

EMF Radiations from Cell Phones and Towers: Are We Safe.

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ABSTRACT

Cell phones emit electromagnetic radiations in the radiofrequency range (450900 MHz in the analog service, and 1,82,2 GHz in the digital service) very close to the user's ear. The skin, inner ear, VIII nerve and the temporal lobe surface, all absorb the radiofrequency energy. We reviewed papers on the effects of cell phone and tower EMF radiations mobile phones on databases, published till 2014, and also materials available in the Internet. Research articles (epidemiologic and animal studies), systemic or meta-analysis review studies, and reports were included in the review. Except for increased risk for glioma at the highest exposure levels, studies published till date haven't shown any increased risk of tumours.

Despite several publications on the carcinogenicity of cell phones, yet, at present, there is no uniformity in the data regarding these effects. Studies concerning cell phone radiation and risk of developing an acoustic neuroma have uncertain results. Continued research is recommended to address carcinogenicity of long-term intensive exposure to cell phones EMF radiations.

KEYWORDS: Cell phone; radiation; EMF; tumor

INTRODUCTION

Telecommunication systems like radio, television, wireless telephones, mobile phones, pagers, radars and satellites all emit invisible electromagnetic radiation or radiofrequency (RF). The radiation spectrum includes microwaves (frequencies between 300 MHz and 300 GHz) and reaches close to infrared radiation.¹ RF is also used daily in microwave ovens and diathermy medical devices (thermos-ablation); the latter are used in treating cardiac arrhythmias, tumours and other conditions.² There are concerns about the possibility of lymphatic cancer, central nervous system tumours (including acoustic neuromas), choroidal melanomas, and other conditions in subjects chronically exposed to RF, which have motivated epidemiological and experimental studies.³⁻⁶

One of the most frequently researched current theme is the effect of mobile phone use on human health, given that these devices transmit microwaves (450-900 MHz in analog systems, and 1.8-2.2 GHz in digital systems)³ very close to a user's heads, specifically to the ear. India has witnessed an exponential increase in the cell phone subscriber base in the last decade. It has also registered an inorganic urban growth with a very high population density in the same period. Indians have a lower body mass index and a lower fat content.

RF is a non-ionizing radiation, as opposed to X-rays and gamma radiation; it does not, therefore, have enough

energy to destabilize electrons or break chemical bonds in DNA.^{1,3,7}

The effect of RF on living organisms may be didactically divided into the following:

THERMAL EFFECTS

They result from water molecule polarization. This is the principle behind microwave ovens and medical diathermy devices.² Telecom workers that are accidentally exposed to high RF loads absorb this energy, which produces heat. They may have skin burns and injury to heat-sensitive tissues, such as the lens of the eye, the testicles and the brain, leading respectively to cataract, male infertility and seizures.^{1,3} Thus, safety guidelines are needed for screening RF/microwave-emitting devices and protecting workers that may be exposed to this radiation.¹ The base stations emit electromagnetic radiations with power ranging above 100 W.⁵ On the other hand the mobile phone handsets usually have a power of around 1-2 W.^{5,8} For mobile phones and base stations the exposures reduce with distance from the source. For mobile phones the principal exposure is to the side of the head for hand held, or to other body parts during hands free use. The base station exposure is for the whole body, but at much lower intensity than from handsets as the handset is much closer except in circumstances when the person is

residing in the vicinity of towers. For the mobile phones the principal exposure is to the side of the head for hand held, or to other body parts during hands free use. It has been calculated that the temperature in the head increases by not more than 0.110C while using a mobile phone, although a feeling of warmth may be felt in the ear during a telephone call.⁹

NON-THERMAL EFFECTS

These effects are mediated by electrical force induction and an increase in heat shock protein synthesis in cells.¹⁰ Continuous heat shock protein synthesis, however, may be involved in oncogenesis, by inhibiting cell apoptosis.¹⁰ . There is a growing body of research on the potential carcinogenic effect of EMFs and though some studies have shown an increased risk of glioma at the highest exposure level, a causal interpretation remains uncertain and subject to debate and further investigation.^{11,12}

The rate at which energy is absorbed by the human body is measured by the Specific Absorption Rate (SAR), which has the unit, Watt/Kg.¹ and its maximum levels for modern handsets have been set by governmental regulating agencies in many countries. SAR value information of the mobile handsets is normally available on the manufacturer's web site & in the handset's manual.

In the USA, the Federal Communications Commission (FCC) has set a SAR limit of 1.6 W/kg, averaged over a volume of 1 gram of tissue, for the head. In Europe, the limit is 2 W/kg, averaged over a volume of 10 grams of tissue. SAR values are heavily dependent on the size of the averaging volume. Without information about the averaging volume used, comparisons between different measurements cannot be made. In India, the SAR limit prescribed for cell phones is 1.6 W/Kg averaged over one gram of human tissue.¹³

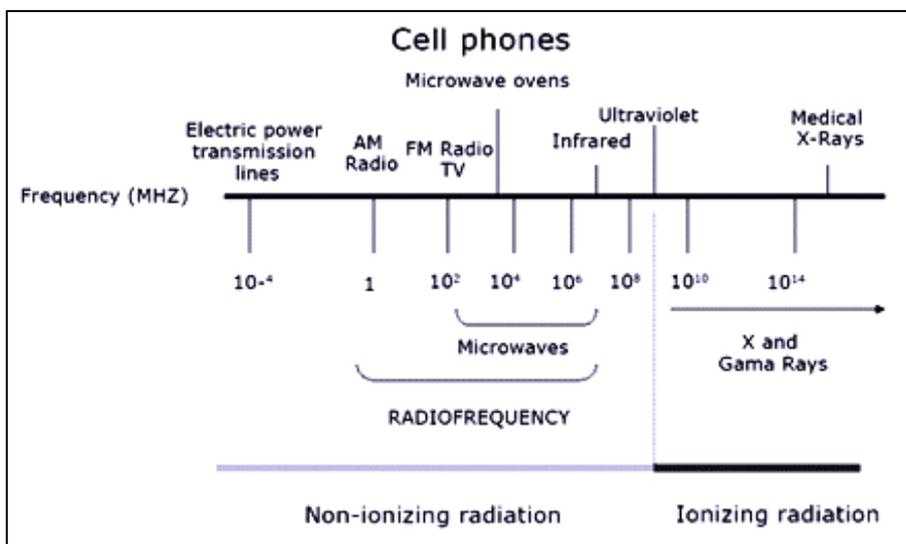


Figure 1: Electromagnetic Radiation Frequency Spectrum.⁸

Various studies have been done to assess the effects of cell phone EMF radiations on the human body. They have reported effects like sensations of burning or warmth around the ear¹⁴, head ache¹⁵, disturbance of sleep¹⁶, alteration of cognitive functions and neural activity^{17, 18} as well as alteration of blood brain barrier and relative decrease in cerebral blood flow.^{19, 20}

Table 1 Comparison of handsets and base stations and Wi-Fi

Exposure	Power	Intensity	Maximum SAR
Source	Watts	Watts per square metre	Watts per kilogram
Handset	1	200	About 1
Base Station	60	0.01	About 0.001
Wi Fi	0.1	<0.01	About 0.0001

EXPOSURE LIMITS

Most exposure limits are now provided in two forms:

- 1) Basic restrictions which are based on SAR values and are difficult to measure.
- 2) Reference (Investigation Levels) which are based on field strengths (v/m, A/m, or W/m²), more easily measured. The reference levels can be exceeded as long as the basic restrictions are not exceeded.

The International commission on non-ionising radiation has set up guidelines on the permitted SAR values for Head and Body³.

Basic restrictions:

- a) Whole Body SAR: up to 0.4 (0.08) W/kg averaged over 6 minutes.
 - b) Head / trunk SAR: up to 10 (2) W/kg based on 10 grams of mass & 6 minute average. [() denotes public.]
- The reference level for general public at cell phone frequency 1800 - 1900 MHz as per ICNIRP is 9 - 9.5 W/m² (based on f in MHz/200)

IN-VITRO STUDIES

Most of the in-vitro studies carried out till date, were concerned with the acute effects of RF rather than the long-term effects. An American study²¹ found no evidence of chromosomal aberrations on assessing cytogenic damage in human lymphocytes that were exposed for 24 h to 835MHz RF at specific absorption rate (SAR) values of 4.4–5W/kg, which are higher than those observed in human tissues exposed to cell phone EMFs. In another American study²², RFR mimicking that of cell phones in frequency (835–847 MHz), modulation, and power (leading to SAR of 0.6 W/kg) was used for a longer duration (42 days) on human fibroblasts. However, no detectable DNA damage was found. A Finnish study by the Bio-Non-Ionizing Radiation Group²³ confirmed the role of the cell phone type of radiation in the induction of a cellular stress response in human endothelial cells through the increase of 'heat shock proteins (hsp-27).' These stress proteins could be responsible for the increase in blood–brain barrier (BBB) permeability to noxious materials.

IN-VIVO ANIMAL STUDIES

According to a very recent review on RFR genotoxicity studies²⁴, to date, most studies of rodents exposed to RFR provide no clear or consistent evidence that this type of radiation causes cancer or that it enhances the carcinogenicity of known chemical carcinogens.

CANCER- RELATED EPIDEMIOLOGICAL STUDIES

By far, the greatest public concern has been that exposure to the low-level RFR emitted from cell phones and their base stations may cause cancer. Although cellular telephone use is comparatively new, since the 1990s, quite a large number of studies have investigated cancer occurrence among cell phone users. However, initial epidemiological studies on brain tumour risk had insufficiently long latency periods to yield a meaningful interpretation of the long-term risk. Only during recent years have a number of studies been published that enable the evaluation of risk related to 10 years or more latency period.

Two case–control studies on brain tumours including assessment of the use of cell phones and cordless phones were undertaken by a Swedish group²⁵ during 1997–2003. The anatomical site in the brain where the tumour was located was assessed for any correlation to the side of the head used for both types of wireless phones. This study reported significant risks for astrocytoma [odds ratio (OR)=3.3, 95% confidence interval (CI)=2.0–5.4] and acoustic neuroma (OR=3.0, 95% CI=1.4–6.2) with ipsilateral cell phone use in the group using cell phones for more than 10 years. The risk was the highest for cases with first use below 20 years of age, with OR=5.2 (95% CI=2.2–12) for astrocytoma and OR=5.0 (95% CI=1.5–16) for acoustic neuroma.

The connection between cell phone use and the risk of glioma was also explored by another case–control study²⁶. The study found an increased OR of statistical significance (OR=1.39, 95% CI 1.01, 1.92) for glioma related to cell phone use for more than 10 years on the side of the head where the tumour was located.

Moreover, a population-based case–control study carried out in three regions of Germany as part of the INTERPHONE study²⁷ reported no significant increase in the risk of glioma and meningioma, except among persons who had used cellular phones for 10 or more years, where the risk for glioma was OR=2.20 (95% CI 0.94, 5.11). The study reached the conclusion that for long-term cellular phone users, results need to be confirmed before firm conclusions can be drawn.

Results of studies on mobile phone handset radiation and the risk of developing acoustic neuroma have been contradictory (Table 1). Some authors have found no increased probability of tumor development in mobile phone users,^{28,29,30,31} while other have stated that the use of mobile phones, particularly analog handsets, for 10 years or more is a risk factor for developing tumors^{5, 32 and 33}.

In 2010, the results of the international multicentre INTERPHONE study carried out from 2000 to 2004 were published¹². The INTERPHONE study was initiated as an international set of case–control studies focusing on four types of tumours in tissues that most absorb RF energy emitted by cell phones: tumours of the brain (glioma and meningioma), acoustic nerve (schwannoma), and the parotid gland.

Sixteen study centres from 13 countries (Australia, Canada, Denmark, Finland, France, Germany, Israel, Italy, Japan, New Zealand, Norway, Sweden, and the United Kingdom) were included, and 2708 glioma and 2409 meningioma cases and matched controls were interviewed.

The objective was to determine whether mobile phone use increases the risk of these tumours and, specifically, whether the RF emitted by mobile phones is carcinogenic. No increase in the risk of glioma or meningioma was observed overall, with the use of cell phones. However, an increased and significant risk of glioma (OR=1.40, 95% CI 1.03–1.89) was observed at the highest exposure levels. Nevertheless, the study group concluded that biases and error prevent a causal interpretation, and recommended further research to explore the possible effects of long-term heavy use of cell phones.

Studies to date have been conflicting about its possibility with mobile phone use. Some epidemiological studies on mobile phone use have hinted at an increased risk of acoustic neuroma, but others have not. The results of the INTERPHONE study were hailed by the mobile phone industry. However this study was criticized by some

researchers, on the grounds that it shares the same limitations as all case-control studies previously carried out on cell phones and cancer. It could investigate only a short period of observation since the exposure onset to cell phones³⁴.

The majority of participants in this study were not heavy cell phone users as per current practices. The brief exposure in most of the cases leaves only a limited incubation time for an exposure-related cancer to develop. Thus, the results of the study are reassuring but should be treated with caution.

Overall, the studies done by several researchers till date indicating no increased risk of cancer in conjunction with cell phone use are larger in number and diversity than studies indicating an increased risk of cancer. Kundi³⁵ in his review article has addressed this controversy. He observed that in most studies; no evidence-based exposure metric was available. The observed duration of cell phone use was generally still too low. These problems precluded the detection of reliable risk estimates. Likewise, in some studies, selection bias, misclassification bias, and effects of the disease on cell phone use could have reduced risk estimates, whereas in other studies, recall bias may have led to dubiously increased risks. He concluded that the overall evidence was in favour of an increased risk, but its extent cannot be assessed properly at present.

As a result of the activities of standards and regulatory bodies, there are a significant number of scientific studies underway within both national and international research programmes, on the health implications of exposure to EMFs, in both public and private laboratories. However, the sheer volume of data being generated can result in the misinterpretation of results or in the inappropriate extrapolation of scientific findings. As a result it can be very difficult to provide relevant timely inputs for the development of policies on EMF and health issues.

The International Agency for Research on Cancer (IARC), a WHO specialized agency, has reviewed the carcinogenic potential of RF fields from Cell phones in May 2011 and now considers them possibly carcinogenic to humans (Group 2B). The reviewed evidence included exposure data, studies of cancer in humans, studies of cancer in experimental animals, and mechanistic and other relevant data. The press release of the IARC working group indicated that the evidence, while still accumulating, is strong enough to support the 2B classification³⁶. This conclusion means that there could be some risk, and that further research is still needed.

This uncertainty over the effects of cell phones justifies future research to better understand the risk of carcinogenicity. Any adverse effect that may eventually be found should be promptly reported; it is a health issue of interest to billions of users worldwide.

HEALTH HAZARDS OF BASE STATIONS

A major concern is the radiation emitted by the fixed infrastructure used for cell phone signal transmission, such as towers, base stations and their antennas. In contrast to mobile handsets, the radiation emitted by these is continuous and more powerful at close quarters. On the other hand, field intensities drop rapidly with distance away from the base of transmitters because of the attenuation of power with the square of distance.

Because base stations operate at less than 100 watts and the antenna is raised up well above ground, the radiation at ground level is much weaker than a cell phone due to the power relationship appropriate for that design of antenna. Base station emissions must comply with safety guidelines. Some countries, however (such as South Africa, for example), have no health regulations governing the placement of base stations.

Several surveys have found a variety of self-reported symptoms for people who live close to base stations³⁷⁻⁴⁰. However, there are significant challenges in conducting studies of populations near base stations, especially in assessment of individual exposure⁴¹. Self-report studies can also be vulnerable to the placebo effect.

Two double-blind placebo-controlled trials conducted at the University of Essex and another in Switzerland⁴² concluded that mobile phone masts were unlikely to be causing these short-term effects in a group of volunteers who complained of such symptoms⁴³. The Essex study found that subjects were unable to tell whether they were being exposed to electromagnetic fields or not, and that sensitive subjects reported lower well-being independently of exposure. The principal investigator concluded "It is clear that sensitive individuals are suffering real symptoms and often have a poor quality of life. It is now important to determine what other factors could be causing these symptoms, so appropriate research studies and treatment strategies can be developed."

In 2000, the World Health Organization (WHO) recommended that the precautionary principle could be voluntarily adopted by all concerned⁴⁴. It follows the recommendations of the European Community for environmental risks. According to the WHO, the "precautionary principle" is "a risk management policy applied in circumstances with a high degree of scientific uncertainty, reflecting the need to take action for a potentially serious risk without awaiting the results of scientific research."

CONCLUSION

The published literature till date does not establish a clear link between cell phone use and the risk of any brain tumour up to 10 years of use. Some association with glioma has been observed at the highest exposure levels. Absence of an association so far, for slower growing tumours such as acoustic neuromas does not

exclude its likelihood, because the observation period has been too short. The need of the hour is a larger prospective cohort study to address the issue of carcinogenicity.

CONFLICTS OF INTEREST

There are no conflicts of interest.

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