

Effect of Exposure to Mobile Phone Radiations on Human Health- a Review

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Abstract— Widespread utilization of mobile phones and other wireless devices raise the concern about potential health effects related to their uses. It is therefore, required to conduct researches to find out the possible biological health effects due to exposure of cell phone radiations. This review summarizes the health issues based on mobile phone radiations and concludes that regular and long term usage of mobile phone can have bad impact upon biological tissues especially of head and brain.

Index Terms— Biological effects, Exposure, radio frequency, SAR, temperature.

I. INTRODUCTION

Wireless systems are nowadays increasingly used. In present time, mobile phones are not only used to talk but also to watch. In the past fifteen years, Widespread utilization of mobile communication systems has caused great concern about the probable health effects caused by the radio frequency (RF) fields emitted from mobile phones. The possible biological effects arising from the use of mobile phones can be regarded as a result of energy absorbed by the head that may affect the brain and nervous system tissue. When using electronic devices such as mobile phone, invisible electromagnetic waves are generated. These waves can be absorbed by lossy material such as human body tissues. The RF fields emitted from mobile phones penetrate the exposed tissues producing heat. This thermal effect can cause harm by increasing body temperature, and damaging biological tissue, particularly those of head and brain. The human head is one of the most sensitive parts of the human entire body when exposed to electromagnetic radiation. The electromagnetic radiation interacts with the human head and may lead to detrimental effects on human health like dizziness, fatigue, headaches, sleep disruptions, altered memory function and poor concentration. However, it must be pointed out that to date there is no serious biological effects have been identified yet. Although most of the experimental data support the effects of mobile phone radiation exposure, there are large areas of confusion, unsureness and actual misinformation. It is important, therefore, to review the present state of biologic effects of electromagnetic radiations.

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In order to determine the biological effects of mobile phone radiations it is necessary to specify the amount of absorbed energy in the tissue which is exposed to the electromagnetic radiations. A measure of this absorbed energy is provided by *Specific Absorption Rate (SAR)*. SAR is defined as the amount of absorbed energy per mass of the tissue and has units in Watts per Kilogram (W/kg). There are some standard regulatory bodies which decide the limit of amount of radiations being absorbed by human bodies. Different countries follow different standards. In United State, for exposure to RF energy from wireless devices, the allowable Federal Communications Commission (FCC) SAR limit is 1.6 W/kg, averaged over 1gram of tissue for duration of 30 minutes [1]. While in Europe, according to International Commission of Non-ionizing Radiation Protection (ICNIRP) the allowable SAR limit is 2W/kg, averaged over 10 gram of tissue for duration of 6 minutes [2]. Additionally IEEE C95.1 gives recommendation to prevent harmful effects in human beings exposed to electromagnetic fields in the frequency range from 3 kHz to 300 GHz [3]. In the present review we emphasize on the studies that indicate the probable biological health effects of electromagnetic radiations which we received through mobile phones.

II. REVIEW ON PROBABLE HEALTH EFFECTS OF MOBILE PHONE RADIATIONS

Many scientific studies have investigated possible health implications of mobile phone radiation. Generally a mobile phone consists of an omnidirectional antenna which ideally radiates in all directions. A part of these radiations is absorbed by nearby biological tissues, which results in increase in temperature in that tissue. Basically electromagnetic radiations are categorized in two ways; ionizing radiations and non-ionizing radiations. Ionizing radiations like X-rays, gamma rays have sufficient energy to liberate an electron from its parent atom and thus it can cause severe damage. Non-ionizing radiations like RF waves, microwaves do not have sufficient energy to liberate an electron from its parent atom. Although it is considered as less dangerous than ionizing radiation but over exposure to non-ionizing radiation can also lead to health issues. Radiations received through mobile phones fall under the category of non-ionizing radiations. Absorption of radiations beyond a certain limit may also lead to adverse health effects. A very small temperature rise in hypothalamus of 0.2–0.3 degree Celsius leads to altered thermoregulatory behavior said E.R. Adair et al. [4]. While, according to J. Wang et al. [5], since the normal active heat transfer is very effective in regulating temperature in the brain, a temperature rise of up to 3.5 degree Celsius in

the brain is harmless and does not cause any physiological damage.

Several studies have suggested that children are more sensitive to electromagnetic radiations than adults. In a study by S. Koulouridis et al. [6] children less than 16 years of age should be discouraged from using mobile telephones since they may absorb more energy from a given telephone than adults do because of their smaller heads, thinner skulls and higher tissue conductivity. Radio frequency radiation is non-ionizing and therefore cannot directly cause DNA damages. But according to C.F. Blackman [7] DNA can be effected even from non-ionizing and low level radiation. Professor D. Leszczynski et al. [8] of Finland's radiation and nuclear safety authority found that, at the maximum legal limit for mobile radiation, one protein in particular, high shock proteins (HSP) 27, was affected. HSP 27 played a critical role in the integrity of the blood-brain barrier. In an another study by Kavindra Kumar Kesari et al. [9] electromagnetic waves from commercially available cell phones might damage to whole brain due to formation of free radicals and hormonal disbalance in brain.

Radiation can affect the biological tissues of human body in many ways. These effects may range from simple skin irritation to serious effects like cancer and tumor. Effects of electromagnetic radiation depend upon amount of absorbed radiation by biological tissue, duration of radiation and also on some environmental conditions. When considering the effects of electromagnetic radiations frequency of exposed radiation become an important parameter in order to determine the amount of absorbed energy by biological tissue. As the frequency increases, amount of radiations emitted from mobile phones also increases. At lower frequency strength of electromagnetic waves to penetrate inside the biological tissues is more while at higher frequency absorption remains confined to the surface of the head tissue i.e. skin. Thus effects of mobile radiations at higher frequencies are more for skin tissue than the brain tissue. Two important properties of a tissue that play a significant role to determine absorption of electromagnetic radiations by biological tissue are permittivity and conductivity. Different tissues have different value of dielectric properties, which are functions of several variables, such as frequency, shape and size of tissue, and water contents. Variation in these dielectric properties in each tissue will directly affect the amount of SAR within the particular biological tissue. In being absorbed, electromagnetic radiations give up their energy to the body tissues and this adds to the energy being produced by the body's metabolism. The SAR is different in different parts of the body because in the different tissues in the body have different electric properties- for example, some tissues are better electric conductors than others. On exposure to mobile phone radiations, energy is not deposited uniformly throughout the body, even if the incident radiation has uniform power density. This is because tissues are made up of water and different salts and organic compounds. Muscles and organs, which contain more water contents, are better conductors than fat or bones, which contain less water contents. In general, the wetter a material is, the more lossy it is, and the drier, the less lossy [10]. Another very important parameter that affects the energy absorbed in the biological tissue when exposed to mobile phone radiation is the distance

between the user and source of radiation. The rate at which radiations emitted from a fixed source of electromagnetic radiation passes through a surface at a distance d from the source is proportional to $1/d^2$. This is known as the Inverse Square Law. According to this law the radiation flow falls off rapidly as the distance between the radiating source and receiving tissue increases.

V.G. Khurana et al. [11] concluded that there is an adequate epidemiologic evidence to suggest a link between prolonged cell phone usage and the development of an ipsilateral brain tumor. In an another study by P.W. French et al. [12] it has discussed that repeated exposure to mobile phone radiation acts as a repetitive stress leading to continuous expression of heat shock proteins in exposed cells and tissues, which in turn affects their normal regulation, and cancer results. On the other hand, M.H. Repacholi et al. [13] discussed that analyses of the in vivo oncogenicity, tumor promotion, and genotoxicity studies showed no statistically significant relationship between exposure to RF energy from the use of wireless phones and genotoxic damage to brain cells, or the incidence of brain cancers or other tumors of the head.

All biological effects related to electromagnetic radiation are due to increase in the internal temperature of the body tissues. Human body tries to regulate its core temperature by the mechanism of thermoregulation. Thermoregulation is the ability of body to keep its temperature within some adequate limits under the variety of external conditions. Blood circulation in biological tissues helps in maintaining the thermal energy balance. The radio frequency fields leads to a local exposure where most of the radiation is exposed to a single tissue rather than the entire body. When a single tissue is exposed to electromagnetic radiation for a short duration the additional heat is dissipated immediately by adequate flow of blood in that tissue. This prevents the tissue from damage. Zaret et al. [14] conducted a study on the frequency of occurrence of lenticular imperfections in the eyes of microwave worker and noted a significant difference between the eyes of microwave exposed and control populations. In the experiment the number of defects showed a linear increase with age. Although an apparent statistical difference in the values of lens changes between the exposed and control groups existed, the difference was not considered as significant from clinical point of view. McAfee [15] presented some evidences that indicate that it is thermal stimulation of the nervous system which produces the neurophysiological and behavioral changes. The interaction between the electromagnetic radiations and nervous system may account for effect on human health. Cinel et al. [16] conducted an experiment in which volunteers are exposed to 888MHz GSM radiations for duration of 40 minutes and symptoms of headache, dizziness, sensation in skin was observed. Similar symptoms were obtained by Curcio et al. [17] in another study. Barker et al. [18] on the other hand did not confirm these effects in his study.

A critical review of studies into the biological effects of electromagnetic radiation indicates that many of the investigations suffer from inadequacies of technical facilities, insufficient information of the biological systems and improper assessment of biological systems and

electromagnetic radiation exposure. In summary, some studies suggested that radiations received from mobile phones may affect the human health while others do not.

III. CONCLUSION

Finally, it has been concluded that non-thermal biological effects of RF frequencies may exist but due to prolonged and excessive usage of mobile phones. Although a considerable amount of work has been done to elaborate the interaction of electromagnetic radiations with biologic systems, there have been lack of proper investigation. It is required, therefore, to conduct some more realistic and systematic experiments to overcome the conflicts exist in present studies and to obtain better understanding in the assessment of biological effects of exposure to mobile phone radiation.

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