

## Mobile Phone and Auditory Effects? Time to Think

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### Abstract

Today this is difficult to think a life without a mobile. Mobile phone use has increased dramatically since its introduction in the early-to-mid 1980's. In the last 20 years, worldwide mobile phone subscriptions have increased from 12.4 million to over 5.6 billion, involving about 70% of the global population. India holds second position with about 885 million users, that is, 74% of Indian population. Mobile phone emits electromagnetic radiation in the microwave range around 2.5 GHz range and health concerns have been raised. On May 31, 2011 the WHO International Agency for Research on Cancer (IARC) categorized the radiation fields from mobile phones, and from other devices that emit similar non-ionizing electromagnetic fields (EMFs), as a Group 2B i.e., a 'possible' human carcinogen. When the mobile is in use, all the components of the auditory system including the skin, external and middle ear, the inner ear, cochlear nerve and the temporal lobe surface absorb the radiofrequency energy. The widespread use of mobile phones in recent years has given rise to concerns about the potential influences of its electromagnetic fields (EMFs) on human ear. Little attention has been paid to the effects of electromagnetic field (EMF) of mobile phones on hearing.

**Keywords:** Electromagnetic fields (EMFs); Mobile, Auditory Effect, Hearing.

### Introduction

Mobile phone use has increased dramatically since its introduction in the early-to-mid 1980's. Mobile phone usage is over 5.6 billion worldwide. In the last

20 years, worldwide mobile phone subscriptions have increased from 12.4 million to over 5.6 billion, involving about 70% of the global population.<sup>1</sup> India holds second position with about 885 million users, that is, 74% of Indian population (November 2011).

Mobile telephones are now an integral part of modern telecommunications. Mobile phone radiation and health concerns have been raised, especially following the enormous increase in the use of wireless mobile telephony throughout the world. This is because cell phones use Electromagnetic radiation in the microwave range around 2.5 GHz range. These concerns have induced a large body of research in animals and in humans. In the late 1990s, several expert groups critically reviewed the evidence on health effects of low-level exposure to radiofrequency (RF) electromagnetic fields, and recommended research into the possible adverse health effects of mobile telephone use. On May 31, 2011 the WHO International Agency for Research on Cancer (IARC) categorized the radiation fields from mobile phones, and from other devices that emit similar non-ionizing electromagnetic fields (EMFs), as a Group 2B i.e., a 'possible' human carcinogen. The widespread use of mobile phones in recent years has given rise to concerns about the potential influences of its electromagnetic fields (EMFs) on human ear. Little attention has been paid to the effects of electromagnetic field (EMF) of mobile phones on hearing. A review of literature failed to prove conclusively the prolonged mobile phone use effect on auditory function. Various studies conducted had contradictory results.

Mobile phones have become indispensable as communication tools; however, to date there is only a limited knowledge about interaction between electromagnetic fields (EMF) emitted by mobile phones and auditory function.<sup>2</sup> A review of literature failed to prove conclusively the prolonged mobile phone use effect on auditory function. Various studies conducted had contradictory results. The reported effects associated with exposure to mobile phones on the auditory system did not show a consistent pattern. With the recent popularity of mobile phone use among the young people and children, and therefore potentially longer lifetime exposure, further studies are required to fill the gaps in the knowledge regarding harmful effects of EMFs from mobile phones on ear.

Mobile phones are two way radios that transmit and receive information via radio waves also known as radiofrequency (RF) energy. Global system for mobile (GSM) communications is the world's most popular standard for mobile telephony systems. GSM networks operate in a number of different carrier frequency, with most 2G GSM networks operating in the 900 MHz or 1800 MHz bands and most 3G networks operate in 2100 MHz. CDMA 2000 (Code Division Multiple Access) is the other

popular technology standard which uses CDMA channel access, CDMA uses frequencies from 824 MHz to 894 MHz. These frequencies fall in the microwave range of the electromagnetic spectrum. In India mobile phones operate in the frequency range of:<sup>3</sup>

- 869–890 MHz (CDMA)
- 935–960 MHz (GSM900)
- 1805–1880 MHz (GSM1800)
- 2110–2170 MHz (3G).

In contrast to ionizing radiation, electromagnetic fields emitted from cellular telephones do not have enough energy to break chemical bonds or damage DNA. Electromagnetic radiation from a cell phone can penetrate the skull and deposit energy 4–6 cm into the brain. This can potentially result in a heating of the tissue of up to 0.1°C.<sup>4</sup> Therefore, it has been debated whether these fields could damage the tissue or not. The radio waves emitted by a GSM handset can have a peak power of 2 W, and a US analogue phone had a maximum transmit power of 3.6 W. Other digital mobile technologies, such as CDMA2000 use lower output power, typically below 1 W.

The use of mobile telephones transmit and receive microwave radiation at frequencies of about 900 Megahertz (MHz) and 1800 MHz and these frequencies excite the rotations of the water and some organic molecules and have been attributed to thermal and non-thermal effects. The widespread use of mobile telephones has given rise to the question of whether the EMFs created by mobile telephones is detrimental to the hearing of their users. Mobile telephone use necessitates to hold in close proximity with the ear, and so far it has not been reported as a cause of hearing loss in the literature.<sup>2</sup>

While using cell phone for talking or being connected to someone the user gets exposed to harmful electro magnetic radiations. The exposure rate to these radiations vary from handset to handset. When cell phones are used in close proximity to human body, the radiations emitted from cell phones penetrate deep inside the human skin. Penetrated radiations produce induced electric field inside the body, resulting in absorption of power, which can be analyzed using a parameter called specific absorption rate (SAR). But still one question arises in mind that are people really aware of Safety standard especially SAR value. What does SAR value mean? It's the specific absorption ratio measure of amount of radio frequency intensity or energy absorbed by body while connected

on cellular network. It is defined as the power absorbed per mass of tissue and has units of watts per kilogram (W/kg) and in a way defines safety range of mobile handset. SAR provides little information about the biological consequences unless the amount of energy absorbed is known. SAR is usually averaged either over the whole body, or over a small sample volume (typically 1 g or 10 g of tissue). The value cited is then the maximum level measured in the body part studied over the stated volume or mass. The maximum power output from a mobile phone is regulated by the mobile phone standard and by the regulatory agencies in each country.<sup>5</sup>

International Commission on Non-Ionising Radiation Protection (ICNIRP) is a body of independent scientific experts established with an aim to provide information and insight into the potential health hazards of exposure to non-ionising radiation. According to ICNIRP guidelines for limiting exposure to time varying electric, magnetic and electromagnetic fields, the maximum SAR value for mobile phones has been set at 2 W/kg localized for the head and the trunk (of a human) in the frequency range of 10 MHz to 10 GHz. It means in countries such as India where these guidelines are adopted, the specific absorption rate (SAR) of every mobile phone sold in the country should be less than 2 W/kg. In India, the SAR limit prescribed for cell phones is 1.6 W/Kg averaged over one gram of human tissue.<sup>3</sup>

There are two direct ways by which exposure to radio frequency radiations can affect health. These are thermal effects caused by holding mobile phones close to the body and possible non-thermal effects.<sup>6</sup> Electromagnetic radiation from a cell phone can penetrate the skull and deposit energy 4-6 cm into the brain. This can potentially result in a heating of the tissue of up to 0.1°C.<sup>4</sup> The non-thermal effects include electrical force induction and possibly an increase in heat shock protein synthesis in cells. Continuous heat shock protein synthesis may be involved in oncogenesis, by inhibiting cell apoptosis. Low-energy EMFs seem to cause structural and functional changes in the cell membrane of different cell types, leading to abnormal cell response. Various studies suggest that EMR directly affects neurons by reducing the neuronal reactivity, increasing the neural membrane conductivity and prolonging their refractory period. Thus, the auditory system, the cochlea and the auditory (VIII) nerve which directly receive EMF during mobile phone use are particularly at risk and therefore should be

studied for any changes resulting from the thermal and non-thermal effects of EMF.<sup>3</sup> Electromagnetic field (EMF) radiations may cause adverse health problems such as headache, sleep disorders, impairment of memory, lack of concentration, dizziness, increased frequency of seizures in epileptic children, brain tumours and high blood pressure.<sup>6</sup> Sensations of burning or warmth around the ear, head ache, disturbance of sleep, alteration of cognitive functions and neural activity as well as alteration of blood brain barrier and relative decrease in cerebral blood flow have been reported as effects of mobile phone use.<sup>3</sup>

Many scientific studies have investigated possible health effects of mobile phone radiations. Exposure to electromagnetic fields has been linked to different forms of cancer<sup>7-11</sup> (e.g., lymphoma, brain tumors, leukemia), various neurological disease (Alzheimer's disease), sleep disturbances,<sup>12,13</sup> and genotoxic effects.<sup>13</sup> Telecommunications systems emit radiofrequency, which is an invisible electromagnetic radiation. Mobile phones operate with microwaves very close to the users ear. The skin, inner ear, cochlear nerve and the temporal lobe surface absorb the radiofrequency energy.<sup>14</sup> The electromagnetic fields emitted from mobile can penetrate skull and deposit energy 4-6 cm into the brain resulting in heating of the tissue. There is general concern regarding the possible hazardous health effects of exposure to radiofrequency electromagnetic radiation emitted from mobile phones. Handsets are held against the head while a call is made. Typically, the distance from the antenna to the head is only about 2 cm or less. The skin, inner ear, VIII nerve and the temporal lobe surface absorb the radiofrequency energy. When the mobile is in use, all the components of the auditory system including the skin, external and middle ear, the inner ear, cochlear nerve and the temporal lobe surface absorb the radiofrequency energy. Also the outer hair cells in the cochlea are known to be highly sensitive to a great variety of exogenous and endogenous agents including externally applied electrical and magnetic fields.<sup>3</sup> The mobile phone is used by bringing it close to the ear which increases the specific absorption rate (SAR) of EMFs by the brain which may affect the auditory system. The absorption of mobile phone's radiofrequency (RF) output power energy in the users head may be as high as 40-55%.<sup>15</sup>

Most of the studies on auditory effects of mobile phones have investigated only the short term effect of mobile phone handset EMF radiation on the auditory system and the result obtained did

not reveal any information regarding the potential effects of longer exposure or chronic cumulative exposure. A review of recent studies on the possible effects of mobile phone signals on the auditory system found that mobile phone use can affect the hearing function of users according to the duration of use. Short-term exposure at the maximum output of consumer mobile phones does not cause measurable immediate effects on the human auditory system, whereas longterm (more than 1 year) and intensive mobile phone use may cause inner-ear damage and can lead to high-frequency hearing loss.<sup>16-20</sup> Almost all studies recommend further studies in larger population over a longer time. However, the limited data can result in the misinterpretation of results or in the inappropriate extrapolation of scientific findings.<sup>3</sup>

Considering that the use of cell phones by children and adolescents, has been increasing in recent years and also with the onset of use starting very early in life, children will have a longer lifetime exposure than adults. However, only a few relevant epidemiological or laboratory studies have addressed the possible effects of cell phone exposure on children.<sup>21</sup>

Little attention has been paid to the effects of electromagnetic field (EMF) of mobile phones on hearing and there are contradictory reports regarding it in literature. Mobile phone usage is widespread and concerns have been raised on the safety of its long-term usage. Since ear is the closest organ to mobile phones receiving higher energy deposition than other organs, the effects of mobile phone radiation on hearing has been debated.<sup>14,22</sup> The widespread use of mobile phone has given rise to genuine concern regarding the potential influences of electromagnetic fields (EMFs) on human health.<sup>23</sup>

## Conclusion

As uncertainty prevails concerning the auditory effects of cell phones, precautionary measures are best adopted by all concerned parties, namely governments, mobile companies, and the public and further research is required in the field.

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