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Research Article

Effects of Electromagnetic Fields on Human Health

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Abstract – In today's world, most children are exposed to various electromagnetic fields (EMFs). EMFs are electromagnetic waves less than 300 GHz. A developing child's brain is vulnerable to electromagnetic radiation; thus, their caregivers' concerns about the health effects of EMFs are increasing. Electromagnetic fields (EMF) have been implicated to influence a range of bodily functions. Given their ubiquitous nature, widespread applications, and capability to produce deleterious effects, conclusive investigations of the health risks are critical. The utilization of Electromagnetic field has become universal from everyday usage of electronic appliances. This Article reviews on various Effect of Electromagnetic Field (EMF) on Human Health. The biological effects of EMFs on humans include stimulation, thermal, and nonthermal, the latter of which is the least known. Among the various health issues related to EMFs, the most important issue is human carcinogenicity. Electromagnetic fields (EMF) have various chemical effects, including causing deterioration in large molecules in cells and imbalance in ionic equilibrium.

Keywords – Radio Frequency, Exteremely Low Frequency, Leukema, Neurological, Biological Effect.

I. INTRODUCTION

Many natural and artificial sources that emit electromagnetic fields (EMF) are crucial to daily life. Every day, more than 3 billion individuals worldwide are exposed to EMF [1]. Since it has the ability to bring about large changes and harmful effects in biological systems, lifelong exposure to EMF is now the focus of extensive scientific research. EMF effects on biological systems can be divided into thermal and non-thermal categories. Thermal impacts are linked to the heat that an area's EMFs produce. Natural surroundings like the geomagnetic field and solar energy can produce electromagnetic radiation, as can man-made sources. As a result of scientific and technical breakthroughs, a variety of artificial electromagnetic fields (EMFs) are present everywhere we go. Electrical lines, transmission towers, telecommunications, home appliances, mobile phones, WiFi, and base stations all produce invisible electromagnetic fields, or EMFs. Children increasingly utilize computers and iPads for

academics, entertainment, and social interactions. Even young children might be exposed to EMFs when using electronic devices or in their homes.

There are 2 main categories of EMFs: extremely low frequency (ELF) and radiofrequency (RF) waves. ELFs can be generated from electrical lines or transmission towers, issues of which have been investigated for the last several decades. RFs can be generated from mobile phones and smart devices and the recent 5th-generation (5G) technologies. The human effects of RFs are less evident and more difficult to study than those of ELFs. The effects of electromagnetic fields (EMFs) on human health has gained extensive attentions over the recent decades. Although some cautious concerns exist for the safe use of EMFs [2],

On one hand, these electromagnetic waves (EMW) provide immeasurable benefits; on the other hand, they may also create potential hazards through uncontrolled and excessive radiation emissions. There are various types of electromagnetic radiations (EMRs) and depending upon their frequency and wavelength they are categorized into different types. Broadly the EMFs are categorized into two groups, namely, extremely low frequency (ELF) EMF (>3 Hz– 3 kHz) and radiofrequency radiation (RFR) EMF (3 kHz– 300 GHz). Scientific investigations concerning the interaction of EMF with living systems, especially its health effects, are increasing in number. There are arguments for both positive and negative bio effects. However, the lack of sufficient knowledge on biological effects of the vast majority of frequencies even below the safety limit leads to several apprehensions [3-4].

EMFs, or electrical and magnetic fields, are generated whenever an electrical current occurs. In contrast to magnetic field strength, which is measured in amperes per metre (A/m), electric field strength is expressed in volts per metre (V/m). Magnetic flux density (Tesla) is a unit of measurement for magnetic fields.

ELF, RF, infrared, visible, ultraviolet, and ionising radiations (x- and -radiation) are the frequencies that make up the electromagnetic spectrum [2]. Waves with a frequency of less than 300 GHz are referred to as EMF, which comprises the majority of exposure frequencies. ELF-EMF refers to the lowest frequencies (3-3,000 Hz), whereas RF-EMF refers to the higher frequencies (30 kHz to 300 GHz, beneath infrared).

Fig. 2 Various source of EMFs

A. Extremely Low Fequency EMFs

ELF-EMFs are generated from electricity, electrical machines, transmission towers, and high-voltage lines. In Korea, electric power is operated at 60 Hz. More EMFs are absorbed with the use of appliances that are close to the body (e.g., hair dryers, bidets, massagers, and electric blankets). The general recommendation is that electrical appliances should be used at least 30 cm away from the body.

B. Radio Frequency EMFs

RF-EMFs are generated from mobile phones, smart devices, WiFi, base stations, and radars. Radio or television transmitters and base stations can be large sources of RF exposure. Mobile phones generate more electromagnetic waves when used in a fast-moving subway or train or when searching for a base station before the ring back tone [5]

II. Literature Review

According to different Researcher we concluded that each and every Researcher worked on Effect on Human Health due to Electromagnetic field, some of them are discussed. Jin-Hwa Moon reviews the current knowledge of EMF exposure on humans, specifically children. EMF exposure sources, biological effects, current WHO and IARC opinions on carcinogenicity, and effects of EMF exposures on children [6]. Xuelei Liu, Xianqiang Yan, and Shujun Zhang, provides a general introduction about natural EMFs and related biological effects. Then the recent progress on the

EMF treatment of some common diseases (such as cancer, diabetes, wound healing and neurological diseases, etc.) has been carefully reviewed and summarized [7]. Sarika Singh and Neeru Kapoor, has been constructed to weigh the bio effects, possible bio interaction mechanisms, and research areas in bio electromagnetics seeking immediate attention [8]. Monalisha Sahu, Shyambhavee Behera tried to gather evidence from the existing literature about the biological effects of EMF on human health [9]. In this paper we discuss about the effect of Electromagnetic field on Human health.

III. Materials and Methods

We conducted a systematic search related to electromagnetics field and its effect to identify all relevant peer-reviewed papers published using key words, "electromagnetic fields", "Extremely low frequency electromagnetic fields (ELF-EMFs)", "biological effects", "health effects". The key words were arranged in different Boolean combinations with different search phrases. The health effects due to EMF were then rearranged in line with different human systems affected. The data from each study were extracted independently by two researchers and recorded. The form extracted information about study design study sample, sampling procedure, exposure, results and health effects.

IV. Result and Discussion

Multiple adverse effects of EMF on different human organ systems have been reported by different studies. Different varieties of biological effects were observed in presence of different type of electromagnetic radiations.

A. Biological Effect of EMFs

The main effects of EMFs on the human body are stimulation, thermal, and nonthermal. Stimulation effects involve the nerves and muscles at a high EMF, can be used for medical devices, and can cause electrical shock at very high stimulation levels. Thermal effects involve an increase in body temperature. Hot senses of the ear or body during mobile phone or laptop use are some examples. Nonthermal effects result from recurrent long-term exposure and may be related to the so-called electromagnetic hypersensitivity syndrome or neurodevelopmental disorders [10].

The effects of EMF exposure differ with respect to frequencies and strength. For frequencies less than 300 GHz, limitation levels for human protection have been well established for public and occupational workers [11]. From 100 kHz to 10 GHz, which includes the use of mobile phones, limitation level is expressed as a specific absorption rate (SAR, W/kg) [12].

One of the major issues of EMF involves human carcinogenesis. Since the first report on residential ELF-EMF and childhood leukemia in 1979, several studies have investigated this association. Brain oxidative stress and epigenetics are considered biological mechanisms of RF-EMF effects. Several theories suggest that EMF exposure results in oxidative stress and reactive oxygen species and loss of cells and blocks their production [13].

B. ELF Effects on children

ELF from high-voltage power lines can affect children living near them; in fact, children can be continuously affected by low-level in-house wiring. Much of the results regarding ELF and children's health are based on epidemiologic studies with childhood leukemia.

C. RF Effect on Children

Whether children are vulnerable to RF has been debated for the last 20 years, when children were widely exposed to mobile phones. Human and animal model studies yielded significant findings regarding cellular phone use: increased headache, sleep disruption, neurotransmitter release, synaptic plasticity alterations, and neuronal cell cycles.

D. Studies of Mobile Phones RF Exposure in Children

The skull thickness of adults is approximately 2 mm. However, the skull thickness of a 5-year-old child is approximately 0.5 mm and 1 mm in 10 years. Therefore, radiation penetration is larger in children than in adults. As a child's head diameter is smaller, the energy-absorbing "hot spots," the most sensitive parts of RF, are more pronounced. Several engineering strategies to avoid the hazard of RF do not consider a child's head specificity.

The results of the study that assessed the associations between RF exposure and cell phone use, residential RF-EMF levels, and cognitive function tests were inconsistent. Ten-year-old children living in areas with higher RF exposure did not show any effects in most of the cognitive parameters; however, they did show lower verbal scores and higher internalizing and total problems. In a study of children aged 5–6 years, greater residential RF exposure from base stations and the presence of indoor sources were associated with improved inhibitory control and flexibility of cognition but also reduced visuomotor coordination.

E. Precautionary Principles for Children

International policies and advisory responses regarding children's exposure to RF-EMF vary. RF-EMF-related advisory policies for children are as follows: banning mobile phone advertising or sale to children, SAR labeling, and preferring wired connection to WiFi in schools.

F. Chemical Effect of Electromagnetic Filed

Electromagnetic fields (EMFs) are typically considered non ionizing radiation, which means they do not have enough energy to break chemical bonds and directly cause chemical reactions in the human body. However, some concern about potential indirect chemical effects arise from the use of devices that emit EMFs, such as mobile phones and wireless technology. These concern may include:

G. Electromagnetic Interference

EMFs can interfere with the operation of medical devices, such as pacemakers or electronic medical equipment, potentially causing malfunctions. However, modern medical device is designed to be shielded against such interfere.

H. Chemical Exposure

Some studies have explored whether the heat generated by mobile phones or other wireless devices might increase the absorption of certain chemical from skin (e.g, from cosmetics or sunscreen). This is a concern primarily because of the thermal (heating) effect of EMFs rather than a direct chemical effect.

I. Psychological and Behavioural Effect

While not chemical in nature, some studies have examined whether EMF exposure can influence human behavior and mood. However, the mechanisms for these effects are not primarily chemical but may involve neurological or psychological factors.

V. DISCUSSION

As, there are multiple sources of EMF in any particular residence or workplace, proper epidemiological evaluation of this matter is quite ambiguous. As the time of use of electronic appliances and telecommunication tools like mobile phones and other EMF devices will increase in coming years, we are exposed to EMF radiation from multiple sources simultaneously every day at work and home. So accurate data regarding EMF pollution from any epidemiological studies could not possibly made in real human population. Experimental studies indicate that short-term exposure at the levels present in the environment or in the home do not cause any apparent detrimental effects. Thus, till the time a definitive health effect has been proven, considering a high index of suspicion, a need arises for proper legislative measure that should be taken to reduce usage of materials that contributes to electromagnetic field pollution. Such as, limitation of numbers of radio stations in crowded area or base station in public place. Electric lines and wiring should be done as such that EMF emission should be least. IEC activities should be undertaken targeting young population to decrease mobile phone time in their daily life, which is increasing day-by-day. Awareness of young population regarding the EMF emission from video displaying units would markedly reduce screen time, thus, electromagnetic field pollution.

VI. CONSLUSION

There is no denying that the existing research works are pointing towards greater risk of adverse health effects ranging from Biological Effect to Chemical Effect, Therefore. the need of the hour is undertaking various preventive measures in order to minimize the exposure in the occupational as well

as non Occupational settings. There should be Mass media effort to generate awareness about the possible health impacts of EMF, particularly focusing on young population and proper legislative measures should be taken to minimize EMF exposure at occupational settings. The nervous systems of children are more vulnerable to the effects of electromagnetic waves than those of adults. Although studies on the effects of EMFs on children's health are unestablished, precautionary principles should be followed for children and the exposure to EMFs among children should be minimized.

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