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**THE IMPACT OF ELECTROMAGNETIC RADIATION (EMR) IN INDIA: UNDERSTANDING POTENTIAL RISKS AND EFFECTS****Kuldip Kumar**

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**ABSTRACT**

*There are several different sources of electromagnetic radiation (EMR), including home appliances, Wi-Fi routers, and mobile towers. The growing usage of these technologies in India has sparked worries about the possible impacts of EMR on the environment and public health. This review addresses potential health impacts like headaches, sleep difficulties, and an increased risk of cancer. It also examines the many sources of EMR, such as cell towers and Wi-Fi routers. It also emphasizes the regulatory controls in place to guarantee that radiation levels stay within safe bounds, as well as the significance of public awareness campaigns and monitoring programs to safeguard the environment and public health.*

*Keywords: Electromagnetic Radiation (EMR), Sources of Electromagnetic radiation, Potential Health Effects due to Electromagnetic Radiation (EMR).*

**INTRODUCTION**

Electronic radiation, also known as electromagnetic radiation (EMR), is a form of energy that originates from a variety of sources, including mobile towers, Wi-Fi routers, and even household appliances like microwave ovens. The Indian telecommunications industry as a whole and mobile telephony in particular have both experienced spectacular growth over the course of the past decade. The number of wireless connections in the country is 910 million, out of a total of 938 million connections as of May 2014. As a consequence of the widespread adoption of wireless communication devices and mobile phones, there has been an increase in the number of cell towers located all over India. As a result of technological advancements, the risk of exposure to electromagnetic radiation (EMR) has increased, particularly in developing regions such as India, which is generally recognized for its steep terrain and rural areas. Through the use of terminology that is straightforward and easy to comprehend, the purpose of this review is to describe the impacts of electromagnetic radiation in India.

**What is Electromagnetic radiation**

The waves that make up electromagnetic radiation are a form of energy that can be found traveling through space. The following is a straightforward explanation of it:

1. **What It Is:** The term "electromagnetic radiation" refers to a wide range of waves, including radio waves, microwaves, infrared light, visible light, ultraviolet light, X-rays, and gamma rays, among others. These waves are all traveling through space and carrying energy with them.
2. **It Works:** Try to picture yourself tossing a stone into a pond. There is a similarity between the ripples that spread out and electromagnetic waves. For the most part, these waves move through the air or even through the vacuum of space, rather than through water.
3. **Sources:** Electromagnetic radiation originates from both natural sources, such as the sun, and man-made sources, such as mobile phones, microwaves, and X-ray devices.
4. **Applications:** The utilization of various kinds of electromagnetic radiation can be found in most aspects of daily life. For instance, radio waves are used for the transmission of music and news, microwaves are utilized to heat meals, and X-rays permit medical professionals to look inside the body.

5. **Effects:** The effects of electromagnetic radiation might vary depending on the type of radiation and the amount of radiation released. Some of them, like visible light, are completely safe and even essential for living things. Some of them, such as high amounts of X-rays, can be hazardous if they are not utilized appropriately.

In conclusion, Electromagnetic Radiation (EMR) is present everywhere, is utilized in a wide variety of technologies, and can have a variety of impacts on living beings determined by the type of radiation and the intensity of the radiation. Radio waves and microwaves are examples of non-ionizing radiation that are frequently encountered in everyday gadgets and infrastructure. The purpose of this page is to discuss the effects of these and other types of radiation.

### **Types of Electromagnetic Field (EMF) radiation**

In electromagnetic field radiations, ionizing and non-ionizing radiations are distinguished from one another based on the frequency and power level of the radiation.

- **Ionizing radiation:** The waves of electromagnetic radiation that have enough energy to overcome the binding energy of electrons in atoms or molecules are referred to as ionizing radiation. This type of radiation is responsible for the creation of ions. electromagnetic radiation, such as cosmic rays, gamma rays, X-rays, and ultraviolet rays.
- **Non-ionizing radiation:** When referring to electromagnetic radiation, the term "non-ionizing radiation" is used to describe any sort of radiation that does not carry sufficient energy per quantum to ionize atoms or molecules. For example, low frequency radiations such as radio waves, microwaves, and infrared radiations, examples of which can be found in figure 1.2 below.

### **Sources of Electromagnetic Radiation**

1. **Mobile Towers:** When it comes to delivering communication services, mobile towers are absolutely necessary, particularly in the more rural and hilly regions of India. These towers are emitting radiofrequency radiation, also known as RF radiation, which is a form of radiation that does not ionize. Radiation levels from these towers have been shown to be below the safety limits established by the Indian government, which are 0.45 W/m<sup>2</sup> for 900 MHz frequency and 0.92 W/m<sup>2</sup> for 1800 MHz frequency (Department of Telecommunications, n.d.). Studies have indicated that these radiation levels are generally within the acceptable range.
2. **Wi-Fi Routers:** The radiofrequency (RF) radiation that is emitted by WiFi routers is a form of radiation that does not include ionizing radiation. Cell phones, microwaves, and other wireless gadgets all release the same kind of radiation, which is the same type of radiation. In general, the radiation levels that are emitted by WiFi routers are extremely low, and the majority of health standards consider them to be safe. A measurement of the rate at which the body absorbs radio frequency (RF) energy is referred to as the Specific Absorption Rate (SAR). The SAR limit for mobile devices in India is 1.6 W/kg, which is approximately equivalent to 1 gram of tissue on average. When compared to mobile phones, WiFi routers typically emit a far lower amount of radiation. Guideline recommendations for exposure to radiofrequency radiation are established by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). The majority of the time, WiFi routers function very well within these limits, which guarantees that they are safe for prolonged exposure. There is a significant reduction in the radiation level as the distance increases. You will be exposed to a low level of radiation if you are only a few feet away from the router. It is common for a WiFi router to have a power output of approximately 100 milliwatts (mW), and the exposure drops substantially with increasing distance.
3. **Household Devices:** Microwave ovens are designed to keep radio frequency radiation within the appliance itself, despite the fact that they run at significantly greater power levels, often ranging from 700 to 1200 watts. Because of the high safety standards, there is only a little amount of leakage. Similar to mobile phones and microwave ovens, other wireless devices, such as Bluetooth speakers, cordless phones, emit radio frequency

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radiation, but at significantly lower levels than the radiation emitted by these devices. These items are regarded as safe for usage on a daily basis.

Sl. No.	EMF Source	Operating Frequency	Transmission Power	Number
1.	AM/FM Tower	540 KHz-108 MHz	1 KW – 30 KW	380
2.	TV Tower	48 MHz – 814 MHz	10 – 500 Watt	1201
3.	Wi-Fi	2.4 – 2.5 GHz	10 – 100 mW	
4.	Cell Towers	800, 900, 1800, 2100, 2300 MHz	20 W	~ 5 lakh
5.	Mobile Phones	GSM-1800/CDMA GSM-900	1 W 2 W	900+ Million

**Table 1:** Emitted Power by Different Sources

### Measurement and Levels of Radiation in India

India's regulations are currently ten times more stringent than those of numerous countries around the world, including the United States of America, Canada, Japan, and Australia, which utilize ICNIRP guidelines. A number of nations have established their own radiation levels, taking into consideration the environmental and physiological elements that were taken into consideration. As can be seen in Table 1.4 below, the power density restrictions range from 0.001 Watts per square meter to 12 Watts per square meter while operating at a frequency of 1800 MHz. As may be seen in Table below, the permitted reference level in India is 0.92 Watts per square meter at 1800 MHz, and it is 0.45 Watts per square meter at 900 MHz.

Frequency	ICNIRP Radiation norms	Revised DoT Norms effective from 01.09.2012
900 MHz	4.5 Watt/ sq.m	0.45 Watt/sq.m
1800 MHz	9 Watt/ sq.m	0.9 Watt/sq.m
2100 MHz	10.5 Watt/ sq.m	1.05 Watt/sq.m

**Table 2:** Revised EMF radiation norms for mobile towers (BTS) in India

To assess the levels of RF radiation in India, several studies have been conducted using standard measurement techniques. Key findings include:

1. **Environmental Monitoring:** Measurements taken near BTS in various urban and rural areas of India indicate varying levels of radiation, often influenced by factors such as distance from the source, height of the antenna, and surrounding buildings.
2. **Exposure Levels:** Data suggests that the RF radiation levels in most areas are within the limits prescribed by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the Indian Council of Medical Research (ICMR). However, certain hotspots have been identified where levels exceed recommended safety standards.

<b>International Exposure limits for EMF (1800 MHz)</b>	
12 W/m <sup>2</sup>	USA, Canada and Japan
9.2 W/m <sup>2</sup>	ICNIRP and EU recommendation 1998
9 W/m <sup>2</sup>	Exposure limit in Australia
2.4 W/m <sup>2</sup>	Exposure limit in Belgium
1.0 W/m <sup>2</sup>	Exposure limit in Italy, Israel
0.5 W/m <sup>2</sup>	Exposure limit in Auckland, New Zealand
0.45 W/m <sup>2</sup>	Exposure limit in Luxembourg
0.4 W/m <sup>2</sup>	Exposure limit in China
0.2 W/m <sup>2</sup>	Exposure limit in Russia, Bulgaria
0.1 W/m <sup>2</sup>	Exposure limit in Poland, Paris, Hungary
0.1 W/m <sup>2</sup>	Exposure limit in Italy in sensitive areas
0.095 W/m <sup>2</sup>	Exposure limit in Switzerland
0.09 W/m <sup>2</sup>	ECOLOG 1998 (Germany) Precaution recommendation only
0.001 W/m <sup>2</sup>	Exposure limit in Austria

**Table 3:** International EMF radiation norms for mobile towers (BTS)

When compared to other countries, India has implemented the most rigorous SAR values for mobile devices. These values are comparable to those taken by the United States of America, Canada, and Australia. From 1st Sept. 2013, only mobile handsets with the revised SAR value of 1.6 W/kg are permitted to be manufactured or imported into India. It is mandatory for manufacturers to display the SAR level on each mobile handset as given in the Table 4.

<b>Countries</b>	<b>SAR value limits</b>
China	2W/kg averaged over 10g of tissue
Singapore	2W/kg averaged over 10g of tissue
Ghana	2W/kg averaged over 10g of tissue
Brazil	2W/kg averaged over 10g of tissue
Nigeria	2W/kg averaged over 10g of tissue
Japan	2W/kg averaged over 10g of tissue
Rep. of Korea	2W/kg averaged over 10g of tissue
Europe	2W/kg averaged over 10g of tissue
Australia	1.6 W/kg averaged over 1 g of tissue
USA	1.6 W/kg averaged over 1 g of tissue
Canada	1.6 W/kg averaged over 1 g of tissue

**Table 4:** SAR values for mobile handsets of some countries

**Potential Health Effects**

There is ongoing research into the potential health effects of long-term exposure to electromagnetic radiation. The health effects of mobile network radiation have been a topic of debate and research. Some potential health impacts include:

**1. Short-term Effects**

- I. **Thermal Effects:** RF radiation can cause heating of body tissues, which may lead to discomfort or thermal burns.
- II. **Electromagnetic Sensitivity:** Some individuals report symptoms like headaches, dizziness, and fatigue when exposed to RF radiation.

**2. Long-term Effects**

- I. **Cancer Risk:** There is ongoing research to determine if long-term exposure to RF radiation increases the risk of cancer. The World Health Organization (WHO) classifies RF radiation as "possibly carcinogenic" to humans.
- II. **Reproductive Health:** Studies have examined the impact of RF radiation on fertility and pregnancy outcomes, with mixed results.

However, the scientific community has not reached a consensus, and many studies have found no conclusive evidence linking EMR to serious health problems (World Health Organization, n.d.). In India, specific research on the health effects of EMR is limited. However, given the increasing use of mobile and wireless technologies, it is important to monitor and study the potential health impacts in the region.

**Environmental Impact**

The effects of electromagnetic radiation on the wildlife of India can be significant and diverse. Here are some of the potential impacts:

1. **Birds:** Electromagnetic radiation can disrupt birds' navigation systems, making it difficult for them to migrate and find food. It can also affect their reproductive success and lead to population declines.
2. **Insects:** Many insects, such as bees, use electromagnetic fields for navigation. Radiation can interfere with their ability to find food and pollinate plants, which can have broader ecological impacts.
3. **Mammals:** Exposure to electromagnetic radiation can lead to stress, behavioral changes, and reproductive issues in mammals. This can impact their health and survival rates.
4. **Amphibians and Reptiles:** These animals can be sensitive to changes in their environment, and radiation can affect their growth, development, and behavior.
5. **Aquatic Life:** Electromagnetic fields can penetrate water and affect aquatic species, potentially disrupting their navigation, communication, and breeding behaviors.
6. **Ecosystem Disruption:** Changes in the behavior and health of individual species can lead to broader ecosystem disruptions. For example, if pollinators like bees are affected, it can impact plant reproduction and food availability for other animals.

Overall, while more research is needed to fully understand the long-term impacts, it is clear that electromagnetic radiation can pose risks to the diverse wildlife of India. Conservation efforts and regulatory measures are essential to mitigate these effects.

**India's Biodiversity**

India is known for its rich biodiversity and natural beauty. Protecting the environment from potential EMR impacts is essential to preserve the state's wildlife and natural habitats. Here are some key points:

- I. **Impact on Wildlife:** Electromagnetic radiation from mobile towers and other sources can disrupt the navigation, reproduction, and overall health of various animal species, including birds, insects, and mammals.
- II. **Plant Life:** Radiation can affect plant growth and development. Some studies suggest that electromagnetic fields can alter the growth patterns of plants and reduce their resistance to diseases.
- III. **Ecosystem Balance:** Changes in the behavior and health of individual species can disrupt the delicate balance of ecosystems. This can lead to a decline in certain populations, affecting the entire food chain.
- IV. **Conservation Efforts:** India is home to many protected areas and endangered species. Increased radiation can pose additional challenges to conservation efforts, making it harder to preserve the region's rich biodiversity.
- V. **Research and Monitoring:** Continuous research and monitoring are needed to understand the long-term effects of electromagnetic radiation on India's biodiversity. This can help in formulating guidelines and regulations to mitigate potential risks.

**REGULATORY MEASURES****1. Government Guidelines**

The Department of Telecommunications (DoT) in India regulates mobile tower radiation. It conducts regular audits and checks to ensure that radiation levels remain within the prescribed safety limits. This regulatory framework helps minimize potential health risks. Regulatory measures to manage the effect of electromagnetic radiation in India include:

- I. **Setting Limits:** Establishing safe exposure limits for electromagnetic radiation to protect both people and wildlife.
- II. **Monitoring:** Regularly checking radiation levels around mobile towers and other sources to ensure they stay within safe limits.
- III. **Buffer Zones:** Creating areas around mobile towers where no construction or development is allowed, reducing the impact on nearby wildlife and plants.
- IV. **Research and Studies:** Supporting studies to understand how radiation affects the environment and using this information to update regulations.
- V. **Public Awareness:** Educating people about the potential risks of electromagnetic radiation and ways to minimize exposure.
- VI. **Protecting Sensitive Areas:** Implementing stricter controls in protected areas like national parks and wildlife sanctuaries to safeguard biodiversity.
- VII. **Monitoring and Compliance:** Regular monitoring and compliance checks are conducted to ensure that the radiation levels from mobile towers and other sources remain within the prescribed safety limits. This helps to minimize potential health risks.

**2. Public Awareness and Safety Measures**

- I. **Reducing Exposure:** People can take simple steps to reduce their exposure to electromagnetic radiation, such as:
  - Using hands-free devices for mobile phones
  - Keeping mobile phones and Wi-Fi routers away from sleeping areas

- Limiting the duration of phone calls
- Turning off Wi-Fi routers when not in use

II. **Educating the Public:** Raising awareness about electromagnetic radiation and its potential effects is crucial. Educating the public on safe practices and the importance of following guidelines can help mitigate any potential risks.

### **Future Research Directions**

To better understand the implications of RF radiation from mobile networks in India, future research should focus on:

1. **Longitudinal Studies:** Conducting long-term studies to assess potential health effects of chronic exposure to low-level RF radiation.
2. **Technological Innovations:** Exploring new technologies and network designs that minimize radiation exposure while maintaining effective communication services.
3. **Public Health Interventions:** Developing and implementing strategies to educate the public about safe mobile phone practices and the importance of adherence to safety standards.

### **CONCLUSION**

The presence of electromagnetic radiation is a characteristic of contemporary living, with its origins ranging from mobile towers to technologies found in one's own home. EMR has become more prevalent in India as a result of the growing influence of technology in the country. Even while there are worries about the possible consequences on both human health and the environment, the laws and guidelines that are now in place serve to ensure that radiation levels remain within acceptable ranges. For the purpose of ensuring the safe utilization of technology and protecting both public health and the environment in India, continuously conducting research, monitoring, and raising public awareness are all important.

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