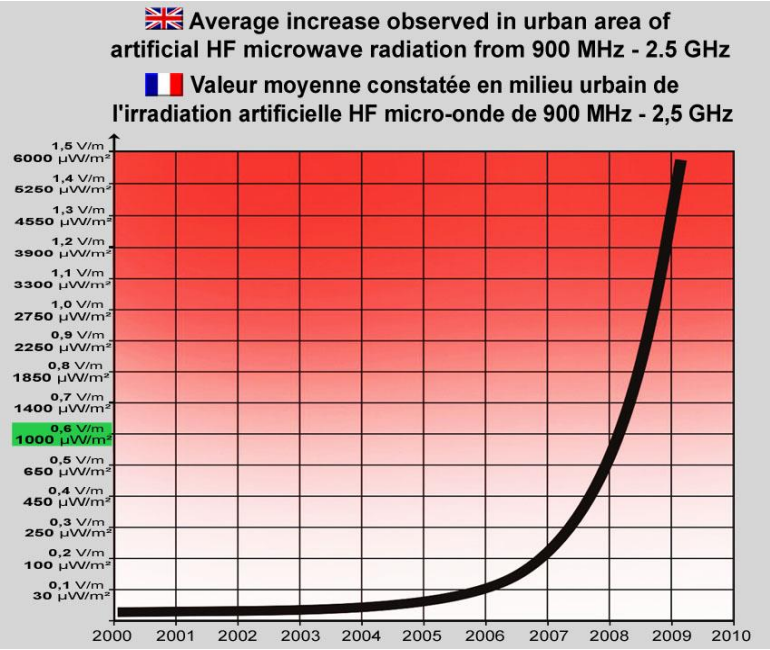
Mobile phone masts

Hallberg and Johansson (2009) found that the Swedish population's health generally improved during the early 1990s but suddenly started to deteriorate from 1997 onwards. They believed that the change was too dramatic to be explained away by improved diagnostics, indicating that there were new physical causes of the health ailments that urgently needed searching for. They thought it possible that modern wireless communication technologies could not be ruled out as this is one of the biggest changes to the environment since 1997. For example, a study by Deatanyah (2012) showed RF exposure from mobile phone masts in 46 towns in Ghana had increased by a factor of 108 since a survey 2 years previously!

Kelsh (2010) suggested that studies should allow for the fact that people in more rural areas may be exposed to higher levels of RF from their phones, as well as the mast, due to their need for a higher power output.

In Chandrigarh, India, RF levels from mobile phone masts were measured to assess public exposure. The results showed that levels were below the ICNIRP limit, but well above the level at which the biological systems of humans and animals start being affected (Dhami 2011).

The graph below shows the dramatic increase in public exposure to RF in urban areas. It is accepted by many researchers that the level at which a significant number of people experience health effects is at 0.6 V/m, highlighted in green on the left.



In many of the studies assessing microwave exposure levels from mobile phone base stations, it appears that symptoms start to show when people live in background levels as low as 0.05 V/m. The symptom data is shown in table 1 in "Radiofrequency EMFs & Health Risks 5 Appendix". Kundi & Hutter (2009) say that *From available evidence it is impossible to delineate a threshold below which no effect occurs, however, it is suggested that power densities around 0.5-1mW/m² must be exceeded in order to observe an effect."* They continued *"The difficulties of investigating long-term effects of base station exposure have been exaggerated, considering that base station and handset exposure have almost nothing in common both needs to be studied independently. It cannot be accepted that studying base stations is postponed until there is firm evidence for mobile phones".*

In February 2017, with Senate Bills 19 and 88, the array of currently-used and planned, harmful frequencies, wavelengths and modulations to be deployed in every public and private space, indoors and out:

5G: 600 MHz = microwaves ~20 inches long

- 4G: 700 MHz = microwaves ~17 inches long
- 3G/4G: 800 MHz = microwaves ~15 inches long
- 3G/4G: 900 MHz = microwaves ~13 inches long
- 3G/4G: 1800 MHz = microwaves ~7 inches long
- 3G/4G: 2100 MHz = microwaves ~6 inches long
- Wi-Fi: 2400 MHz = microwaves ~5 inches long
- **5G**: 3100 MHz to 3550 MHz = microwaves ~3.8 to 3.3 inches long
- **5G**: 3550 MHz to 3700 MHz = microwaves ~3.3 to 3.2 inches long
- **5G**: 3700 MHz to 4200 MHz = microwaves ~3.2 to 2.8 inches long

- **5G**: 4200 to 4900 MHz = microwaves ~2.8 to 2.4 inches long
- Wi-Fi: 5800 MHz = microwaves ~2.0 inches long
- **5G**: 24,250 to 24,450 MHz = microwaves ~**0.5 of an inch long**
- **5G**: 25,050 to 25,250 MHz = microwaves ~**0.5 of an inch long**
- **5G**: 25,250 to 27,500 MHz = microwaves ~**0.4 of an inch long**
- **5G**: 27,500 to 29,500 MHz = microwaves ~**0.4 of an inch long**
- **5G**: 31,800 to 33,400 MHz = microwaves ~**0.4 of an inch long**
- **5G**: 37,000 to 40,000 MHz = microwaves ~**0.3 of an inch long**
- **5G**: 42,000 to 42,500 MHz = microwaves ~**0.3 of an inch long**
- **5G**: 64,000 to 71,000 MHz = microwaves ~**0.2 of an inch long**
- **5G**: 71,000 to 76,000 MHz = microwaves ~**0.2 of an inch long**
- **5G**: 81,000 to 86,000 MHz = microwaves ~**0.1 of an inch long**

Microwave radiation bioeffects synergistically, not merely additively, with a complexity of simultaneous frequency deployments.

In Switzerland, Sagar (2016) measured public RF exposure levels. The major exposure contribution at outdoor locations was from mobile phone base stations, reaching 0.89 V/m for total RF-EMF. There were quite high levels of exposure in public transport systems; 0.69V/m in trams, 0.46V/m in trains and 0.39V/m in buses.

A study by Dode (2011) looked at the proliferation of mobile phone masts in Belo Horizonte, Brazil. The highest field measured was 12.4 V/m and the lowest was 0.4 V/m. Between 1996 and 2006 the highest mortality rate from tumours was in residents living within 500 metres of the masts.

In 2008 Telstra, the Australian telco had built a high-speed mobile broadband network covering 99% of the population, covering 2 million square kilometres and penetrating up to 100 km offshore and down mines.

Nasseri (2013) concluded that installing antennas in a crowded area needs more care because of higher radiation emissions. More rigid surfaces and mobile phone users are two important factors in crowded areas that can increase RF density and raise public microwave exposure.

In March 2012, Ofcom predicted that the demand for high mobile data rates could grow 800-fold between 2012 and 2030, due largely to the popularity of smartphones and tablet computers. This demand will put a huge strain on mobile networks. Meeting these demands would include building lots more base stations (masts), though all of the measures suggested were felt unequal to meet the growing demand. Ofcom is considering freeing a chunk of the UHF spectrum, the 700 MHz band, currently used for digital TV signals. After exposure to UHF radiation, brain tissue in rats was damaged (Burlaka 2016). The damage caused metabolic reprogramming of cell mitochondria increasing the rate of superoxide radical generation and nitric oxide, which may initiate the development of neurodegenerative diseases and cancer.

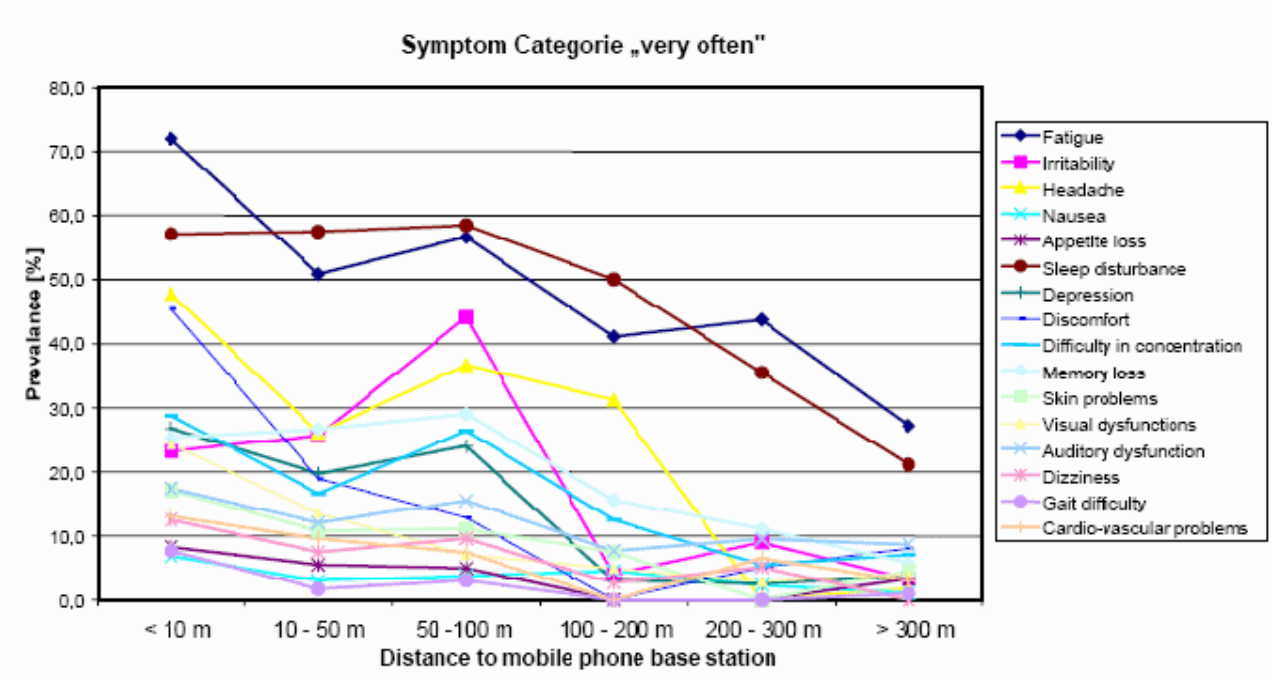
The EU is planning to fill in gaps in legislation and standards to prepare for pan-European deployment of 5G (Science/business February 2016). The plan, due at the end of 2016 will include a commonly agreed calendar for commercial roll out, with the Commission aiming to encourage the automotive, healthcare, energy, and entertainment industries to work with telecommunications companies on the initial deployment of 5G in Europe. By the end of 2020 the technology is expected to be available for industrial use, assuming that new frequency bands for 5G are available. The dependence on 5G will require companies to build new security systems. The world's first 5G network will make its debut at the 2018 Winter Olympics in South Korea, and Oettinger suggested Europe could deploy its first 5G network at a similar event, saying the

final of the EURO 2020 UEFA football championship, which will be played in London, might be one possibility.

Finland introduced the world's most advanced 5G test network at Mobile World Congress 2016 in February. It is also open to companies from outside Finland

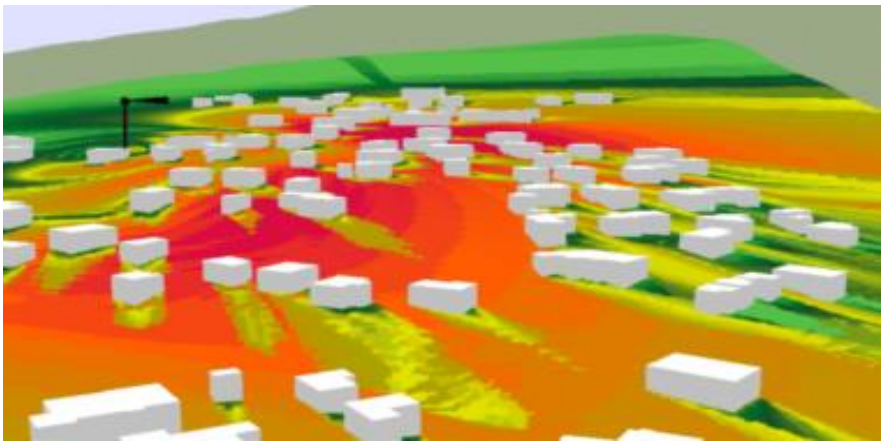
In March 2016 the UK Prime Minister Cameron was asked about how he is going to supply super fast broadband to the whole country. His reply... "well we were all a bit silly 10 years ago when some of us were against phone masts being erected but now we need to change the law so that we can put phone masts where they are needed to cope with the demand ……"

Santini in 2002 produced the following graph of symptoms reported by people living within 300 metres of mobile phone base stations. Professor Santini was told to "shut up or leave his employment" after he had revealed these results. Dimitris Panagopoulos, a researcher at the University of Athens' department of cell biology and biophysics, told the Wire Report that he has been kept back from doing experiments, and gradually excluded from lectures, remaining a post-doctoral fellow when he should have been an assistant professor. After testifying in Canada in 2010, before the House Standing Committee on Health about health risks associated with wireless signals, he was asked to leave his office.



See also: http://www.emrnetwork.org/position/santini_hearing_march6_02.pdf

It seems that there are 2 peaks of symptoms at less than 10 metres and 50 to 100 metres. The second peak in radiation can be clearly seen in the map below.



Navarro (2003) and, in a further re-analysis of Navarro's research, Oberfeld (2004), Bortkiewicz (2004), Hutter (2006), Abdel-Rassoul (2007) and Eger & Jahn (2010) all found significant numbers of people reporting very similar collections of symptoms. The effects began in many cases at 0.05 V/m and often, where measured, the higher the exposure the more the symptoms were reported. Hutter's control threshold of 0.2 V/m may have significantly underestimated the problem. Preece (2007) carried out a questionnaire survey of 3 villages in Cyprus, 2 exposed to GSM phone mast signals (up to 1.4 V/m) and one unexposed. There were also 17.6 MHz military signals but they did not exceed 0.3 V/m. Similar symptoms were found and the higher the exposure, the greater number or severity of symptoms reported. Kim (2010) found signals from mobile phone masts could be as high as 1.5 V/m in Korea.

In Sarabha Nagar, Ludhiana, India, residents in a particular block of flats have become concerned about the number of cancers being reported by the people living there; 7 patients in 7 houses, mainly women and 3 have died. They attribute the cancers to the high level of EMFs from the mobile phone base stations which are nearest to the area where the cancers have occurred.

Santini commented in the study he and his colleagues did in 2003 that "*Our results show a significant increase in symptoms in relation to the age of subjects (older subjects are more sensitive) and also, that facing the location is the worst position for some symptoms studied, especially for distances up to 100 metres from the base stations. No significant difference is observed in the frequency of symptoms related to the duration of exposure from less than 1 year to more than 5 years, with the exception of irritability which significantly increased after more than 5 years.*"

A group of German doctors wrote an open letter to the President of Bavaria, expressing their concern after they had studied the medical records of 357 of their patients and compared their health reports with measured microwave fields at their homes. The doctors found that 70% of patients did not experience health effects if the microwave field levels they lived in were less than 0.06 V/m, whereas when these levels rose to 0.2 V/m and above, only 5-6% of their patients ***did not*** experience health effects. It is important to remember when looking at the graphs (included in Section 4) that microwave signals from mobile phone masts are often above **0.6 V/m** within 400 metres! A Serbian study (Koprivica 2014) found that at distances of less than 50 metres from the bottom of a mobile phone mast, the RF fields varied between less than 1 and 2 volts per metre. A further study found that the maximum measured field exceeded ICNIRP general public exposure reference levels at 2.5 % of locations and Serbian national reference levels at 15.6 % of locations (Koprivica 2016). Koprivica (2016b) reported that microcell base stations with antennas installed indoors typically emit less power than outdoor macrocell base stations, however the fact that people can be found close to antennas requires exposure originating from these base stations to be carefully considered. Measurement results showed that maximum recorded value of electric field strength exceeded International Commission on Non-Ionizing Radiation Protection reference levels at 7% of indoor base station locations.

The German doctors reported that the health disturbances disappear when the exposure ceased.

See: http://www.powerwatch.org.uk/news/20050722_bamberg.asp

Dr. Cornelia Waldmann Selsam, spokesperson for the German doctors, concluded that in order to protect the general public, microwave levels should be below 0.06 volts per metre (V/m). The current UK-allowed level is between 28 and 60 V/m depending on frequency.

In October 2002, several thousand Germans, including 200 qualified medical doctors, signed the 'Freiburger Appeal'. This states that, in their clinical experience, a wide range of symptoms and conditions have increased in incidence in the last few years and they are convinced it is pulsing microwave pollution from cell-phone systems that are causing this. They call for a reduction in mobile phone base station signals, for education to persuade people only to use their mobile phones in emergencies, and for a ban on the use of mobile phones by children.

A German study by Blettner (2008) involved responses from 30,047 people surveyed. They found 18.7% of participants were concerned about adverse health effects of mobile phone base stations, and an additional 10.3% attributed their personal adverse health effects to the exposure from them. The authors concluded "*A substantial proportion of the German population is concerned about adverse health effects caused by exposure from mobile phone base stations. The observed slightly higher prevalence of health complaints near base stations can not however be fully explained by attributions or concerns.*" Hutter, in 2004, after a questionnaire survey concluded that *"contrary to the claims of the telecommunication industry, opponents of celltowers generally do not express unusual fears concerning electromagnetic field exposure."*

In a study by Gómez-Perretta (2013), it was found that concerns about base stations were 3 times more likely to be associated with trouble sleeping. However, when exposure levels only were considered, there was still 1½ times the chance of troubled sleep. Also associated with exposure were lack of appetite, lack of concentration and irritability.

Augner (2009) concluded in his study that *"short-term exposure to GSM base station signals may have an impact on well-being by reducing psychological arousal."*

Many, especially industry, people suggest that the effects people report are due to psychological reasons. The people attribute their feelings of ill-health to the mast, as it is visible to them, and they believe it is affecting them. Kowall (2012) suggested that risk perception as a result of mobile phone base station exposure was strongly associated with concerns about various other risks like the side effects of medications, air pollution or power lines. The number of people expressing their concerns in a self-administered questionnaire stayed at just under 50% from 2004 to 2006.

It is unclear how psychological factors could account for the effects such as those found by Balmori (2005) on a population of storks in Valladolid, Spain; where 40% of storks nesting within 200m of a mast had no chicks, yet only 3.3% of those further than 300m did not have chicks, a highly significant difference. The behaviour of those nearer the masts was also different, more aggressive and less co-ordinated.

Waldmann-Selsam (2016) reported that electromagnetic radiation from mobile phone masts is harmful for trees. The results of the authors' study are consistent with the fact that damage afflicted on trees by mobile phone towers usually start on the side nearest the mast, extending to the whole tree over time.

A study by Furubayashi (2009) looked at a group of women who declared themselves sensitive to RF exposure and compared them with a control group. They found no evidence of a causal link between exposure and symptoms. As they only had 11 subjects in the sensitive group (out of

2,472 returned questionnaires), it seems as if their conclusion was somewhat hasty, and maybe their inclusion criteria need to be re-visited.

It can sometimes be difficult to find out for certain whether the reported health effects are as serious as some people believe. This can be because some of the research is undertaken with industry-funded money and the results are not made freely available. T-Mobile commissioned a scientific report that concluded that mobile phone handsets masts contribute to cancer and genetic damage. The report recommended that exposure limits should be cut to 1/1,000th of our current limits. Dr Hans-Peter Neitzke, of the Ecolog Institute, which produced the report for T-Mobile (2000), accused T-Mobile of diluting the findings by commissioning other studies from which it knew that *"no critical results or recommendations were to be expected"*. Ecolog's report concluded *"Given the results of the present epidemiological studies, it can be concluded that electromagnetic fields with frequencies in the mobile telecommunications range do play a role in the development of cancer." "This is particularly notable for tumours of the central nervous system."*

Over 44% of the World's population live in countries and regions where there are EMF exposure guideline levels which are at least a tenfold stricter than those permitted by ICNIRP. Sometimes these restrictions are only for what are often termed "sensitive areas", in other instances they are the standard maximum permitted exposures for the general public.

It is worth noting that Huss (2007) conducted a systematic review of studies of controlled exposure to radiofrequency radiation with health-related outcomes. From a total of 59 studies in their analysis, 12 were funded exclusively by the telecommunications industry, 11 were funded by public agencies and charities, 14 had mixed funding (including industry), and in 22 the funding was not reported. They found that *"studies funded exclusively by industry reported the largest number of outcomes, but were least likely to report a statistically significant result. The odds ratio was 0.11 compared with studies funded by public agencies or charities."* This means that according to their data, studies funded by the mobile phone industries alone were 9 times more likely to find no effect as those by purely public agencies and charities, and that this difference was significant! They concluded that *"The interpretation of results from studies of health effects of radiofrequency radiation should take sponsorship into account."*

For more information about funding bias, the following books are worth looking out for:

- books by Robert Becker
- "Cell Phones: Invisible Hazards in the Wireless Age: An Insider's Alarming Discoveries About Cancer and Genetic damage" by George Carlo and Martin Schram
- "Something in the Air" by Roger Coghill
- Martin Walker's publications "Skewed" and other recent ones. His website is also interesting www.slingshotpublications.com

It is not just the funding that can result in inadequate research. In one paper looking at measuring personal exposure to RF (Viel 2009) the study subjects carried them in different places, or had the monitor next to them, and the authors themselves admit that most of the time the readings were below the measuring instrument base level sensitivity. It seems as though it couldn't have been designed better if it were intended not to find an effect.

Most inline water conditioners use a weak pulsed electromagnetic field to remove lime scale from plumbing. It is quite possible that mobile phone antennas mounted on water towers could have a similar ionic effect on the water stored inside. If it were to remove the protective lime scale from lead plumbing, the water could become contaminated with lead.

Internet of Things (IoT)

A new generation of short high frequency 5G wavelengths is being proposed to power the Internet of Things. Controversy continues with regards to harm from current 2G, 3G and 4G wireless technologies. 5G technologies are far less studied for human or environmental effects. It is argued that the addition of this added high frequency 5G radiation to an already complex mix of lower frequencies, will contribute to a negative public health outcome both from both physical and mental health perspectives. Like other common toxic exposures, the effects of radiofrequency electromagnetic radiation (RF EMR) will be problematic if not impossible to sort out epidemiologically as there no longer remains an unexposed control group. This is especially important considering these effects are likely magnified by synergistic toxic exposures and other common health risk behaviours. Effects can also be non-linear. Because this is the first generation to have cradle-to-grave lifespan exposure to this level of man-made microwave (RF EMR) radiofrequencies, it will be years or decades before the true health consequences are known (Russell 2018).

Safety zones

The signatories of the Venice Resolution, initiated by the International Commission for Electromagnetic Safety, June 6th 2008, stated *"We are compelled to confirm the existence of non-thermal effects of electromagnetic fields on living matter, which seem to occur at every level of investigation from molecular to epidemiological. We, who are at the forefront of this research, encourage an ethical approach in setting of exposure standards which protect the health of all, including those who are more vulnerable."*

In November 2009, a scientific panel met in Seletun, Norway, for three days of intensive discussion on existing scientific evidence and public health implications of the unprecedented global exposures to artificial electromagnetic fields (EMF). EMF exposures (static to 300 GHz) result from the use of electric power and from wireless telecommunications technologies for voice and data transmission, energy, security, military and radar use in weather and transportation. The panel recommended that new, biologically-based public exposure standards were urgently needed to protect public health worldwide (Fragopoulou (2010).

Blank & Goodman (2009) also call for EMF safety limits to be changed from the thermal standard, due to the increasing evidence for DNA change occurring long before the threshold for thermal changes is reached.

Some countries have imposed a safety zone around telecommunications masts. In Russia, this is 2,000 metres and in New Zealand it is 500 metres. This may merely *change* the health risks. For mobile phone ***users*** the health risks will increase as their phones will have to work at a higher power to connect to, and *stay* connected to, a mast that is further away than to one that is nearer. Phone users have a choice not to use a phone in an area where the signal strength is poor, however. The base stations will have to work hard to get the signal to phone users some distance away, so the people who live nearest to these masts will get higher levels of radiation than those living further away, who may be the people wanting the signal! Crude precautionary measures do not always achieve the desired results, however attractive they may appear to be at first glance. Some national and regional governments have set 'preventive' exposure limits (lower than those advocated by ICNIRP), rather than distance to protect their citizens. These countries include China, Switzerland and Russia, as well as at least 9 EU member states (European Parliament resolution April 2009).

Table: General Public Exposure Limits to RF/microwave radiation in China (Chiang 2009).

Frequency	1st class exposure limits	2nd class exposure limits
0.1-30 MHz	10 V/m	25 V/m
>30-300 MHz	5 V/m	12 V/m
>0.3-300 GHz	10 μW/cm²	40 μW/cm²

1st class exposure limits: Exposures below these levels thought to be safe for permanent exposure and all people (including infants, pregnant mothers, patients, older people, etc.).

2nd class exposure limits: Exposures below these levels acceptable for short-term exposures (factories, parks, recreation spaces, etc.). **Living quarters, hospitals, schools, kindergartens, etc., not allowed to receive such exposures.**

In February 2009, a French Telecommunications company, Bouygues Telecom, appealed against a decision for them to remove a mast. The appeals court ruled "To expose one's neighbour against his will to a risk that is certain and not hypothetical, as claimed by the defence, constitutes a nuisance to one's neighbour. The removal of the risk in this case can only be obtained by the removal of the installation." The company lost its appeal.

The special Eurobarometer report on Electromagnetic Fields (June 2007) indicated that the majority of people do not feel that the public authorities inform them adequately on measures to protect them from EMFs.

After intensive discussion, in 2016, the Swiss Council of States spoke out against an increase of the limit values for mobile phone base stations. The National Council wanted the Council of States to revise the Ordinance on the Protection from Non-Ionizing Radiation because the current conditions were too restrictive from its point of view. However, the Council of States rejected the revision by 20 votes to 19 with 3 abstentions, thus maintaining the current limits. Read the original announcement on the homepage of the Swiss Parliament (in German).

Lloyd's of London

Lloyd's of London excludes any liability coverage for claims "directly or indirectly arising out of, resulting from or contributed to be electromagnetic fields, electromagnetic radiation, electromagnetism, radio waves or noise." This would smart meters, Wi-Fi, appliances in homes, wireless devices in schools, offices and homes.

Potentially people who allow such devices could be held liable for negligence and directors' insurance may not provide financial protection. Lawsuits in some countries have resulted in huge payments (Sharon Noble, Director, Coalition to Stop Smart Meters in British Columbia). http://www.citizensforsafetechnology.org/Lloyds-of-London-excludes-coverage-for-RFEMR-claims,2,4168