



## **Effect of Electromagnetic Waves and Environment Conditions on Intracranial Pressure Increase and Headache**

### **Elektromanyetik Dalgaların ve Çevre Koşullarının İntrakraniyal Basınç Artışına Etkisi**

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**Abstract:** Headache has become an illness that many people complain of in daily life. In particular, it is thought that the widespread use of electromagnetic devices and the varying environmental conditions may cause an increase in headache prevalence. This review examines scientific research on electromagnetic waves and environmental conditions that are believed to cause headaches.

**Keywords:** Environment Conditions, Electromagnetic Waves, Headache

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**Özet:** Baş ağrısı, birçok insanın günlük hayatta şikayet ettiği bir hastalık haline geldi. Özellikle, elektromanyetik cihazların yaygın olarak kullanılmasının ve değişen çevresel koşulların baş ağrısı yaygınlığında bir artışa neden olabileceği düşünülmektedir. Bu derleme, baş ağrılarının neden olduğuna inanılan elektromanyetik dalgalar ve çevresel koşullar hakkındaki bilimsel araştırmaları incelemektedir.

**Anahtar Kelimeler:** Çevre koşulları, Elektromanyetik Dalgalar, Baş ağrısı

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## 1. Introduction

Headache is one of the most common complaints in the community. The proportion of those suffering from headaches reaches 90 percent in the society. Migraine and tension headaches make up 90 percent of all headaches. The International Headache Society has classified headaches into 14 main groups and hundreds of subgroups. Headaches that appear directly with a headache and are not related to any other disease are primary headaches. These are migraine, tension type and cluster headaches. Secondary headaches are headaches that occur during the course of diseases such as brain vascular diseases, nervous system diseases, brain tumors, eye diseases, sinusitis, meningitis, the cause of which is 10 percent, depending on a particular disease. Developing technology and changing environmental conditions are also thought to be factors that can trigger headaches. For this reason, we also need to examine the devices and environmental conditions that we use frequently in our daily

lives and that form electromagnetic fields.

### 1.1. Electromagnetic Field and Headache

Electromagnetic fields are created by electrical charges. Positive (+) and negative (-) electric charges of electric fields; moving electrical charges are the source of magnetic fields. The electric and magnetic fields emitted from the source are combined in an electromagnetic field. Electromagnetic fields are shown in 4 different quantities; magnetic flow intensity  $B$ ,  $T$  (Tesla), magnetic field intensity  $H$ ,  $A / m$  (Ampere / meter), electric field intensity  $E$ ,  $V / m$  (Volt / meter), electric flow density  $D$ ,  $C / m^2$  (Coulomb / square meter). Electromagnetic waves consist of both electrical and magnetic components that change periodically (Figure 1). The vibration of the waves in 1 second is called frequency and is expressed in Hertz (Hz) unit. As the frequency of a diffuse decreases, its destruction on living cells decreases.

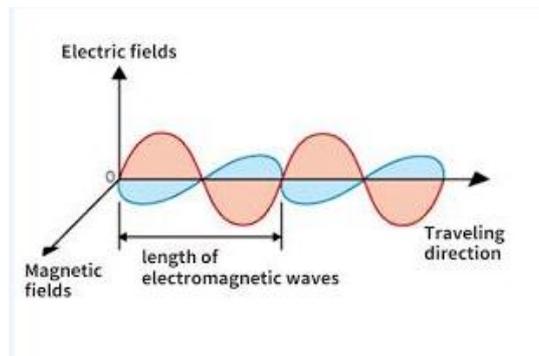


Figure 1. Components of the electromagnetic wave

Electromagnetic vibrations are called radio waves, infrared (infrared), visible light, ultraviolet (ultraviolet), X and gamma ray, and

cosmic ray, according to their wavelengths (Figure 2). Electromagnetic radiation is divided into two as ionizing and non ionizing.

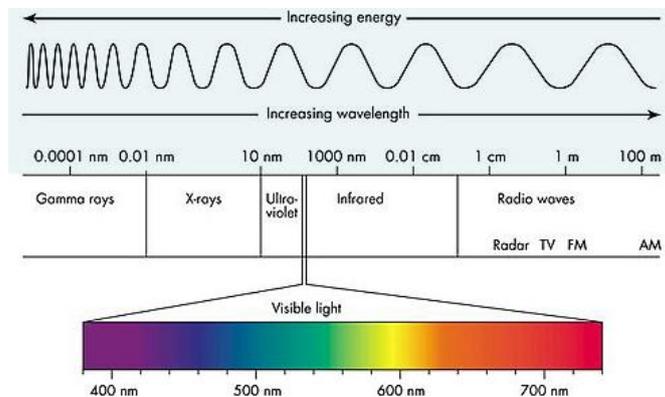


Figure 2. Electromagnetic spectrum

Ionizing radiation is a type of radiation that can remove electrons from the outer orbits of the atom, thereby forming charged particles, i.e., ionizing the atom in the atoms of the substance it hits. Ionizing radiation consists of electromagnetic and particle-type radiation. X and gamma rays in the electromagnetic wave spectrum are ionizing electromagnetic wave type radiation. Alpha and beta particles, neutrons, protons and electrons are examples of particle-type ionizing radiation.

Low energy diffusion is called "Nonionizing Radiation". Photon energies of non ionized radiation are less than 12 electron volts and are considered as the limit of ionized radiation. This energy is too low to induce the ionisation of molecules and is also very weak for breaking chemical bonds (1).

The radiation caused by mobile communication systems is located within the non-ionizing radiation zone. It has not been proven to date whether nonionized broadcasting directly causes cancer or a similar disease (2).

It is understood from the researches that the effects of environmental and human health on the magnetic field created by non-ionizing radiation sources vary depending on the density and frequency of the sources (3).

As a result of being affected by the non-ionizing electromagnetic waves in the environment, two kinds of effects can occur in living things. Thermal effects and non-thermal effects. Thermal effects are defined as the conversion of electromagnetic energy absorbed by the body into heat and increasing the body temperature. This temperature increase lasts until the heat is removed by blood circulation. The temperature rise caused by RF sources such as mobile phones is actually very low and can easily be inactivated by the normal mechanisms of the body. The average temperature increase that can occur in the brain by mobile phone is around 0.1 ° C. Disorders and diseases that radiofrequency waves are claimed to be effective due to non-thermal effects include changes in brain activities, sleep disorders, attention disorders and headaches. However, these risks may be valid at very high experimental doses and times and are not applicable for uses such as mobile phones (4).

Radiofrequency fields, especially microwave (300 MHz - 300GHz), constitute an important

part of the electromagnetic spectrum because of their effects on both the application area and health. Over the past decade, there has been intense debate on the effects of microwave ovens (2450 MHz), radar devices, wireless communication (eg mobile phones). Mobile phones, which have gained popularity rapidly, can not be excluded from this discussion even if they use different systems. GSM (Global System for Mobile Communication), which is also used in our country, is used in TDMA (Time DIVISION Multiple Access) technique, which is frequently used in Europe. The carrier frequency bands determined for these services are in the spectrum of 800-900 MHz and 1800-2200 MHz. The general opinion is that mobile phones may cause damage at the molecular or cellular level as a result of the antenna being held close to the head during calls or calls. In fact, some researchers state that microwave energy absorbed from the head creates a hot spot in the brain (5). As a result, it is suggested that eye damage, headache and cancer can be observed as potential biological effects (6).

Not only mobile phones, but high voltage lines, microwave ovens, TV, computer, etc. Continuous studies and experiments are continuing on the effects of devices on human health. Different experimental results and findings are published and evaluations are made every day. An important compilation of these studies is included in the report published by an independent group of experts in the UK over a year, as a result of meticulous work. In the report in question, it is stated that a significant part of the medical findings that are said to have been obtained through experiments (such as headache, insomnia, creates forgetfulness, increases the risk of cancer, disrupts the P55 gene, weakens the immune system, damages the blood barriers) are not contradictory or even inconsistent, it is emphasized that some of them cannot be associated with base stations and the need for scientific experiments is emphasized (7).

Clinical findings created by Magnetic Field in humans; It may occur as fatigue, muscle pain, headache and dizziness that can last for weeks (8). Along with magnetic disturbances, weakness, neck pain, chest pain, loss of consciousness, headache, circulatory and digestive problems due to heartbeat may occur (8).

### **1.2. Environment Conditions and Headache**

Air quality is perceived as a common trigger of migraine headache, especially by migraine patients, but findings from epidemiological studies remain inconclusive (9, 10). Studies conducted several years ago compared the frequencies of headaches between participants during or after different weather conditions and gave mixed results (11). Findings from more recent studies suggest that there may be a subset of migraine patients sensitive to weather conditions; two of these studies reported the relationship between lower temperature and more migraine headaches among "weather sensitive" participants (12). Some large-scale epidemiological studies have collected data from emergency medicine divisions and found generally positive relationships between the average daily temperature and the number of visits for migraine headaches. In these studies, relative humidity or barometric pressure findings are also inconsistent (13). In a recent prospective daily-based study, high pressure was found to be associated with headache attacks, but its association with migraine has not been demonstrated (14).

Headache is a clinical finding currently undergoing research on its pathogenesis. High-altitude headache is a situation in which we know less about it, yet its etiology is not fully enlightened (15). Although critical approaches still continue, when the international classifications of headaches are examined (ICHD III), there are also systemic causes of headaches due to systemic causes, as well as specific conditions including high altitudes such as 'flight travel' that may develop with short-term hypoxia (16).

Airplane travel headache, which is a rare type of headache, was first reported as a case in the literature in 2004. The necessity of new diagnostic criteria has emerged for this type of headache, as it has been increasingly seen in recent years (17, 18).

As it is known, brain membranes, namely meninges (pia mater, arachnoid and dura mater) and accompanying blood vessels are pain sensitive and are the most important structures causing headache (19).

In a pathogenesis, the trigeminovascular pathway is thought to play an important role in headache at high altitude. The signals generated

by these nerve fibers at high altitudes, which have an effect on meningeal vascular structures, affect the vascular structures in the brain and brain. With the resulting edema of the brain and increased intracranial pressure, pain-sensitive structures such as meninges are affected and headaches occur clinically (19).

In a prospective study by Broessner G et al. In 2015, it was revealed that the risk factors and headache characteristics should be better understood and hypoxia may be a trigger for migraine attacks, given the clinical effect of headache at high altitude. The study showed that migraine-like headache attacks were observed in normobaric hypoxic areas, even in healthy volunteers without a history of migraine (20).

The resulting headache is a neurogenic problem seen as secondary to hypoxia caused by hypobarism and its common denominator in all pathogenesis is its effects on the brain (21).

Akyol et al. was presented in a case published in 2018 by the patient with both plane travel and high-altitude headaches, and was thought to be related to giant Virchow-Robin spaces in the brain, especially related to pain areas (22).

### **1.3. Hyperbaric Oxygen Therapy in Neurological and Neurosurgical Cases**

Hyperbaric Oxygen Therapy (HBO) is a medical treatment method that is applied to patients or experimental animals in completely closed pressure chambers by breathing 100% oxygen under pressures higher than normal atmospheric pressure. The physical laws of pressure, which form the basis of the treatment mechanisms of HBO, are well defined and laid down. Gas under pressure stores surprisingly large energy. At the same time, small changes in the proportions of various gases are greatly magnified by changes in pressure in the environment. The resulting physiological effects vary widely depending on the pressure (23). Therefore, basic gas laws should be well known in the treatment of HBO. Basic gas laws,

- **Boyle-Mariotte Law**

The pressure of the constant mass of the gas at a constant temperature is inversely proportional to its volume. That is, the pressure decreases as the volume increases, and the pressure increases as the volume decreases.

*Pressure x Volume = Constant*

- **Dalton Law**

The partial pressure of each gas in a gas mixture is directly proportional to its quantities in the mixture.

*Partial Pressure of Gas = Total Pressure x Total Volume of Gas*

- **Henry's Law**

At a constant temperature, the amount of gas dissolved in a liquid is directly proportional to the partial pressure of the gas on the liquid. That is, the resolution increases as the pressure increases.

*Concentration of a Dissolved Gas = Pressure x Solubility Coefficient*

It can be summarized as.

Today, HBO is the main treatment method for pathologies such as air and gas embolism, decompression sickness, CO poisoning and smoke inhalation. In addition, there are many new research areas that do not fall within the common indication areas of HBO, but have successful results and case series. Examples of multiple sclerosis, septic shock, fibromyalgia,

migraine, hemorrhagic cystitis, cerebral palsy, and autistic children are examples.

HBO has been used in a variety of neurological diseases including conditions such as cerebral air embolism, CO poisoning, vegetative conditions, global cerebral ischemia caused by cardiac arrest, focal cerebral ischemia, acute spinal cord injury, chronic brain injury, and cerebral vasospasm after subarachnoid hemorrhage. The mechanisms of HBO's protection of neurons can be listed as improvement in brain metabolism, reduction of cancerous barrier permeability and brain edema, decrease in intracranial pressure, weakening of inflammatory response and prevention of apoptotic cell death (24-27).

## 2. Conclusion

The headache complaint is based on many different reasons by scientists. But today, radiation exposure and ambient conditions also have the possibility to play an important role in the increase of headache prevalence. Scientific data in the literature show that these two factors are associated with eye damage, headache, dizziness, weakness and potential biological effects of cancer. However, since non-ionizing radiation types and environment conditions have a very wide mechanism of action, more scientific research is needed in this area.

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