

BIOPHYSICAL IMPACTS OF RADIO FREQUENCY RADIATION FROM CELL TOWERS ON LIVING BEINGS-AN OVERVIEW

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Abstract

The unprecedented growth in global communication industry in the recent years has resulted in dramatic increase in no. of wireless devices like cell phones. In India , currently there are nearly 904.5 million cell phone subscribers. This has led to mushrooming growth of supporting infrastructure in the form of cell towers which provides link to and from the cell phone. With no regulations on the location of cell towers, they are being placed haphazardly closer to schools, crèches, public playgrounds, on commercial buildings, hospitals, college campuses and terraces of densely populated urban residential areas. Hence the public is being exposed to continuous low intensity radiation from these towers. Since these electromagnetic radiations can't be seen , smelt or felt, one would not realize their potential harm over long periods of exposure until they manifest in the form of biological disorders. We have made an attempt to review the biophysical impacts of these radiations being emitted continuously from cell towers.

Keywords: Electromagnetic Radiations,Exposure, Biophysical Impact

1. Introduction

In the last decade, the Indian telecom sector in general and mobile telephony in particular has witnessed phenomenal growth. ^[1]As on Dec 2015, In India , currently there are nearly 904.5 million cell phone subscribers.The popularity of the cell phone and wireless communication devices has resulted in a proliferation of cell towers across the country.. There has been growing public concern on possible adverse health effects due to Electro-magnetic field (EMF) Radiation from mobile towers and mobile handsets. Over the past few years, a number of health activists and resident organisations have started opposing the erection of telecom towers on rooftops of houses and in densely populated areas, claiming that radiation from such installations causes serious health risks. There have been several studies suggesting either the presence or absence of risk to human beings from EMF radiation. The main areas

of concern are the radiation emitted by the base transceiver stations (BTS) and mobile handsets. Concerns have also been raised that continuous exposure to EMF radiation emanating from telecom towers causes harmful thermal and non-thermal health effects. The effects of exposure to EMF have created an active scientific debate among the research agencies across the globe..

1.1.Radiation from Cell Towers:

A cell phone transmits 1 to 2 Watt of power in the frequency range of 824 - 849 MHz (CDMA), 890 - 915 MHz (GSM900) and 1710 – 1780 MHz (GSM1800). A cell phone has a SAR (Specific Absorption Rate) rating. In USA, SAR limit for cell phones is 1.6W/Kg which is actually for 6 minutes per day usage. It has a safety margin of 3 to 4, so a person should not use cell phone for more than 18 to 24 minutes per day. This information is not commonly known to the people in India, so crores of people use cell phones for more than an hour per day without realizing its associated health hazards.

Cell tower antennas transmit in the frequency range of 869 - 894 MHz (CDMA), 935 - 960 MHz (GSM900) and 1810 – 1880 MHz (GSM1800)^[2]. Also, 3G has been deployed in a few cities, in which base station antenna transmits in the frequency range of 2110 – 2170 MHz. Mobile phone operators divide a region in large number of cells, and each cell is divided into number of sectors. The base stations are normally configured to transmit different signals into each of these sectors. In general, there may be three sectors with equal angular coverage of 120 degrees in the horizontal direction as this is a convenient way to divide a hexagonal cell. If number of users is distributed unevenly in the surrounding area, then the sectors may be uneven. These base stations are normally connected to directional antennas that are mounted on the roofs of buildings or on free-standing masts. The antennas may have electrical or mechanical down-tilt, so that the signals are directed towards ground level.

A base station and its transmitting power are designed in such a way that mobile phone should be able to transmit and receive enough signal for proper communication up to a few kilometers. Majority of these towers are mounted near the residential and office buildings to provide good mobile phone coverage to the users. These cell towers transmit radiation 24x7, so people living within 10's of meters from the tower will receive 10,000 to 10,000,000 times stronger signal than required for mobile communication. In India, crores of people reside within these high radiation zones.

A GSM900 base station antenna transmits in the frequency range of 935 - 960 MHz. This frequency band of 25 MHz is divided into twenty sub-bands of 1.2 MHz, which are allocated to various operators. There may be several carrier frequencies (1 to 5) allotted to one operator with upper limit of 6.2 MHz bandwidth. Each carrier frequency may transmit 10 to 20W of power. So, 4 one operator may transmit 50 to 100W of power and there may be 3-4 operators on the same roof top or tower, thereby total transmitted power may be 200 to 400W. In addition, directional antennas are used, which typically may have a gain of around 17 dB (numeric value is 50), so effectively, several KW of power may be transmitted in the main beam direction.

1.2 Radiated Power Density from cell Tower:

Power density P_d at a distance R is given by

$$P_d = (P_t \times G_t) / 4\pi R^2$$

Where, P_t = Transmitter power in Watts

G_t = Gain of transmitting antenna

R = Distance from the antenna in meters

One should know actual radiation pattern of the antenna to calculate exact radiation density at a point.

1.3 Radiation Pattern of the Antenna:

The simulated radiation pattern of GSM900 antenna of approximately 17 dB gain at 950 MHz of size 2400 mm x 30 mm is shown in Fig. 1. below. ^[3] Radiation pattern of the antenna is shown in two planes – horizontal and vertical. There is one main lobe and several side lobes. For the main lobe, half-power beam-width (HPBW – defined as angular range over which maximum power decreases to half of its value) in the horizontal direction is 65 degrees and HPBW in the vertical direction is 6 degrees. There are several side lobes, whose maximum levels are about -13 to -20 dB below the main level.

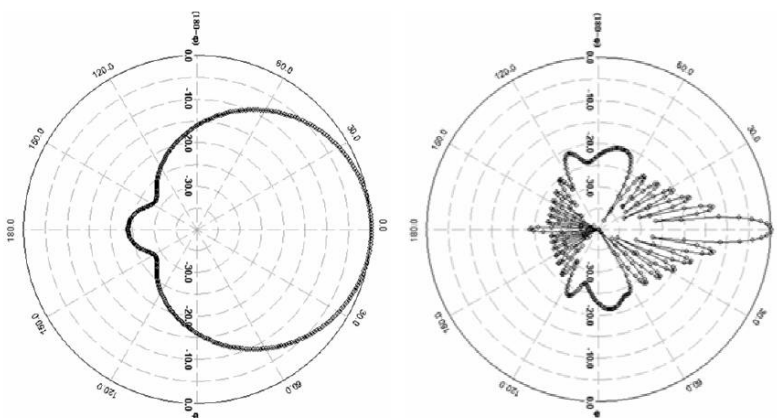


Fig 1. Horizontal and vertical radiation pattern of antenna

1.4 Radiations standards in India:

In India, we have adopted radiation standards given by ICNIRP guidelines of 1998 for safe power density of $f/200$, where frequency (f) is in MHz. Hence, for GSM900 transmitting band (935-960 MHz), power density is 4.7W/m² and for GSM1800 transmitting band (1810-1880 MHz), it is 9.2W/m².^[4]The ICNIRP guidelines clearly state that for simultaneous exposure to multiple frequency fields, the sum of all the radiation must be taken into consideration. However, in India, we have applied this limit to individual carrier, so the radiation level exceeds by several times than even prescribed by ICNIRP guidelines, depending upon the total number of transmitters in that area. Some of the people (especially older people, house wives, small children) living near the towers are exposed to this radiation 24 hours a day. Unfortunately, ICNIRP has considered only the thermal effects of radiation, whereas scientists all over the world have found nonthermal effects of these radiations to have significant health effects and these non-thermal health effects occur at levels much below these norms.

2. Review of related literature:

Santini R.(2003), conducted a survey using a questionnaire having 18 different non specific health symptoms described as radio frequency sickness and studied using chi square test. results show significant increase ($p < 0.05$) in relation with age of subjects (elder subjects are more sensitive) and also, that the facing location is the worst position for some symptoms studied, especially for distances till 100 m from base stations. No significant difference is observed in the frequency of symptoms related to the duration of exposure (from < 1 year to > 5 years), excepted for irritability significantly increased after > 5 years. **Sivani.S(2012)**, studied the effect of radio-frequency electromagnetic field (RF-EMF) from cell towers and wireless devices on the biosphere. It was concluded that RF-EMF radiation exposure can change neurotransmitter functions, blood-brain barrier, morphology, electrophysiology, cellular metabolism, calcium efflux, and gene and protein expression in certain types of cells even at lower intensities. The biological consequences of such changes remain unclear. Short-term studies on the impacts of RF-EMF on frogs, honey bees, house sparrows, bats, and even humans are scarce and long-term studies are non-existent in India. **Sakharam D. Aghav(2014)**, conducted ECG study, two groups of subjects of age 20 to 30 and 30- 40 year

were selected. It is observed that for male of age group 20-30, R_c varies from 2.81% to 6.41% showing significant change of 6.4% bpm in heart rate in silent mode. This is because in silent mode all the signals are totally electromagnetic radiation which is very harmful to our heart and in other modes some signal is utilized for vibration or ringing. For female of same group the variation in HR is -2.46 to 1.46%. It is also noted that the change varies from person to person.

3. Biological effects of RF radiation emanating from cell tower:

When a human body is exposed to the electromagnetic radiation, it absorbs radiation, because human body consists of 70% liquid. It is similar to that of cooking in the microwave oven where the water in the food content is heated first.^[5] Microwave absorption effect is much more

significant by the body parts which contain more fluid (water, blood, etc.), like the brain which consists of about 90% water. Effect is more pronounced where the movement of the fluid is less, for example, eyes, brain, joints, heart, abdomen, etc. Also, human height is much greater than the wavelength of the cell tower transmitting frequencies, so there will be multiple resonances in the body, which creates localized heating inside the body. This results in boils, drying up of the fluids around eyes, brain, joints, heart, abdomen, etc.

There are several health hazards associated with cell phones and cell towers. Some of these are described in the following sub-sections.

3.1 The Blood Brain Barrier:

The brain is protected by tight junctions between adjacent cells of capillary walls by the blood brain barrier (BBB), which selectively lets nutrients pass through from the blood to the brain, but keeps toxic substances out.^[6] Experiments conducted on young laboratory rats found that RF from mobile phones can significantly open the BBB in animals and cause leakage of albumin from blood vessels in inappropriate locations (neurons and glial cells surrounding the capillaries) in the brain.

3.2 Risk to Children and Pregnant Women:

Children are more vulnerable to cell phone radiation as they:

- Absorb more energy than adults from the same phone owing to their smaller head and brain size, thinner cranial bones and skin, thinner, more elastic ears, lower blood cell volume, as well as greater conductivity of nerve cells and the energy penetrates more deeply.^[7] Tumors in

the mid brain are more deadly than in the temporal lobe,

- Children's cells reproduce more quickly than adults which makes cancers more deadly,
- Their immune system is not as well developed as adults hence are less effective against fighting cancer growth,
- Children have longer life time exposure.

In a recent finding,^[8] an association was found between a mother's cell phone use during pregnancy and greater likelihood for spontaneous abortion, congenital malformations and behavioral problems in their children. It is believed that the eggs, which form the embryo, are affected and the damage will become apparent after the child reaches puberty.

3.3 Irreversible infertility:

Recent studies confirm that cell phone radiation can drastically affect male fertility. In 2006, the American Society for Reproductive Medicine reported that use of cell phones by men is associated with decrease in semen quality, sperm count, motility, viability and normal morphology and is related to the duration of cell phone use.^[9] Studies have found 30% sperm decrease in intensive mobile phone users, in addition to damage of sperms. The average sperm count was found to be at 59 million sperm per milliliter of seminal fluid compared to 83 million for men not continually exposed to mobile phone radiation.

3.4 Interference with other gadgets including Pace Makers:

Cell phone radiation interferes with navigational equipment; therefore its use is banned in airborne flights.^[10] Electromagnetic interference (EMI) from mobile phones can cause malfunctioning of life-line electronic gadgets in the hospitals thereby potentially endangering patients. It is also advisable to restrict mobile phone use in clinical areas like operating theatres and intensive care units.

3.5 Effect on Skin:

Radiation from cell towers and mobile phones affects human skin.^[11] People who talk often on cell phones have a higher concentration of the *transthyretin* protein than those who do not. *Transthyretin* is formed in the liver; it helps transport vitamin A in the body and plays an important role in nervous diseases such as Alzheimers.

3.6 Tinnitus and Ear Damage:

Tinnitus, popularly known as "Ringxiety"- is the psychological disease of hearing phantom sound and sensation of cell phone ring and it has been reported among millions of cell phone users in the world^[12]. People with severe tinnitus may have trouble hearing, working or even sleeping. The radiation emitted by mobile phones may damage the delicate workings of the inner ear, and long-term and intensive mobile phone use for more than four years and for

longer periods than 30 minutes in a day are at a higher risk of developing hearing loss, which cannot be reversed.

3.7 Effect on Eye/ Uveal Melanoma:

Frequent use of mobile phones can also damage the visual system in many ways and cause uveal melanoma i.e. tumor of the eye. ^[13]Tumors involve the choroid (98%), iris (1%) and unknown parts of the uveal tract (1%). Computational modeling and experiments with several laboratory animals show that microwave radiation similar to mobile phone frequencies (900, 1800 MHz and 2450 MHz) can induce chromosomal breaks in the corneal epithelial cells and increase the intraocular temperature of the eye with prolonged exposure.

3.8 Sleep Disorders:

Electromagnetic fields have been shown to affect the brain physiology. Use of mobile phones disturbs Stage 4 sleep, the stage important for full recuperation of brain and body^[14]. Use of the handsets before bed, delays and reduces sleep, and causes headaches, confusion and depression. The findings are especially alarming for children and teenagers as they use cell phones at night and also keep the phone next to their head; which may lead to mood and personality changes, depression, lack of concentration and poor academic performance.

3.9 Increase in Cancer risk:

Heavy use of mobile phones can cause cancer. ^[15]Use of mobile phones for >10 years give a consistent pattern of increased risk for brain cancer - glioma (cancer of the glial cells that support the central nervous system) and acoustic neuroma (a benign tumor in the brain on a nerve related to hearing). The risk is highest for ipsilateral (on the same side of the head where the instrument is held) exposure. Children and teenagers, before the age of 20 are five times more likely to get brain cancer, as their brain is not fully developed and radiation penetration is much deeper. It is possible that today's young people may suffer an "epidemic" of the disease in later life. Besides increase in brain tumour and acoustic neuroma, there is an increased risk of several other types of cancers following prolonged exposure to mobile phone/ tower radiation, such as, salivary gland tumors, uveal melanoma, lymphoma, facial nerve tumors, skin, blood, testicular and breast cancer. Interphone study has also found a 'significantly increased risk' of some brain tumors for heavy users of mobile phones (> 20 minutes per day) for a period of 10 years or more.

3.10 Possible Solutions to reduce the ill effects of cell tower radiation:

There are several health hazards due to radiation from the cell towers to the human, birds, animals and environment. In India, we have adopted very relaxed radiation norms of 4.7 W/m² for GSM900, whereas serious health effects have been noted at as low as 0.0001

$W/m^2 = 100 \mu W/m^2$ ^[16] One of the first steps to be taken is to tighten the radiation norms and yet it should be practical enough to be cost effective without causing too much inconvenience to the users. It is recommended that maximum cumulative power density allowed should be reduced with immediate effect to $0.1 W/m^2$, which should then be subsequently reduced to $0.01 W/m^2$ within a year, so that network planning can be carried out in a phased manner. It must be noted that a few countries have even adopted $0.001 W/m^2$ or lower^[17], so our proposed recommendation is higher than these countries to keep it cost effective. All the operators must be strictly instructed that power density inside residential or office buildings, schools, hospitals, and at common frequently visited places should be within these guidelines.

4. Conclusions:

The seriousness of the health hazards due to radiation from the cell phones and cell towers has not been realized among the common man. Cell operators continue to claim that there are no health issues. Even organizations like WHO, ICNIRP, FCC, etc. have not recommended stricter safe radiation guidelines, whereas several countries have adopted radiation norms, which are 1/100th to 1/1000th of these values based on their studies. Cell phone industry is becoming another cigarette industry, which kept claiming that smoking is not harmful and now there are millions of people around the world who have suffered from smoking. In fact, cell phone/tower radiation is worse than smoking; as one cannot see it or smell it, and its effect on health is noted after a long period of exposure. Therefore, majority of people tend to have casualness towards personal protection. Unfortunately, ignorance and non-awareness adds to this misery and all of us are absorbing this slow poison unknowingly. Even if people are aware of the radiation hazard, they may not have the choice to move away from it if the tower is installed near their office or residential building.

Acknowledgements: The authors are thankful to Principal ,I B college, Panipat for her help and cooperation in writing this review paper.

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