

Biological Radiation Effects of Cellphones: A Short Review from Engineering Perspectives

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ARTICLE INFO

Received: 📅 July 01, 2024

Published: 📅 July 09, 2024

Citation: Muhammad H El-Saba. Biological Radiation Effects of Cellphones: A Short Review from Engineering Perspectives. Biomed J Sci & Tech Res 57(3)-2024. BJSTR. MS.ID.009006.

ABSTRACT

The electromagnetic radiation from cellphones (or mobile phones) consists of high-frequency radio waves (microwaves). Although largely denied by conflict of interest companies, the adverse biological effects of microwave radiation from cellphones have been indeed observed in humans [1,2]. Several health problems have been reported worldwide due to cell phones and cell towers much below the FCC and ICNIRP guidelines. Most common complaints are: Sleep disruption, Dizziness Headache Palpitations of the heart Concentration Visual disorders Forgetful memory Cardiovascular problems Depression Buzzing in the head Fatigue Altered reflexes The main clinical manifestations were tumors, blood changes, reproductive and cardiovascular abnormalities, depression, irritability, and memory impairment. Many of these are related to changes in the electrical activity of the brain. Therefore, many people are concerned that radio frequency energy from cell phones will cause cancer or other serious health hazards

Keywords: Cellphone Biological Hazards; Ionizing Radiation Effects

Introduction

Electromagnetic radiation from cellphones (or mobile phones) consists of high-frequency radio waves (microwaves). Although largely denied by conflict of interest companies, the adverse biological effects of microwave radiation from cellphones have been indeed observed in humans [1-3]. Several health problems have been reported worldwide due to cell phones and cell towers much below the FCC and ICNIRP guide lines. Most common complaints are: Sleep disruption, Dizziness, Headache, Palpitations of the heart, Concentration Visual disorders, Forgetful memory, Cardiovascular problems, Depression Buzzing in the head, Fatigue and Altered reflexes. The main clinical manifestations are tumors, blood changes, reproductive and

cardiovascular abnormalities, depression, irritability, and memory impairment. Many of these are related to changes in the electrical activity of the brain. Therefore, many people are concerned that RF and microwave energy from cellphones ca, and wheter it can cause cancer or other serious health hazards [1]. In addition, mobile phone radiation can seriously mess up your sleep! Smart phones emit high levels of radiation which can cause dysfunction or unbalance to your biological clock. In this way, sleeping next to your phone may actually lead to more nightmares because your cardiac rhythm can be thrown. In this paper, I resume the radiation effects and their consequences, as reported in medical research during the last decade and add some reasons from the engineering point of view. I also demonstrate the famous tests, upon which current safety standards are based (Figure 1).



Figure 1: Schematic of the biological effects.

Radiation Biology Effects

Although cellphone frequencies are generally considered non-ionizing, but the ionization threshold of human cells atoms is not well defined. Ionizing radiation can cause tissue damage. Tissue damage occurs through the change in chemical properties of molecules in the tissue following exposure to radiation. The major contributor to damage from radiation is through radiation changing a water molecule into a new form called a “free radical”. Free radicals are chemically highly active and as such can have reactions with genetic molecules of the cell (i.e., the DNA). This can cause damage to the DNA most of which is readily repaired by the cell. DNA damage, if not repaired, can potentially lead to tumors or result in cell death. Alternatively, if the DNA damage is repaired erroneously, it can result in an alteration of the genetic encoding leading to hereditary changes or cancer induc-

tion. In addition to the possible ionization effects, the cell membranes in the body are electrically charged and the pulsed RF waves of mobiles are dislodging the calcium that binds the human cells together.

This makes them more permeable and releases enzymes that can damage the DNA in genes, including those that protect against cancer. This means the cells are more susceptible to damage. According to Dr Lennart Hardell [2], studies showed that brain cells begin to die after two hours of phone use. Furthermore, children are more vulnerable to mobile radiation, for two reasons, a cancer specialist at Or University Hospital in Sweden. First, they have thinner skulls so absorb more biologically susceptible to brain damage, they will be exposed to the risks for far longer than today’s adults. Research has also found that mobiles affect the unborn babies because the RF waves can cross the placenta (Table 1).

Table 1: Dose Threshold for Severe Effects.

Tissue	Total acute dose Threshold (Gy)	Time to develop effect
Lens of Eye		
Detectable opacities	0.5-2	> 1 year
Cataract formation	5.0	> 1 year
Skin		
Skin reddening	3-6	1-4 weeks
Temporary hair loss	4	2-3 weeks
Skin death and scarring	5-10	1-4 weeks
Testes		
Temporary sterility	0.15	3-9 weeks
Permanent sterility	3.5-6	3 weeks
Ovaries		
Permanent sterility	2.5-6	< 1 week
Gastrointestinal		
Mucosa lining loss	6	6-9 days
Bone Marrow		
Reduction of blood cell production	0.5	1-2 months

Note: * 1% Incidence level based on ICRP Publication 103 (2007).

Mobile Phone Radiation Tests

The FDA's physicians, scientists, and engineers should cooperate to analyze scientific studies and publications for evidence of health effects of exposure to radio frequency energy from cell phones. Unfortunately, the current adopted tests are all about the heating effects of microwave radiation from cellphone hand sets and their masts (transmission towers). This is based on the imagination that the cellphone radiation is not ionizing (like UV and X-rays) and therefore, the main biological effect is the heating effect! In fact, many physicists used to divide the spectrum of electromagnetic waves (EMW) into two parts: ionizing radiation and non-ionizing radiation. As cell phone frequencies are usually considered non-ionizing radiation sources, they are excluded as a risk! Scientifically speaking, the ionization effect happens after a certain threshold energy per quanta of radiation ($E = hf$, where h is Planck's constant and f is the radiation frequency). This threshold is different from element to another, and I don't think there exists a true physical data about the ionization threshold of human biological cells. In addition, communication engineers tell us that cellphone radiation is not composed of a single carrier frequency, but usually have higher harmonics, which have lower strength but higher frequencies (harmonics), which are more likely ionizing. These harmonics (integer multiples of the fundamental carrier frequency) are due to several design (nonlinearity) issues as well as microwave wave propagation effects (e.g., multipath diffraction). All these effects need to be tested and assessed.

Specific Absorption Rate (SAR) Test

The effects of mobile phone radiation depend on the rate at which energy is absorbed by the body tissue. This test measures the Specific Absorption Rate (SAR) of the mobile phones. The SAR value shows how much heat energy is absorbed in the head area from a mobile phone. For the duration of the test, the mobile phone operates at its maximum power. The technology used in the phone, different user settings, and the anatomic features of the user's head, both children's and adults' are taken into account when carrying out this test.

Specific Anthropomorphic Mannequin (SAM) Test

SAM is an abbreviation for Specific Anthropomorphic Mannequin. SAM phantoms are used to simulate the effects of the human body on the radiation characteristics of the cellphone handset. Both TRP and TIS of the handset can be dramatically affected by the simple act of holding the handset in the hand and placing it next to the head.

Biomedical Engineering Studies and Findings

Many organizations conducted toxicology studies on living tissues of animals (rats and mice) to help clarify potential health hazards, including cancer risk, from exposure to mobile phone radiation. Accordingly, NTP published an article in October 2019 that evaluated DNA damage in three regions of the brain, the liver, and in blood cells in rats and mice [4-10]. This study showed that RFR exposure was associated with an increase in DNA damage. Specifically, they found RF exposure was linked with significant increases in DNA damage.

The frontal cortex of the brain in male mice. The blood cells of female mice, and • The hippocampus of male rats. The exposure system in this study was designed to allow to conduct studies with various RF frequencies and modulation techniques, which are used by cellphones to keep up with changing technologies in the telecommunications industry.5. Total Acute Dose of Radiation Threshold The current revision of biological and clinical studies have shown that below 0.1Gy radiation dose, no sever effects from radiation exposure have been proven. This is primarily due to the fact that cellular repair mechanisms occur continuously and this prevents sever effects at low radiation exposure levels.

Conclusion

The cell phones (or mobile phones) make use of RF transmitters that emit radiofrequency (RF) electromagnetic waves (EMW) in order to communicate with a nearby base station, where high-power mobile antennas are erected. Concerns have been raised about the level of RF emissions to which the human is being exposed when using a mobile phone having potential health consequences. You always hear: there is no established scientific evidence that the use of mobile phones causes any health effects. This analysis is not trustworthy, because it is based upon the heating effects of radiation (microwave oven effect!) and overlooks the effect of microwave vibrations on the charged cell membranes in humans. Unfortunately, only few studies about the effects of mobile phone radiation and cancer disease are available. Also, the majority of the available articles come from the medical research, without in-depth engineering analysis from communication engineering research community. However, some studies have shown an association between heavy mobile phone use and brain cancer as well as other biological cells malfunctions. These effects are most likely due to vibration effects on charged cell membranes, as well as the ionizing effects of higher harmonics of mobile phone radiation. These

effects will likely increase with 5G technology, which utilize a broader range of frequencies. Researchers and concerned associations, such as WHO [9], should continue to review the unbiased research into potential health effects of RF EM emissions from mobile phones.

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ISSN: 2574-1241

DOI: 10.26717/BJSTR.2024.57.009006

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