

# Investigation of the Effects of Pollution Caused by the Emission of Electromagnetic Waves on Human Health

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## ABSTRACT

Electromagnetic force, despite its useful efficiency and achievements, if not controlled and managed, is very dangerous for humans and will have irreversible effects that will remain even after thousands of years. Telecommunication devices such as mobile phones, cordless phones, VHF and SSB wireless and radar .... emit electromagnetic waves that when these waves collide with the living tissue of the body, cause changes in them that They endanger life.

Magnetic and electric fields are generated by power lines, electrical wires, and electrical equipment, and are the invisible power lines that exist around each device, and its power increases with increasing voltage. The electromagnetic field is generated by electrical appliances such as personal computers, televisions, refrigerators, etc., as well as high-voltage power lines. The electromagnetic field disrupts the nervous system and the growth and development and repair of cells, leading to unknown diseases such as cancers, brain tumors and infertility in humans. Therefore, people who are exposed to such fields frequently and for a long time, as well as people working in the electrical and telephone industries, TV repairmen and welders are more vulnerable. Therefore, we must create a suitable environment for work and activity by installing carcinogen control devices in the workplace and identifying the sources of electromagnetic radiation production, observing safety points in the workplace and, if possible, using equipment that has the least amount of electromagnetic waves.

**Keywords-** Electromagnetic pollution, electromagnetic waves, electromagnetic field, ionizing radiation, non-verve and non-manufacturing radiation;

**General purpose-** Identify the effects of pollution caused by the propagation of electromagnetic waves on human health.

## I. INTRODUCTION

Humans are exposed to a variety of electromagnetic fields from natural and artificial sources. These fields create an electric field in the body and affect the movement of ions, heat, nerve and muscle stimulation and various other effects [12]. Electromagnetic fields from ordinary household appliances, which are normal, do not seem to pose a danger to humans, but in certain situations, such as living near power lines and telecommunication network antennas, working or living

near high-power transmitter stations. Radio and television, radars and other types of high-power stations, the electromagnetic field has harmful effects and such fields and electromagnetic waves should be avoided as much as possible or health aspects should be observed [25].

Electromagnetic waves have filled the space around us, many of these fields and waves have existed since the beginning of the universe and played a role in the origin of life and its evolution millions of years ago [26]. Today, in addition to natural fields, with the advancement of technology and industry development and with more applications of electromagnetic fields in science, industry and medicine, these fields are threatening human health and the environment every day. The biological effects of these fields depend on the intensity of the field, its frequency, its changes, and the physical properties of the irradiated person or part of the irradiated tissue [14].

On the other hand, most household appliances that use city electricity have a field around them that changes with a frequency equal to the frequency of city electricity. Telecommunication devices, power transmission networks, microwave ovens, cell phones, video devices, and MRI devices are among the sources of electromagnetic fields [25].

## II. RESEARCH METHOD

To find documents related to writing an article on pollution caused by the propagation of electromagnetic waves and its impact on human health in Google and Yahoo databases using the keywords Electromagnetic pollution, Electromagnetic waves, Electromagnetic field, and search for The effect of electromagnetic waves on human health in Elsevier, Scopus, Science Direct, Springer, Wiley Online Library, Ensco, Taylor & Francis Online and Persian Internet scientific databases such as the large scientific base of Jihad Daneshgahi (<http://www.sid.ir>), Research Institute of Information and Scientific Documents of Iran (<http://www.irandoc.ac.ir>) and the Database of Iranian Publications (<http://www.magiran.com>) using environmental thematic headings of search terms ("Electromagnetic pollution Topic" [Mesh] AND "Writing" [Mesh]) AND "" Narration "[Mesh]) Searched. During the search, more than two hundred documents were reviewed and the relevant items were extracted according to the following criteria.

To select the documents used, the titles found by the search engine were first examined in terms of thematic relevance. The content found was divided into three groups: web portal, book and article. The criterion for selecting Internet portals after thematic communication was having a university (ac) or educational (edu) extension. After reviewing these portals, the items that were more complete than the others were selected as the reference used. Regarding books, the selection criteria were thematic relevance and availability. After reviewing the title, the articles were evaluated in the next stage in terms of the relationship between the abstract and the intended purpose.

The selected cases were thoroughly studied and finalized. Items that were not related to the selected topic of the article were excluded from the study. Selected documents were removed. The collected materials were divided and summarized in three areas: "The nature of electromagnetic waves and the sources that produce them", "Effects of electromagnetic waves on the human body" and "Solutions to prevent or at least reduce the effects of electromagnetic waves on the human body". If necessary, the content was critiqued by the author.

### III. WHAT IS ELECTROMAGNETIC POLLUTION?

Electromagnetic pollution is the peripheral displacement of waves generated by a combination of oscillating electric and magnetic fields [3]. Electromagnetic radiation from unnatural sources is polluting. But it must be said that the electromagnetic fields generated by the earth, the sun and electric storms are not considered electromagnetic pollution [4].

Electromagnetic pollution began with the beginning of the electrical age in the late nineteenth century and is mainly due to the emission of electromagnetic waves from electronic devices. Sources of electromagnetic pollution include household appliances such as microwaves, televisions, radios, cell phones, home telephones, Wi-Fi modems, electronic surveillance systems, radars, connected transmission systems (mobile phone bases and antennas), systems Wireless or Wi-Fi and computer systems that cause electromagnetic pollution [2].

The energy of electronic waves is non-ionizing. This means that it is not possible to break the relationship in these waves. In other words, it does not damage the cell nucleus and cause cancer. However, electromagnetic waves, while not causing direct damage, can cause serious damage to humans through constant contact with the devices that emit these waves [7].

### IV. ELECTROMAGNETIC WAVES

Waves are simply layers of energy that travel in a straight line. In these layers, the amount of energy gradually reaches the minimum (so-called wave valley) to

the maximum (so-called wave peak) and gradually decreases again. The distance between two wave peaks is called the "wavelength". The difference in the different colors that can be seen is in their wavelength [5].

Electromagnetic waves are waves generated by the motion of electrically charged particles. These waves are also called electromagnetic rays; Because they are formed by the radiation of charged electric particles [16].

Radio and television waves, ultraviolet waves, light waves, microwaves, gamma rays, X-rays and light are among the electromagnetic waves. Radiofrequency and microwave radiation is non-ionizing because its associated energy is not high enough to ionize atoms and molecules [6].

Studies and research by scientists on the effect of electromagnetic waves on various biological systems began in 1935. The results of many of these studies showed that electromagnetic waves have effects on living organisms, including their growth, by changing the distribution of ions [27].

The wire that passes under the wall surface has electromagnetic radiation; So when you lean against the wall, you are in the field of radiation. When an electrical appliance is off but its two branches are plugged in, it has an electric field; But as soon as it is lit, a magnetic field is created around it. The higher the voltage of a device, the stronger its magnetic field. Many of us may have heard about the dangerous waves emitted from high voltage towers, but did you know that according to scientific research, the magnetic field of a light hair dryer is several times the magnetic field created under a power tower? The same goes for the magnetic field from the washing machine. Therefore, it is recommended that you never put your child to sleep near a lighted washing machine [11].

Due to the potential harm of radio waves to people, the significant increase in mobile phones has caused significant concerns for humans [13]. Since mobile phones are used in situations very close to the human body and require a large number of antenna stations, the effect of mobile phone networks on human health has always been considered [5].

In response to public concerns about the use of these waves on human health, in 1996 the World Health Organization (WHO) began research efforts in this area. In May 2011, the World Health Organization-affiliated International Agency for Research on Cancer published a summary of the health risks of electromagnetic fields. The report states that there is limited evidence of the dangers of electromagnetic waves on human health, including an increased risk of developing neurological and brain cancerous tumors. As a result of this organization; Classifies electromagnetic waves in the category of possibly carcinogenic waves [15].

#### *Types of waves of the electromagnetic spectrum*

Magnetic fields are created in the form of alternating fields (frequency dependent) and stable fields due to natural and artificial resources. The Earth as a natural resource is surrounded by a stable magnetic field

between 25 and 65 microns Tesla. A view of the radiation sources is shown in Figure 1.

Electromagnetic beams can also pass through empty spaces; All forms of electromagnetic radiation fall into the electromagnetic spectrum; The spectrum in which rays are arranged from the lowest energy level and highest wavelength to the highest energy level and lowest wavelength values. The higher the energy of the radiation, the more power it naturally has, and therefore the greater the risk. Figure 2 shows an overview of the electromagnetic spectrum [5].

Electromagnetic radiation; Based on the amount of energy and penetration power in matter, they are classified into two groups:

### 1. Ionizing Radiation

Ionizing radiation has a high energy that breaks the chemical bonds of the tissue in contact with the human body and can sometimes have very serious side effects. Radiation emitted from medical equipment such as radiography, radiology, mammography, MRI, CT scan, as well as radiation from natural sources; Like X-rays, gamma, ultraviolet, and infrared, which reach the earth from the universe, are ionizing rays [8].



Figure 1. Radiation sources [5]

Electromagnetic radiation also indirectly affects human health; Because when it is released into the air, it can cause ionization of air molecules, which ionized molecules have an adverse effect on the human body. In terms of energy, a beam has ionizing power that contains at least 12.4 electron volts of energy and its wavelength is less than 100 nm [24].

Because ionizing electromagnetic radiation is defined by its ability to break chemical bonds due to its high energy and ion formation, electromagnetic pollution also refers to this type of radiation [17].

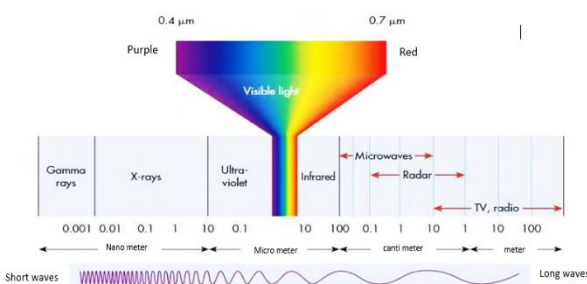


Figure 2: The spectrum of electromagnetic waves (the wave line on the right indicates that there is more energy at higher frequencies [5])

### 2. Nonionizing Radiation

Non-ionizing radiation that does not have enough energy to break the chemical bond and ionize the material; Includes radii from telecommunications equipment, cell phones, BTS, ultraviolet disinfection systems, laser generating sources, telecommunication microwaves, microwave ovens, infrared, as well as radiation from home appliances such as and is a washing machine (30). It should be noted; All electrical appliances emit electric waves as long as their two plugs are connected to electricity, but when they are turned on, they emit electromagnetic waves in addition to electrical waves [10].

Non-ionizing radiation is widely used today. When these rays are scattered in the air or material environment, part is absorbed by the environment and is mainly converted into heat. This radiation contains radiation with a wavelength of more than 100 nm and the energy of each electron is less than 12.4 volts [14].

#### Sources of electromagnetic waves

Common sources of electromagnetic radiation in the laboratory and the environment can be listed as follows:

1. Types of controllers;
2. The sun's ultraviolet rays;
3. Medical equipment including MRI machine, various stimuli, surgical electrodes;
4. All kinds of medical, military, radio and television receivers and transmitters;
5. Laboratory, household and industrial electrical equipment;
6. Textile, plastics, paper, food and wood industries;
7. Navigation waves, satellites, telephones, internet, etc.
8. Generation equipment and transmission lines;
9. Electrical circuits in laboratories, homes and public places;
10. Security devices (such as anti-theft devices);
11. Electric trains;
12. Power supply cables for laboratory equipment, television and radio;
13. Telecommunications and related equipment [33];

## V. ELECTROMAGNETIC FIELDS

In today's society, electromagnetic fields are ubiquitous, like electrical systems, as well as radio and television stations and devices. After the 1990s (the 20th century), with the introduction of wireless communications, there was a leap in this field, and with the development of mobile phone technology, these electromagnetic fields attacked all areas of life. These structures, as an abnormal element in the environment, became a factor of environmental pollution [31].

#### Effects of electromagnetic waves on the human body

Concerns about the damaging effects of electromagnetic waves on human health are on the rise these days, although this is not surprising given the proliferation of new technologies [1].

Today, humans are surrounded by dozens of magnetic generators. Scientists estimate that modern humans experience 200 million times more electromagnetic radiation than they did before industrialization [28]. All wireless communication devices, including mobile phones, VHF cordless phones, microwaves, Bluetooth, even radio and television receivers, as well as children's control toys, etc., generate electromagnetic waves to communicate with their central antenna. Therefore, in addition to the waves emitted from the various mobile phones and wireless used, their central stations and antennas should also be considered as high-power centers [20].

It should be noted that there is still no conclusive evidence about the possible effects of electromagnetic pollution. However, the results of scientific research continue to warn of possible negative effects [35].

The dangers associated with high-energy electromagnetic radiation are quite obvious. An organism that is exposed to gamma rays and ultraviolet rays can take serious risks depending on the dose and timing of the radiation exposure.

Doubts in the scientific community are related to low-intensity electromagnetic radiation. In this regard, it is not clear whether prolonged exposure to microwaves and radio frequencies can affect health [29].

The effect of electromagnetic radiation (low intensity) on chicken embryos was studied in Ramon and Catchall Hospital (Spain). The investigation began in 1982 with a team of Jocelyn Lal, Alejandro Abda and Angeles Trill. The results showed the possible mutagenic effects of weak electromagnetic radiation [34].

The World Health Organization (2013) classified electromagnetic fields of radio frequency as possibly carcinogenic to humans. Two epidemiological studies (USA and Sweden) show higher rates of leukemia in workers in the electrical, electronics and telecommunications industries [21].

The effect of radiofrequency radiation on body tissue can be manifested in several ways:

#### 1. *Creating heat in the tissue:*

Creating heat or heat in the tissue causes its destruction and damage. Sensitive organs, mainly the lens of the eye, the central nervous system and the testicles, are vulnerable to electromagnetic radiation in men. Symptoms such as headache, nervous irritation, fatigue, sweating, anorexia, watery eyes, hair loss, hearing loss and menstrual irregularities in women are some of the possible effects of electromagnetic radiation on humans (18). Under the influence of this radiation body fluids; They act like electrolytes. When a time-varying electric field passes through an electrolyte, because the applied field frequency is too high (radio frequency), it causes the ions to move back and forth first in one direction and then in the opposite direction; Therefore, before the charged particles have a chance to move, they change direction regularly and cause the ions to vibrate in their place. This process produces heat in the body [32].

#### 2. *Induction of electric current:*

Induction of electric current in excitable tissues (nerves and muscles) disrupts their normal function [21].

#### 3. *Changes in the natural role of molecules in the body:*

Changes in brain activity (including slowing of consciousness, slow reaction) and changes in heart function (including slowing of the heartbeat) have been attributed to this radiation. On the other hand, research on pregnant women who are exposed to these fields shows an increase in abortions and the birth of babies with birth defects. Some vital changes made by radiofrequency radiation can lead to cancer in the organs of the body, in other words, these rays are carcinogenic [18].

The effects of low-frequency (low-frequency) radiation on children can cause a variety of cancers, including leukemia, nervous system cancer, and lymphatic system cancer. Some epidemiological research suggests that strong magnetic fields can increase the risk of cancer in children [9].

One of the strongest evidences of epidemiological studies is that women working in electrical jobs (telephone installers, repairmen, transmission line workers, etc.) are 38% more likely to develop breast cancer than women working in non-electrical parts. This study shows that the incidence of breast cancer can be associated with exposure to magnetic fields. Recent studies also show that breast cancer deaths in women working in the electrical profession are twice as high as in other women [15].

In general, the effects of electromagnetic radiation on the human body can be categorized as follows:

1. Increase in body temperature;
2. Increased heart rate, palpitations and increased blood circulation and high blood pressure;
3. Weakness, fatigue, and darkening of the eyes and premature cataracts;
4. Nausea, dizziness and headache, especially in the migraine area, tinnitus;
5. Skin irritation, especially in the parietal area;
6. Feeling of general malaise, insomnia, insomnia and drowsiness at work (due to hormonal imbalance);
7. Changes in nervous response (intolerance and irritability);
8. Muscle pain in the spine and shoulders, inflammation between the vertebrae of the spine and pelvic joints;
9. Chest pressure and pain in the back of the retina;
10. Disorders of the neuromuscular systems;
11. Decreased learning power and academic failure, decreased memory, especially short-term memory;
12. Decreased sexual potency and impaired fertility;
13. Deformation of blood proteins, leukemia (leukemia), especially in children, cancer of the glaucoma and breast cancer;
14. DNA changes;
15. Weakening of the body's defense system [30];



## VI. SOLUTIONS TO REDUCE THE EFFECT OF ELECTROMAGNETIC WAVES

The two golden principles for protection against the effects of electromagnetic waves that every person must follow are:

A. Increasing the distance to the source producing the electromagnetic radiation;

B. Reduction of irradiation time [22];

Based on the above two principles, some of the protection measures against electromagnetic waves are as follows:

1. Awareness of electromagnetic waves and their possible dangers;
2. Use of appropriate protection;
3. Installation of physical barriers;
4. Installation of alarm equipment;
5. Reduce the risk of human error;
6. Use of fiber optic cables in communication networks;
7. Not using wireless communication;
8. Keep cordless phones and cell phones out of the body;
9. Reduce talk time if you need to use cordless or cellular phones;
10. Reduce the duration of using a speaker or headset during a call;
11. Turn on wireless internet and data internet only when necessary;
12. Do not use microwave ovens;
13. Put Wi-Fi in the farthest part of the home and turn it off when sleeping and when not in use.
14. Use of protection products against waves such as Wi-Fi modem cover, anti-wave maternity clothes, anti-wave paint and ....
15. Pay attention to the regulations of protection against electromagnetic radiation;
16. Use of appropriate hazard signs on devices producing or using electromagnetic radiation;
17. Identify areas that are not open to the public;
18. Pay attention to the instructions on how to use devices and equipment that produce electromagnetic radiation;
19. Repair or cleaning of electromagnetic radiation generating devices by responsible persons;
20. See a doctor in case of radiation [23];

## VII. CONCLUSION

Today, humans are surrounded by dozens of magnetic generators, which scientists estimate are 200 million times more likely to experience electromagnetic radiation today than they were before industrialization. All wireless communication devices, including mobile phones, cordless phones, VHF, microwaves, Bluetooth, even radio and television receivers, as well as children's control toys, etc., generate electromagnetic waves to communicate with their central antenna. Therefore, in addition to the waves emitted from the various mobile phones and wireless used, we should also pay attention to

the stations and their central antennas as high-power centers that emit electromagnetic waves. Most measurements taken from different distances of ground antennas show that the strength of the wave and the intensity of the frequency are directly related to the health of people and the environment, and according to what power and frequency and for how long and in what When it hits the body, it can have different effects.

Many household appliances, such as hair dryers and washing machines, emit harmful electromagnetic waves that can be even stronger than the electromagnetic waves emitted under high-voltage power towers.

Based on the results obtained from the study of the findings of this study, it can be concluded; The act of radiation protection is a special aspect of controlling environmental health risks that is done using technical facilities. In industrial and laboratory environments, it is usually tried to eliminate the danger center completely, and if it is not possible to eliminate the danger center at all, it is tried to enclose it and thus prevent it from harming the person. . If none of them is completely possible, the mentioned methods try to reduce the amount of radiation while doing the work. In general, there is no danger to humans if the standards set by radio and microwaves in public environments are observed.

### *Offers*

The solution to the problem of electromagnetic pollution is not easy; Because the extent of the problem and its true extent are not yet known.

On the other hand, in today's society, due to the characteristics of electromagnetic radiation, it is not possible to eradicate the use of technologies that cause electromagnetic pollution. with that too; General suggestions for reducing electromagnetic pollution in the environment and protecting against electromagnetic radiation can be named as follows:

1. At home, it is important to unplug any unused electrical appliances and avoid turning them on unnecessarily if possible, to prevent an environmental electric field and to protect children, the elderly, and the sick.
2. Try to talk less on your cell phone and use a headset or hands-free as much as possible. When you are not using your mobile phone, keep it away and set it to flight mode when sleeping and resting. You can also set the phone to unobtrusive mode to both save your battery and emit less radiation.
3. Installation and relocation of telecommunication antennas, high voltage networks, radars or similar equipment near educational and health centers should be avoided.
4. Children and patients should be protected from prolonged exposure to electromagnetic pollution.
5. Continuous use of goggles and protective masks with appropriate degrees of opacity;
6. Use of shields in the direction of radiation propagation, such as the use of tarpaulins or reflective sheets made of aluminum;

7. Increase the distance from the radiation source to reduce the intensity of the radiation according to the law of inverse squares;
8. Training on radiation hazards and how to use personal protective equipment correctly;
9. Isolate radiation-producing sources by limiting the welding position by using chambers or walls of suitable height;
10. Distance from sources of radiation;
11. Use proper eye protection;
12. Reduce radiation exposure time;
13. Creating proper air conditioning and establishing more favorable working conditions in the work environment;
14. Use of appropriate clothing and protective equipment such as aluminum reflectors and clothing equipped with metal fibers;
15. Less use of devices that scatter electromagnetic radiation.

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