

The study of electromagnetic fields on the human body

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Abstract: - The purpose of this paper is to study the influence the new technology has in our daily life. The aim of this is to show possible gaps, the negative parts of new technologies, a dark illusion which is increasing at large scale, making our life easier day by day. Technology from our home, office, appliances or personal gadgets are evolving, are important, are affordable and we are almost dependent on them, giving us maxim comfort at a minim effort. One day we must figure out that health is much more important and the surrounding technology may cause us harm. Technically, wherever electricity exists, a magnetic field is being carried around, with us being directly exposed to EMF (electromagnetic field), Wi-Fi, routers and our human cells, may be very vulnerable.

Key-Words: - EMF (electromagnetic field), radiation exposure, new technologies, Wi-Fi, router

1 Introduction

The world's populations – from children to scientists and physicians – are increasingly faced with great pressures from advertising urging the incorporation of the latest wireless device into their everyday lives. [1]

In today's world, every living cell from Earth is exposed to its surface ranges, from 25 to 65 μT (microteslas – unit measure for magnetic field) but nowadays a strong, dangerous, artificial, manmade field is also rising with different frequencies and levels of radiations.

Lots of researches were made before year 2000 and many more till today, resulting a link between technology and health statistics. The common thing from this connectivity link between this two is the adjective 'increasing'.

Health statistics are increasing with a large number of diseases percentage (headaches, high blood pressure, cancer, etc.). Artificial electromagnetic radiation sources include in great way all kinds of electric appliances and devices that are being used every day, with a powerful, unobserved or ignored by many of us, exposure radiation which can be prevented and reduced.

So, starting from here, the scientists were driven by a great motivation to research and to study the level of magnetic field exposure, which comes

from the latest common technology used at a large scale, worldwide nowadays by many of us. As part of it, finding the most dangerous EMF generator that could influence our health, providing the possible effects, symptoms, safety limits research and actions is urgent in order to eliminate the risk.

The tendency to discover new things and new technologies defines us as human beings. What seemed to be linked to the science fiction stories one hundreds of years ago, now has been transformed into something real and accepted. The world never stopped from evolving, on the contrary, development is fast and technologies are more and more sophisticated. The problem seems to occur when we can no longer keep up to everything that is new and we are not always aware that new things does not always mean that are something good. With the technical development, more and more devices started to use electricity. Wherever electricity exists, magnetic fields exist. Many researches were done in the last decades in order to answer the question: "Could these magnetic fields represent a risk to humans?" Until now, no clear answer has yet to be found.

In the last century, because of technical progress, the level of magnetic fields has visibly increased, so has the level of exposure. The potential health effects of the magnetic interactions have been discussed over the last decades and the debate is still

open. So these questions, regarding the existence of the magnetic fields or the values their strength has escalated to, should not be overlooked. Also, the presence of the sources of extremely low frequency magnetic field and static field has been a concern among scientists.

Human are exposed to magnetic fields from many sources and in different situations, both in indoor and outdoor areas. The coffeemaker, the TV, our smartphone and computer, all represent sources of magnetic radiation. Indeed the values of these magnetic fields are not so high compared to the geomagnetic field, but in combination, they could represent a threat for our health. [4]

2 Background and theory

2.1 The magnetic field

A magnetic field is a space region that emerges from the electric charges motion. The field may be pictured as force lines, also called flux lines: the field direction at any point is given by the line direction in that point. Its magnitude is proportional to the density of lines near the point. The flux lines are continuous without beginning and end. The magnetic field is described by two vector quantities: the magnetic field strength H and the magnetic flux density B , related by the relation:

$$B = \mu * H \quad (1)$$

The proportionality constant or the magnetic permeability, μ , depends on the medium. In biological tissues case is assumed to be equal to the permeability free space value $\mu_0 = 4\pi \times 10^{-7}$ (T•m/A -1). The magnetic flux density B is defined in the Lorentz force terms F acting on a charge q that moves in a magnetic field with a velocity

$$F = qv * B \quad (2)$$

The magnetic field unit is the Tesla (T), in the SI system, while in the CGS system (Centimetre, Gram, Second system) it is the Gauss (G) - $1 G = 10^{-4} T$. The magnetic field strength decreases with the distance from the source. In the approximation of a long wire carrying an electric current (valid for small distances r compared to the straight portion of the wire) the magnitude of the field varies as:

$$B = \mu_0 * I / 2\pi R \quad (3)$$

2.2 The Earth's Magnetic Field

The Earth's magnetic field is dipolar. That means, the magnetic poles are not coincident with the geographic poles (1). It fluctuates at the surface from $26 \mu T$ near the Equator to about $60 \mu T$ near the poles. In the last centuries, the dipole moment is continually decreasing and it is assumed that it reverses every 200,000 years.

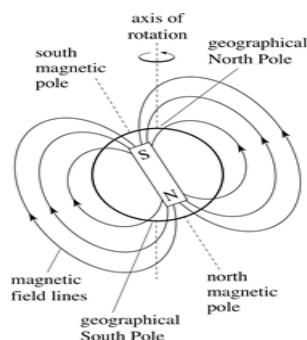


Fig. 1: Earth's magnetic and geographic poles and the Earth's magnetic field

The magnetic field is maintained by the geodynamo. Geodynamo represents the interaction of the existing Earth's field with the molten iron of the outer core that flows around the solid inner core. In this core an electric current is induced just as in a metallic wire that moves across a magnet. Once the electric current is established it generates a constant magnetic field that sustains the Earth field. [3]

2.3 Laboratory studies

The safety issues related to the static magnetic fields exposure is a question starting from concern in the last century. In 1892 Peterson and Kennelly studied the exposure effects to the largest magnet then available. That magnet had a strength around 0.15 T. They exposed a dog and a young boy to the whole-body magnetic field, but no positive result was found and they concluded that "The ordinary magnets used in medicine have a purely suggestive or psychic effect and would in all probability be quite as useful if made of wood".

In 1921, Harvard psychologists Drinker and Thompson investigated the possible health consequences of exposing to industrial magnetic fields to a number of workers. They performed numerous experiments both on nerve-muscle cells

and on living animals. Again, they found no effects of the magnetic fields and deduced that *“It seems certain that the magnetic field has no significance as a health hazard”*.

There were a lot of studies done afterwards, but no clear answer could be given, due to the incapability to reproduce positive findings. In a series of publications in the 1950s, it was reported that the magnetic field exposure on mice led to retardation of the overall growth rate, tumour growth rate, and white blood cell counts. However, the attempts to reproduce some gave negative results. [3]

The interest in the biological effects of the static magnetic fields has increased in the 80s. That happened due to the invention of the MRI – magnetic resonance imaging. Safety issues and discussions about potential hazards associated with magnetic resonance imaging systems and procedures have been extremely controversial, because of the disputed assertions about the role of electromagnetic fields in carcinogenesis or the promotion of abnormalities in growth and development and because the assumption that MRI was inherently a safe procedure had reduced the publication importance of negative results. [12]

2.4 Effects

The World Health Organization has done multiple studies regarding magnetic fields and the risks associated with them. They determined that the effects caused by exposure can be of two types: short-term effects and long-term effects.

Short-term effects are established biological effects from acute exposure at high levels - above 100 μT - that are explained by recognized biophysical mechanisms. External extremely low frequency magnetic fields induce electric fields and currents in the body which can cause nerve and muscle stimulation and changes in nerve cell excitability in the central nervous system. [17]

Potential long-term effects. Much of the scientific research examining long-term risks from extremely low frequency fields has aimed attention on childhood leukaemia. In 2002, International Agency for Research on Cancer (IARC) published a monograph classifying extremely low frequency magnetic fields as *“possibly carcinogenic to humans”*. This classification stands for an agent for which there is limited evidence of carcinogenicity in

humans and less than sufficient evidence for carcinogenicity in experimental animals. This classification was based on pooled analyses of epidemiological studies demonstrating a consistent pattern of a two-fold increase in childhood leukaemia associated with average exposure to residential power-frequency magnetic field above 0.3 to 0.4 μT . [15]

World Health Organization determined other possible adverse health effects associated with the magnetic exposure. These include other childhood cancers, cancers on adults, depression, suicide, cardiovascular disorders, reproductive dysfunction, developmental disorders, immunological modifications, neurobehavioral effects and neurodegenerative disease. The World Health Organization deduced that scientific evidence supporting an association between extremely low frequency magnetic field exposure and all of these health effects is much poorer than for childhood leukaemia. In some cases, as for cardiovascular disease or breast cancer, the evidence suggests that these fields do not cause them. [18]

Radiations are interacting electrons-atoms based on energy strength, in other words the energy emitted from a source which is being transmitted with speed of light or could be absorbed. With 2 main types of, ionizing radiation comes in special from Ultra-Violet Light, X-ray, Gamma ray with a higher/DNA damage to humans, instead of Non-ionizing which can come from power lines, radio, cell-phones, microwave, infrared (ELF, RF) and all the EMF exposure appliances covered in this paper.

In today's world, everyone is exposed to two types of EMFs: (1) extremely low frequency electromagnetic fields (ELF) from electrical and electronic appliances and power lines and (2) radiofrequency radiation (RF) from wireless devices such as cell phones and cordless phones, cellular antennas and towers, and broadcast transmission towers. [13]

The evidence that power lines and other sources of ELF are consistently associated with higher rates of childhood leukemia has resulted in the International Agency for Cancer Research (an arm of the World Health Organization) to classify ELF as a Possible Human Carcinogen (in the Group 2B carcinogen list). Leukemia is the most common type of cancer in children. [12]

3 Solution

The measurements were done with GM 3120 Electromagnetic Radiation Tester device and Meterk Mk08 presented in the Figure 2 and 3.



Fig. 2. Electromagnetic Radiation Tester (GM 3120 model) [6]

This Electromagnetic Tester is a tool device used for the measurement of the EMF radiation emission. It has a radiation sensor and micro-chip built-in which is processing the data radiation with both measurements capabilities: electric field and the magnetic field at the same time.

One important note here is that the manufacturer designed the device to have a special testing bandwidth above 5Hz—3500MHz, making the range of the magnetic field from 0.01μT to 19.99μT with a notification of a dangerous (harmful) case of a value greater than 0.4 μT and 40V/m. But this values are passing the target very easily and in the next measurements study, values went up to maximum range registered in different cases studied.



Fig. 3 Meterk EMF Meter (Mk08 model) [7]

The Meterk EMF Meter is a tool for magnetic field emission to reach the optimal test result measurements being widely used to test and learn electromagnetic radiation situation indoor and outdoor.

As an observation, this two EMF radiation tester devices used, are single axis, requiring a carefully and long time consuming measurements in order to align with the electric direction for a correct and accurate reading.

4 Experimental results

Starting with Light bulb types exposure measurements, which represents a high importance in selecting for our light conditions, lamps etc., the Table 1 covers the most risk exposure to distance with a the most dangerous value received at maximum electricity power.

Scenario	Distance	GM 3120	Meterk mk08
Fluorescent lightbulb 60W	10 cm	2.54 μT	0 μT
Incandescent light bulb 100W	10 cm	0.52 μT	0 μT
Led Bulb 15W	10 cm	2.28μT	0 μT
Smart Music Bulb LED-5W-Uink Bluetooth	10 cm	0.52 μT	0 μT
Neon Light Tube 1m	40 cm	3.33 μT	0.42 μT

Table 1 - Light Bulb types EMF exposure

Even if the music is important nowadays and we want the cosiest, comfortable headsets or devices, they come with a significant exposure, measurements being made at maximum sound power at a distance risk exposure.

Scenario	Tech. type	Distance	GM 3120	Meterk mk08
Apple AirPods headphones	Bluetooth	1 cm	2.57 μT	1.19 μT
Samsung HS130 headphones	wired	1 cm	0.64 μT	0.3 μT
JBL GO Mini Speaker	Bluetooth	10cm	6.42 μT	0.28 μT

Table 2 - Headsets and Bluetooth Mini Speaker EMF exposure

Our working station is also important even in home situation or office, but from here may come possible glitches exposure at a higher EMF risk present in Table 3.

Scenario	Distance	GM 3120	Meterk mk08
Laptop 2 in 1-Lenovo YOGA 720-15IKB	1 cm	19.99 μ T	67.4 μ T
Router Wireless-N Tenda N301, 300Mbps	1 cm	19.99 μ T	19.93 μ T
Extension cord with 4 sockets	1 cm	2.54 μ T	1 μ T
MODEM INTERNET USB	1 cm	5.14 μ T	9.51 μ T

Table 3 - Working station appliances EMF exposure

Observations: As one of the most commonly source radiation, the number of mobile phone users nowadays it's increasing hugely, but in case of some example measurements, they contain a higher risk exposure both in long time usage or keeping it closer to the body.

Scenario	Distance	GM 3120	Meterk mk08
Samsung S8 (airplane mode)	1 cm	19.99 μ T	0.74 μ T
Samsung S8 (YouTube playing via Wi-Fi)	1 cm	19.99 μ T	16.12 μ T
Samsung S8(YouTube playing via Wi-Fi)	10 cm	19.07 μ T	5.29 μ T
Wireless Charger with S8	3 cm	15.52 μ T	2.3 μ T
LG G3 (screen locked, Data Mobile on)	1 cm	19.99 μ T	19.99 μ T
iPhone 6S Plus (screen locked, Data Mobile on)	1 cm	17.19 μ T	21.09 μ T
iPhone 6S Plus - leather case	1 cm	2.8 μ T	0.98 μ T

Table 4 - Personal mobile phones EMF exposure

Nowadays, the children are very close to some big, dangerous EMF generators and health is ignored. The exposure risks are covered in Table 5.

Scenario	Distance	Gm 3120	Meterk mk08
A+Smart-Fitness Bracelet	1 cm	0.38 μ T	0 μ T
Radio & Digital Clock Alarm Philips AJ4800	10 cm	3.73 μ T	0.41 μ T
Wireless Baby Monitor *videocam	20 cm	1.04 μ T	0.37 μ T
Oral B Pro Expert Toothbrush	20 cm	4.7 μ T	0 μ T
Microwave	1 m	11.83 μ T	6.96 μ T

Table 5 - Higher risk EMF appliances generator

5 Future research

For future research there could be 2 big chapters. Chapter 1: We're getting with fast steps to new digital era of Smart-Homes and Internet of Things. The best scenario to investigate is the one of a simple family (4 people, mother and father with 2 kids) in smart home with lots of sensors on, where we'll have a strong, large range Wi-Fi router which is connected to: 4 phones, 4 laptops/PCs, some tablets, 1-2 Smart TVs, smart fridge, smart washing machine and lots of appliances connected 24/7. Plus, we could add another EMF generators mentioned in this paper and all of this, in a flat, with neighbors that are using the same technologies.

Another enumeration of EMF radiations is the next generation mobile communication technology that would be 5G with fast data streaming; the cars which will incorporate lots of smart sensors and tablets, wireless communication, being considerate to interfere to car boundaries as a microwave box; the new Smart Intelligent Glasses similar to Google Glass Device Explorer being as a radiation crown, with a higher risk of radiation specially to children or phone keeping closer to the body with maximum exposure radiation by using VR Glasses or Sport armband for mobile phones.

And, as a chapter 2 future research, there are a lot of EMF protecting shields that appeared on the worldwide market and not fully tested: necklaces, leathers, plug-in products that can clear and protect

an entire home or office space. A great argument for this chapter is the last scenario covered in Table 4, which numbers proved the significant EMF reducing values.

6 Conclusion

Finally after the research, study measurements, we could express with confidence that nowadays exposure to EMF has significantly increased at a large scale relating to health growing concerns.

For now or best solution is to prevent, seek and reduce the risk of EMF circle that surrounds us, using the safest technology. Someday the health of the world will be much more important than industry money.

The studies effected until nowadays have shown mismatching results related to the effects caused by the magnetic radiation. It can be expected that more studies will be done, as the technology continues to develop in a rapidly accelerating pace that will show if the magnetic field radiation represents a real danger for human's health. Related to our everyday life, we should take into account the possibility of being exposed to such peril and keep distance from the sources of radiation.

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