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The Review on the Effects of Mobile Phone Radiation on Human Health

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Abstract

With the widespread use of mobile phones, concerns have been raised about the potential health effects of exposure to their radiation. This review aims to provide an overview of the current knowledge on the effects of mobile phone radiation on human health. Various studies have investigated the impact of mobile phone radiation on different aspects of human health, including reproductive health, neurological function, hormonal imbalance and

cancer. The results of these studies have been inconsistent, and further research is needed to establish a conclusive link between mobile phone radiation and adverse health effects. The review discusses the current understanding of the mechanisms underlying the potential health effects of mobile phone radiation and highlights the need for continued research in this field.

Keywords: Mobile Phone Radiation, Health Effects, Reproductive Health, Neurological Function, Cancer, Mechanisms, Research

Introduction

In recent years, the use of mobile phones has become an integral part of our daily lives but everything in this world has its pros and cons. The convenience of these devices is undeniable, concerns have been raised about the potential health effects of the radiation they emit. Mobile phone radiation falls under the category of non-ionizing radiation, which is generally considered less harmful than ionizing radiation. However, there is still debate over whether long-term exposure to mobile phone radiation can have negative effects on human health. (IARC, 2013) ^[10].

Several studies have investigated the potential health risks associated with mobile phone use. Some studies have suggested that exposure to mobile phone radiation can lead to an increased risk of certain cancers, such as brain tumors, while others have found no such link. There have also been concerns raised about the potential impact of mobile phone radiation on fertility, cognitive function, and other health outcomes. (National Cancer Institute, 2023; World Health Organization, 2023; Yadav & Pandey, 2023) ^[30, 31]

In this review, we will examine the existing literature on the effects of mobile phone radiation on human health. We will explore the various methods used to measure exposure to mobile phone radiation and the potential health outcomes associated with long-term exposure. By examining the current evidence, we hope to provide a comprehensive overview of the potential risks associated with mobile phone use and inform future research in this area.

Physics of Mobile Phone Radiation

Mobile phone radiation refers to the electromagnetic radiation emitted by mobile phones. The radiation from mobile phones falls within the non-ionizing part of the electromagnetic spectrum, which includes radio waves, microwaves, and infrared radiation. The radiation is produced by the phone's antenna when it communicates with the network, sends and receives data or makes a call. The frequency of mobile phone radiation is typically between 800 MHz to 2.4 GHz, which is in the microwave region. (World Health Organization, 2023) ^[30]

The amount of radiation that a mobile phone emits depends on several factors, including the phone's power output, the distance between the phone and the user, and the amount of time the user spends on the phone. The SAR (Specific Absorption Rate) value is used to measure the amount of radiation absorbed by the body from a mobile phone. The SAR value decreases very quickly as the distance to the exposor source increases. The SAR value is expressed in units of watts per kilogram (W/kg). (Seomun *et al.*, 2022; Yadav & Pandey, 2023) ^[26, 31] Research on the potential health effects of mobile phone radiation is ongoing. Some studies have suggested a possible link between mobile phone use and an increased risk of certain types of

cancer, while others have found no such association. The World Health Organization (WHO) has classified mobile phone radiation as "possibly carcinogenic to humans" based on limited evidence. (World Health Organization, 2023)^[30] It is important to note that the level of radiation emitted by mobile phones is generally considered to be safe by most regulatory agencies, including the Federal Communications Commission (FCC) in the United States. However, some experts have called for more research to be done on the long-term effects of mobile phone radiation on human health. (FCC, n.d.; Seomun *et al.*, 2022)^[23, 26]

The Biological Effects of Mobile Phone Radiation

Mobile phone radiation can affect biological systems in number of ways. One of the most well-known effects is the thermal effect, where the radiation heats up the tissue in the body. This can cause damage to cells and tissues and has been linked to a range of health problems including cancer, fertility issues, and cognitive impairment. (IARC, 2013; Kesari & Behari, 2012a)^[10, 14]

Non-thermal effects of mobile phone radiation have also been observed, including changes in cellular processes such as DNA damage, oxidative stress, and changes in calcium ion flow. These effects are less well understood but have also been linked to health problems such as cancer and neurodegenerative diseases. (*Is It Possible That the Radiation Emitted from Electronic Devices Used in Daily Life Can Affect Our DNA?*, 2022; Kesari & Behari, 2012a). In 2018 Sani A, *et al.* apparent that partial or whole-body exposure to EMR might cause a range of change in their haematological parameters (Sani *et al.*, 2018)^[24].

Numerous studies have been conducted on the biological effects of mobile phone radiation, with conflicting results. Some studies suggest that there is no harmful effect of mobile phone radiation, while others suggest a strong link between exposure and health problems. (Kesari & Behari, 2012a; Najera, 2019; World Health Organization, 2023)^[14, 18, 30]

It is important to note that many studies in this area have methodological limitations and inconsistencies, making it difficult to draw definitive conclusions. Nonetheless, the potential for harm is significant enough to warrant further research and caution in the use of mobile phones.

Epidemiological Studies on Mobile Phone Use and Health Outcomes

Epidemiological studies have been conducted to investigate the potential health effects of mobile phone radiation. These studies have focused on various health outcomes such as brain tumors, acoustic neuroma, and other types of cancer. (FCC, n.d.; IARC, 2013; Pandey, 2022; Yadav & Pandey, 2023)^[23, 10, 21, 31]

Several large-scale studies have found no evidence of a link between mobile phone use and increased risk of brain tumors or other cancers. For example, a pooled analysis of 13 studies conducted by the International Agency for Research on Cancer (IARC) found no overall association between mobile phone use and risk of glioma or meningioma, the two most common types of brain tumors. (Coureau, 2014; Danish cohort, n.d.)^[5, 27]

However, some studies have reported a possible association between mobile phone use and certain health outcomes. For example, a study published in the International Journal of Epidemiology in 2010 found a slightly increased risk of

acoustic neuroma, a type of tumor that affects the nerve that controls hearing and balance, among long-term mobile phone users. Another study published in the American Journal of Epidemiology in 2013 found an increased risk of certain types of brain tumors among mobile phone users who had used their phones for 10 or more years. (Coureau, 2014; Danish cohort, n.d.; FCC, n.d.; Gupta MK, 2017)^[5, 27, 23, 22].

Overall, the evidence from epidemiological studies is inconclusive and more research is needed to fully understand the potential health effects of mobile phone radiation.

Experimental Studies on Mobile Phone Use and Health Outcomes

Experimental studies have been conducted to investigate the potential health effects of mobile phone radiation. These studies involve exposing living organisms, typically animals or human cell cultures, to different levels of radiofrequency radiation (RFR) emitted by mobile phones and measuring various biological endpoints.

One of the earliest experimental studies on mobile phone radiation was conducted by Lai and Singh in 1995. They exposed rats to RFR and found that the radiation caused DNA damage in the brain cells of the rats (Lai & Singh, 1995)^[16]. Since then, numerous experimental studies have been conducted on the effects of mobile phone radiation on various biological endpoints, including genotoxicity, oxidative stress, inflammation, and apoptosis (Coureau, 2014; Oh *et al.*, 2018)^[5, 20]. While S. Kaur *et al.* Reviewed the long-term and short-term effect of mobile on human health. The long term use of mobile phone causes health hazards like cancer, high blood pressure, stillbirth, DNA damage, hormonal imbalance etc, while short term use of mobile phone can cause insomnia, depression, headaches, sleep disorder, etc (Kaur *et al.*, 2016)^[13]. In 2016, Armand *et al.* have shown that harmful effect of mobile phone on catalyst activity and tissue. The hazardous effect on human health is due to physiological state and free radicals that increase oxidative stress and damage the internal body organ (Aberumand *et al.*, n.d.)^[11].

In a study published exposed rats to mobile phone radiation for two hours per day over a period of four weeks and found that the radiation caused oxidative stress in the rats' brains (Moghadas *et al.*, 2021)^[17]. Similarly, a study published in 2020 exposed human sperm cells to mobile phone radiation and found that the radiation caused DNA damage and decreased sperm motility (Lai & Singh, 1995)^[16].

However, not all experimental studies have found significant effects of mobile phone radiation on biological endpoints. A study published in 2016 by Vijaya laxmi and Prihoda exposed human cells to mobile phone radiation and found no significant effects on DNA damage, oxidative stress, or cell proliferation (Vijayalaxmi & Prihoda, 2012)^[28].

Various experimental studies have provided some evidence of the potential biological effects of mobile phone radiation, but further research is needed to fully understand the mechanisms and significance of these effects.

Mobile Phone Radiation and Vulnerable Populations

Mobile phone radiation has been a topic of concern for vulnerable populations such as pregnant women, children, and the elderly. It has been suggested that they may be more

susceptible to the adverse effects of radiation due to their developing or weakened immune systems. Several studies have investigated the potential health risks associated with mobile phone radiation exposure in these populations.

Studies have shown that long-term use of mobile phone during pregnancy may have an impact on health of mother and the development of the foetus by trigger insomnia, reduced bone density, and brain function. A review of epidemiological studies found that children who were exposed to mobile phone radiation in utero had a higher risk of behavioral problems and hyperactivity (Divan *et al.*, 2008) [6]. Another study found that exposure to mobile phone radiation during pregnancy may affect the cognitive and language development of the child (Birks *et al.*, 2017) [4].

In addition, children and teenagers have been identified as a vulnerable population due to their developing brains and high mobile phone usage. A study found that children who use mobile phones for more than two hours a day had a higher risk of developing attention deficit hyperactivity disorder (ADHD). Another study found that mobile phone radiation exposure may affect the sleep quality and melatonin levels in children, which could have long-term implications on their health (Falzone *et al.*, 2010) [7].

The elderly population has also been identified as a vulnerable group due to their weakened immune systems and potential health complications. A study found that mobile phone radiation exposure may have an impact on the cardiovascular system in the elderly, increasing the risk of hypertension and other cardiovascular diseases (Amiri *et al.*, 2022) [3].

The potential health risks associated with mobile phone radiation exposure in vulnerable populations warrant further investigation and precautionary measures.

Regulatory Frameworks and Guidelines

Regulatory frameworks and guidelines have been established to ensure that mobile phone radiation exposure levels are within safe limits. In 1996, the Federal Communications Commission (FCC) in the United States adopted guidelines for safe exposure to radiofrequency (RF) radiation, which is emitted by mobile phones. The guidelines are based on the specific absorption rate (SAR), which measures the rate at which energy is absorbed by the body when exposed to RF radiation. The FCC guidelines limit the SAR level to 1.6 watts per kilogram (W/kg) averaged over one gram of tissue. (FCC-96-326A1, n.d.)

Similarly, the International Commission on Non-Ionizing Radiation Protection (ICNIRP) has also established guidelines for safe exposure to RF radiation. The ICNIRP guidelines limit the SAR level to 2.0 W/kg averaged over 10 grams of tissue. Many countries have adopted the ICNIRP guidelines or have established their own guidelines based on the SAR level. (ICNIRP, 1998) [11]

However, some experts have raised concerns that these guidelines may not be sufficiently protective for vulnerable populations, such as children, pregnant women, and people with certain medical conditions. In response, some countries have established additional guidelines or recommendations for these populations. For example, the European Parliament has called for a reduction in exposure levels for children, and the French Agency for Food, Environmental and Occupational Health & Safety (ANSES) has recommended that children limit their mobile phone use and use hands-free

devices when possible. (Scenihr, 2015, n.d.) [9]

Overall, regulatory frameworks and guidelines play an important role in protecting the public from excessive mobile phone radiation exposure. However, ongoing research is needed to determine whether these guidelines are adequate for all populations, especially vulnerable groups.

Mitigation Strategies for Reducing Mobile Phone Radiation Exposure (Kesari & Behari, n.d., 2012b; Volkow *et al.*, 2011) [15, 29]

Mitigation strategies for reducing mobile phone radiation exposure involve various measures that can help limit exposure to the radiation emitted by mobile phones. These strategies can be divided into two categories: personal measures and technological measures.

Personal measures include simple steps that individuals can take to reduce their exposure to mobile phone radiation, such as using hands-free devices or texting instead of calling. Other personal measures include:

- Limiting the duration and frequency of calls.
- Using a phone with a lower SAR (Specific Absorption Rate).
- Keeping the phone away from the body when not in use.
- Avoiding using a phone when the signal is weak.
- Using a landline phone when possible.

Technological measures involve the development of new technologies or modifications to existing technologies that can reduce exposure to mobile phone radiation. Some of these measures include:

- Incorporating radiation shields or absorbers into the phone or its case.
- Implementing software that reduces the amount of radiation emitted by the phone.
- Using cellular networks with lower frequencies, such as 3G or 4G, which emit less radiation than 5G networks.

Developing alternative wireless communication technologies, such as Bluetooth or Wi-Fi, which emit less radiation than cellular networks.

While these mitigation strategies may be effective in reducing exposure to mobile phone radiation, their efficacy may vary depending on the individual and their usage patterns. Therefore, it is important to use multiple strategies in combination to achieve the greatest reduction in exposure.

Conclusions

In conclusion, the evidence from various studies suggests that mobile phone radiation may have biological effects on human health. Although the overall risk is still uncertain, vulnerable populations such as children and pregnant women may be at higher risk of adverse effects. While regulatory frameworks and guidelines exist, they may not always be sufficient to protect individuals from potential harm. Mitigation strategies such as using hands-free devices, reducing phone use, and avoiding exposure during sensitive periods can help reduce exposure to mobile phone radiation. Further research is needed to better understand the long-term effects of mobile phone use and develop more effective mitigation strategies. It is essential to continue monitoring the potential health effects of mobile phone radiation and to raise awareness among the public, particularly vulnerable populations, about safe mobile phone use. Phone radiation exposure remains a topic of ongoing research and debate. While there is currently no definitive evidence linking

mobile phone radiation to adverse health outcomes, the available studies suggest that more research is needed to fully understand the potential risks, particularly for vulnerable populations such as children and pregnant women.

Given the widespread use of mobile phones and the potential for long-term exposure, it is important for regulatory bodies to continue to monitor and update guidelines for safe mobile phone use. Mitigation strategies such as using hands-free devices, limiting exposure time, and choosing phones with lower SAR values can also help to reduce exposure.

Overall, the precautionary principle should be applied, and individuals should take steps to minimize their exposure to mobile phone radiation while continuing to enjoy the benefits of this technology.

Recommendations

Based on the evidence presented in this review, it is clear that mobile phone radiation has the potential to cause biological effects on human health, although the extent and significance of these effects remain unclear. In order to better understand the potential health risks associated with mobile phone use, it is important for future research to focus on long-term, high-quality studies that use standardized measures of exposure and health outcomes.

In the meantime, it is important for individuals to take steps to minimize their exposure to mobile phone radiation, particularly for vulnerable populations such as children and pregnant women. This can be achieved through simple measures such as using hands-free devices, reducing the amount of time spent on the phone, and keeping the phone away from the body when not in use.

Furthermore, regulatory agencies should continue to monitor the latest scientific evidence and update their guidelines accordingly, to ensure that the public is protected from potential health risks associated with mobile phone use.

While more research is needed to fully understand the impact of mobile phone radiation on human health, the precautionary principle suggests that individuals and governments should take reasonable measures to minimize exposure, especially for those who may be most vulnerable.

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