

Electromagnetic Field Exposure Assessment for Public Health Risk

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ABSTRACT

The proliferation of life-improving devices in our everyday personal and professional lives due to recent technological breakthroughs has significantly changed the ambient natural electromagnetic field levels. As a result, the rapid use of these electronic devices has given rise to a phenomenon known as "electromagnetic pollution" or "electro-pollution." EMRs are a growing source of pollution in both personal and professional settings, and they constitute a risk that could have long-term negative effects on health. Previous studies in the bioelectronics sector have shown that electromagnetic fields (EMF) can cause harm from a variety of sources. Nevertheless, concurrent researchers have also eliminated the potential for unfavourable health consequences, which breeds ambiguity and impedes the comprehension of EMF bio-effects and bio-interaction mechanisms. Consequently, further research is required, particularly in the field of public health, as epidemiological studies are crucial for assessing the health risks associated with electromagnetic fields.

1. Introduction

The proliferation of electromagnetic field (EMF)-using life-enhancing devices in our everyday personal and professional lives, along with the resulting emissions from these devices, have sparked major concerns about their possible biological effects. As a result, this is a topic of high priority for research and a topic of ongoing public discussion [3]. Earth's magnetic fields (EMFs) have always been on Earth; they are not a modern invention. These geomagnetic and electromagnetic fields, which have stayed constant for hundreds of millions of years, have supported the evolution of life on Earth [1]. Recent technological advancements and the widespread use of electronic devices have caused a significant change in ambient electromagnetic fields (EMFs), which has given rise to a novel phenomenon known as "electromagnetic pollution" or "electro-pollution." Because it's invisible, we didn't know that its concentration in our surroundings was steadily increasing [13]. The risk to our health and safety posed by electromagnetic pollution is a new environmental concern that was scarcely there even ten years ago [6]. The scientific community has recognised this invisible pollution as the biggest threat to human health and well-being among all living things on Earth. It is a sort of pollution that envelops us constantly. A range of additional physical and biological factors have been linked to the health consequences of electromagnetic waves (EMWs), which can cause diverse effects at varying frequencies, power levels, and exposure times. [2].

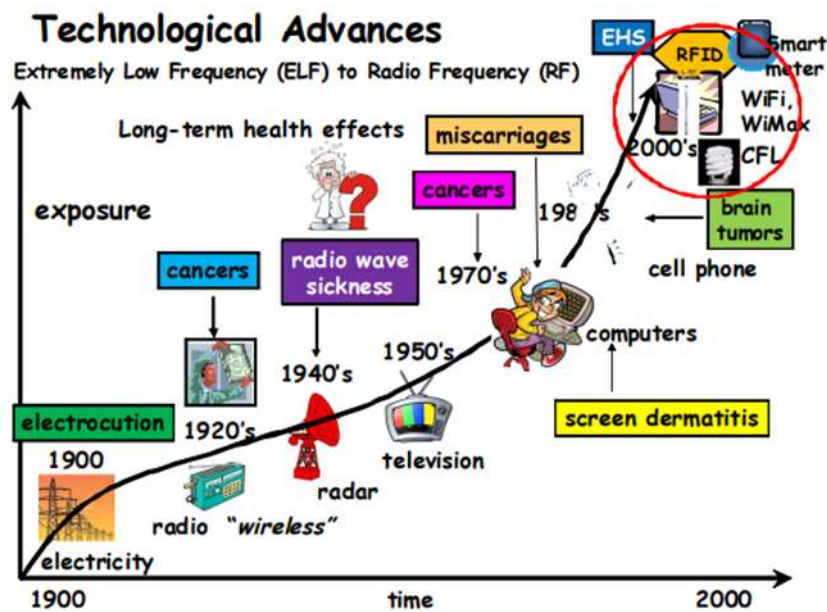


Figure 1. Showing the inventions and applications of electromagnetic field together with their associated biological effects.

Additionally, it is being shown that millimetre wave resonance therapy (MRT) is a fantastic therapeutic approach that may be used to treat underlying pathologies such as gastric and duodenal ulcers, chronic bronchitis, bronchial asthma, migraines, neurosis, and neuralgia. The emission properties of the many sources that use EMF vary [11]. Therefore, the health impacts and subsequent exposures may differ. For example, MP exposures are localised, brief, and usually occur in close proximity to the auditory region; in contrast, base station emissions result in a constant whole-body experience, albeit at low levels [10]. However, despite the fact that other sources are similarly concerning, base stations represent a serious hazard to life because of their abundant and continuous emissions [4]. The production that leads to oxidative stress and disruption of the antioxidant/prooxidant equilibrium, which impacts biochemistry and physiology and manifests as public health symptoms. In this instance, section 1 of the paper examines the introduction, and section 2 discusses the review of the EMF issues. Section 3 and 4 presents a discussion of the implication of EMF, while Section 5 wraps up the project.

2. Literature Review

Numerous scientific studies have been conducted regarding the potential health impacts of near-infrared radiation (NIR), and researchers have linked exposure to electromagnetic fields (EMF) to a range of health outcomes due to changes in the functioning of different body systems. Changes in pineal indoleamines, hormone secretions, catecholamines, induction of heat shock protein (hsp), effects on spatial memory, changes in intracellular calcium concentration, modifications in blood-brain barrier permeability (BBB), enzyme activity, genotoxicity, non-specific disabilities, and subjective symptoms are a few of the biological effects that have been reported. [5].

Furthermore, auditory neuromas, brain tumours, and tinnitus have all been connected to radiation exposure, especially from cell phones [7]. Research has also linked mother exposures to hydrocephalus and spina bifida, as well as anencephaly, to an increased incidence of neural tube disorders in the offspring [12]. Studies on the long-term health impacts of electromagnetic fields are necessary to close the knowledge gap because the majority of recorded health consequences relate to short-term exposures [14]. This study would therefore make a significant contribution to the body of knowledge regarding the usage of electromagnetic fields at work and the reactions that result in oxidative and hormonal indicators as well as subjective complaints.

In addition to the benefits, there are worries about potential harmful health impacts, which is why prevention is necessary. As a result, regulations have been developed to shield both humans and animals from their negative effects. The primary focus in developing the standards for human exposures has been placed on the behavioural reactions. In order to prevent thermal effects—the only known biological impacts of RF-EMF the ICNIRP has released guidelines restricting public exposures below which no bio-interaction mechanism has yet been identified. Most nations adhere to the ICNIRP recommendations. The established standard levels prevent the body temperature from rising above 1°C, which could affect a number of physiological processes. The reference values are based on the idea of surface area radiation (SAR), which is the body's total energy absorption measured in watts per kilogramme (W/kg) and dependent on the frequency and field strength of the exposure source. The SAR value is also dependent on other incident field parameters, such as the EMF polarisation, the source object configuration (near or far field), the mass, shape, size, geometry, and dielectric properties of the various tissues of the exposed body, as well as ground and reflection effects from other objects in the vicinity. There are now three coupling bio-interaction processes that have been postulated. [8].

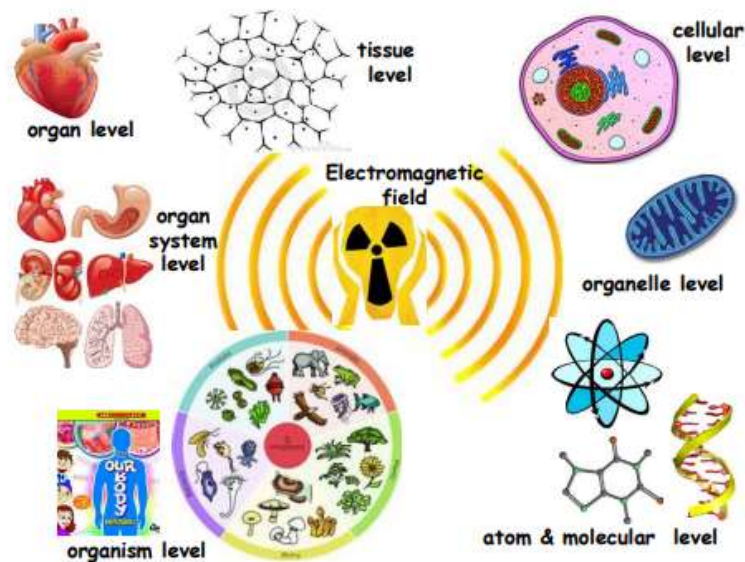


Figure 2. Bio-physical interactions at various levels of organization

Coupling with low frequency EF

It is suggested that the interaction of time-varying low frequency EFs causes induced body currents to develop, electric dipoles to grow, and already-existing dipoles to reorient. These processes are said to be dependent on the electrical characteristics of the body, specifically permittivity and conductivity. Additionally, the kind of bodily tissue and the frequency of the field control electrical conductivity and permittivity.

Coupling with low frequency MF

The body experiences induced EFs and circulating electric currents as a result of bio-interaction with time-varying MFs. The tissue's electrical conductivity determines the induced current's direction and strength. In addition, the induced current density depends on the body cross-sectional radius, frequency, magnetic flux density, environment permeability, and magnetic field intensity. The body's average electric conductivity is used to get the induced current density values. Moreover, the body's electrical conductivity varies with age and has been found to peak in newborns and young children. Due to superior coupling with the human body compared to alternative designs, it has been demonstrated that higher current densities and EFs are induced when the direction of the external EF is parallel to the longer vertical axis of the body (from head to foot) and the MFs are from front to rear, respectively. The body parts that often have the smallest cross-sections, such as the hands, feet, fingers, and toes, acquire the highest current densities and EFs.

Energy absorption from EMFs

When an EMF above 100 kHz is experienced, the body often experiences a significant temperature increase and uneven energy absorption. The recognised mode of RF-EMF bio-interaction is shown in Figure 6. Four ranges of electromagnetic fields (EMFs) can be distinguished based on how the human body absorbs different amounts of energy. Energy absorption in the trunk decreases rapidly with decreasing frequency in the region of roughly 100 kHz to 20 MHz, whereas the neck and legs with their small cross sections may absorb a significant amount of energy. Higher absorptions in the entire body and in specific parts of the body (such as the head) may occur if resonances in the frequency range of 20 MHz to 300 MHz are considered. Substantial non-uniform local heating may occur above 300 MHz and up to several GHz, and above 10 GHz, heating of the surface layer, primarily the skin, takes place [9].

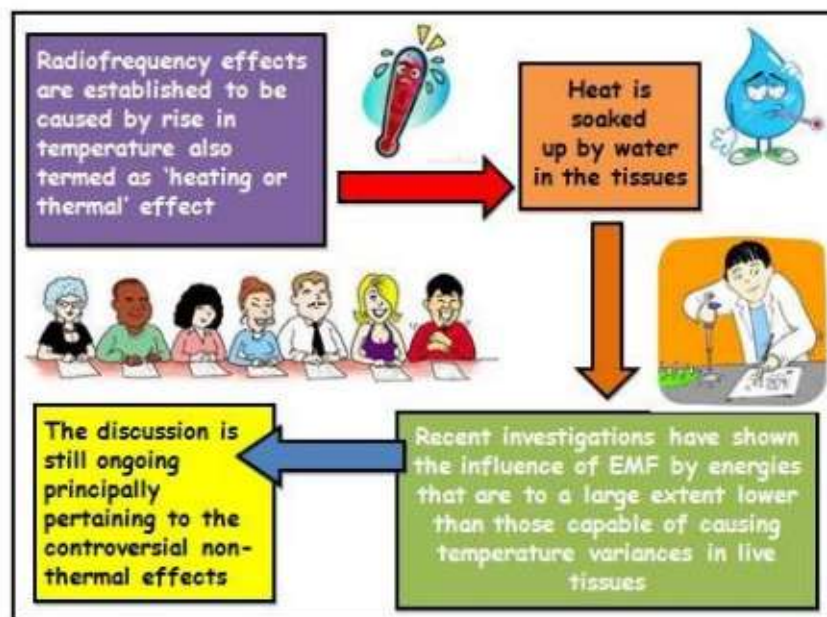


Figure 3. Depicting the established mode of energy absorption from radiofrequency electromagnetic fields (RF-EMFs) and controversy surrounding it

Health Implications of Emf

EHS is a relatively new and little-known phenomenon that occurs when sensitive people who have been exposed to electromagnetic fields from a variety of electronic devices experience a wide range of subjective and objective (skin and mucosa-related) signs and symptoms [15]. Microwave sickness was the term used to describe the phenomenon that was initially identified among East European radar workers who were exposed to electromagnetic fields (EMF) for extended periods of time and at lower levels. In addition, signs of illness have recently been reported in the general population at lower exposure levels to electromagnetic fields. Figure 4 depicts the several unpleasant subjective signs and symptoms associated with EHS. This group of nonspecific symptoms is known as idiopathic environmental intolerance (IEI) with ascribed to electromagnetic fields (EMF) since it is not associated with any recognised condition and so resembles other hypersensitivities to environmental variables.

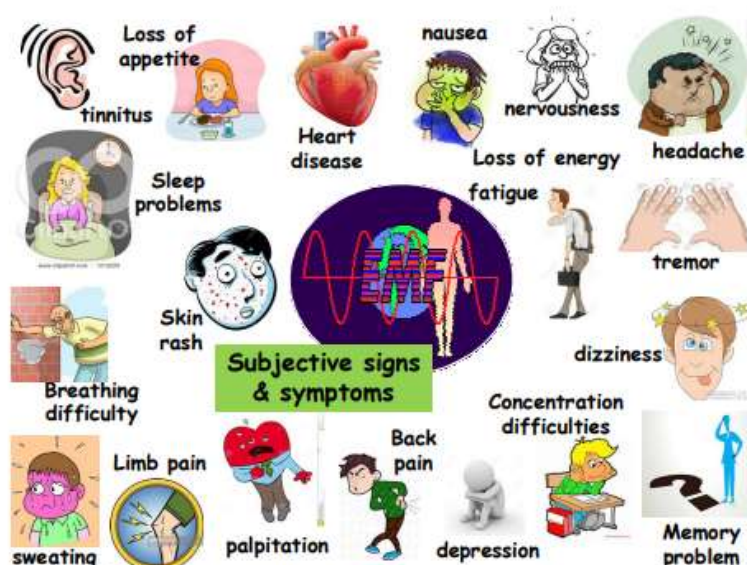


Figure 4. Various subjective health symptoms and signs of electromagnetic hypersensitivity (EHS) Neuropsychiatric complaints, including headaches, sleep disturbances, depressive symptoms, dizziness, and tremors, were much more common in exposed residents than in controls in a cross-sectional study that looked for neuro-behavioural deficits in people who lived near base stations. According to epidemiological studies, the severity and frequency of symptoms tend to worsen with exposure duration and to go away when exposure is temporarily or permanently stopped while receiving supportive care for symptoms. Moreover, the intensity of symptoms decreases with increasing separation from the cause. Ninety percent of those who self-affirmed as EHS participants in a health survey reported that their health symptoms disappeared after leaving the exposure zone.

3. Conclusion and future scope

Overall, this study demonstrated the ability of RF-EMF at the X and Ku radar frequency bands to cause stress through changes in oxidative stress and hormonal parameters along with some obvious effects on subjective health symptoms and signs, even though the measured power density levels were well below the occupational limits for RF-EMF exposure. Although the likelihood of detrimental biological effects is not ruled out, the negligible results obtained at some exposure combinations in some of the parameters highlight the significance of both biological sensitivity and EMF exposure features in highlighting the effect. However, there is no indication of a causal association in this study. Still, the results are important because they emphasise how important it is to put preventative measures in place. Before drawing any strong conclusions, more research is required to validate these findings and provide an explanation for the observed variances. Higher exposures should be avoided in the interim by taking the appropriate precautions.

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