



## Mobile phone: An arch enemy?

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### Abstract

The use of mobile phones is increasing day-by-day. However, with every technological advancement showing its positive aspect has some negative effect on health too. This is a comprehensive review highlighting about all the possible hazards related to the effect of cell phone radiations on human health. It recapitulates and shows the damaging biological effects of radiofrequency radiations released by mobile phones on human body including oral cavity. This article has emphasized on the deteriorating changes in the individuals using mobile phones frequently.

### Introduction

The usage of mobile phones has amplified in the past few decades. It has become as a status symbol as well as need in our daily lives. It is seen that everything has its own positive as well as negative aspects. As cell phones popularity is of growing concern these days, it has also shown the injurious impact of cell phone radiation (radiofrequency electromagnetic waves [RF-EMWs]) on human health. Depending on the area in the world, there are variations present in the radiation frequency which may vary in the range of 300–2100 MHz.<sup>[1]</sup>

### What is Radiation?

Radiation also known as electromagnetic radiation is defined as a combined energy of electrical and magnetic waves that travel through space at the speed of light. There are two types of radiations,

- Ionizing radiation: Capable of producing variations in atoms or molecules in the body causing subsequent tissue damage such as cancer, for example, X-rays and gamma rays.
- Non-ionizing radiation: It does not show any changes, but molecules vibrate causing raise in temperature, for example, ultraviolet radiation in sunlight, visible light, infrared radiation, microwave energy, and RF energy.<sup>[2]</sup>

### What is Mobile Phone?

Mobile phones are defined as classy wireless receivers. The World Health Organization has recommended mobile phones as

radio waves that are transmitted through a series of base stations with EMWs as RF that cannot break chemical bonds or cause ionization in the human body.<sup>[3]</sup>

### History

The first mobile phone was invented by Dr. Martin Cooper of Motorola. The main story behind its invention is on April 3, 1973, Martin placed a call to rival Joel Engel, while walking the streets of New York City talking on the first Motorola Dynatac Prototype; hence, Motorola Startac was the first phone introduced in the world with its vibrating alert function. It was disclosed in North America on January 3, 1992, and Sharp J-SH04 was the industry's first mobile phone to be featured an integrated 110,000-pixel image sensor for taking digital photos (camera mobile phone).<sup>[2]</sup>

### Generations

- First generation: Basic voice service, analog-based protocol, speed is 2.4 kbps.
- Second generation: Designed for voice with improved coverage capacity, first digital standards
- (GSM, CDMA), speed is 64 kbps.
- Third generation: Designed for voice with some data consideration (multimedia, text, and internet), speed is 2000 kbps.
- Fourth generation: Designed primarily for data (IP-based protocol), speed is 100,000 kbps.<sup>[3]</sup>

## Analog and Digital Signals

An analog signal can be signified as sine waves which have a base carrier's radiofrequency signal to amplify the strength of the signal or vary the frequency to add information to the signal. For example, in digital phones, there will be conversion of voice into binary information (1 and 0) and then compression, which allows 10 digital phones to occupy the same frequency space as one analog cell phone.<sup>[4]</sup>

### Advantages

- Basic communication
- Training delivery
- Information access
- Social networking
- Content creation.

### Disadvantages

- Effect of RF on General Health
- Electromagnetic Interference
- Traffic Accidents
- Oral cavity

## Effect of RF on General Health

Cell phone toxins and the harmful effects on the human body:

- Lead - lead is present in circuit boards and batteries of mobile phone and leads to the damage of reproductive, blood, and nervous systems
- Mercury - mercury is present in circuit boards and batteries of mobile phone and leads to the damage of brain and kidney. A single cell phone contains up to 2 g of mercury
- Arsenic - it is present in microchips of mobile phones, and in high doses, arsenic poisoning is lethal. At low levels of exposure cause negative impacts on skin, liver, nervous, and respiratory systems
- Cadmium - it is present in batteries and its deficiency leads to cognition, learning, behavior, and neuromotor skills in children, kidney damage
- Chlorine - it is present as polyvinyl chloride in covers and on exposure to improperly dispose chlorine causes tissue damage and the destruction of cell structure.

### Effects on Cardiovascular System

- Braune *et al.* (1998) found increase in blood pressure (both systolic and diastolic) on exposure to RF-EMW at 900 MHz for 35 min on human helpers. There was raise in blood pressure by 5–10 mmHg along with a significant decrease in capillary perfusion due to vasoconstriction.<sup>[5]</sup>

### Effects on sleep

There are five stages of sleep which are characterized by different brain activities performing different functions which are vital for good health.

Stage 1 and 2 are under non-REM stage and Stage 3 and 4 are under deep non-REM stage. The mobile signals affect the deep non-REM sleep, will take longer time to reach the Stage 3 and reduced Stage 4.<sup>[6]</sup>

A study was conducted at the University of Gothenburg, Sweden, on 20–24-year-old young individuals who responded to a questionnaire, in addition to a 1-year follow-up and concluded that it was equally affected both women and men with more stress and sleep disturbances in women and sleep disturbances with symptoms of depression.<sup>[5]</sup>

## Tumorigenesis

The effect of cell phone radiation on carcinogenic potential is one of the most contradictory aspects and DNA damage is a two-stage process:

Firstly, by ionizing radiation under direct X-rays.

Second, by non-ionizing radiations under mobile phones and DNA damage will show the following characteristics as base loss, cross-linkage, hydrogen bond breakage, and double-stranded breakage.<sup>[3]</sup>

- A study conducted by Hardell *et al.* (2006) was an epidemiological questionnaire-based study and concluded that patient usually suffers from glioma, meningioma, and acoustic neuroma.<sup>[5]</sup>

## Cell Phone and Effects on Male Fertility

A study conducted by Kandeel and Swerdloff (1988) observed the fact that for optimal spermatogenesis human testes usually need physiological temperatures 2°C lower than body temperature, but RF produces thermal effects on the testes and an increase in temperature causes reversible interference of spermatogenesis in which spermatozoa will lose their cytoplasm, leading to the loss of their antioxidant shielding mechanism leading to the damage of DNA.

- Aitken *et al.* (2005): The induction of DNA damage in spermatozoa has been associated with male infertility, early pregnancy loss, and morbidity in the offspring, including childhood cancer.<sup>[5]</sup>

## Pregnant female

Babies in the womb are more susceptible population of all as children due to their thinner skull, smaller brains, and softer brain tissue, their nervous system is still developing.<sup>[7]</sup>

## Risk to children

Children absorb more energy than adults from the same phone as on comparing the skull thickness and penetrating power of a 5 year old, 10 year old, and an adult the values were ½ mm, 1 mm, and 2 mm and 4.4 w/kg, 3.2 w/kg, and 2.9 w/kg, respectively, revealing that risk is more in children because their bodies and nervous systems are still developing.<sup>[7]</sup>

### Infections

Researchers at the London school of hygiene and tropical medicine and Queen Mary, University of London, took samples of 390 cell phones and hands to measure levels of bacteria in both and concluded that 92% of the cell phones sampled had bacteria on them, 82% of hands had bacteria, and 16% of cell phones and hands had *Escherichia coli*, and the interpretation was easy transfer of fecal matter through cell phones among individuals.<sup>[8]</sup>

### Bones and Joints

Cell phones require continuous usage of hands, particularly when sending text messages and e-mails, therefore, retorting to messages at fast speed are the source of pain and inflammation of joints. To perform multitasking jobs due to our busy schedule may lead to back pain exclusively while holding the phone between neck and shoulders.

### Risk of Eye Vision Problems

Due to smaller screens than computers, staring at mobile device can cause problems in vision later in life, which may lead to people with squint and strain eyes while reading messages and by disrupting melatonin, smartphone light destroys the sleep schedules causing to all kinds of health problems.

### Electromagnetic Interference

It may interrupt the normal functioning of medical devices such as pacemakers and certain hearing aids.

### Traffic Accidents

Due to disruption chances of an accident have been increased about 3–4 times on its use (either handheld or with a “hands-free” kit) while driving.

### Oral mucosa

Damage caused by mobile phones to oral mucosa is important to be considered due to its close proximity during telephonic conversations and because 90% of human cancers are carcinomas indicates that epithelial tissue is most susceptible to genetic changes. A study done by Ros-Llor *et al.*, in 2012, assessed cytokinetic and genetic defects, cell death parameters occurring due to RF waves emitted by mobile phones in asymptomatic young population.<sup>[9]</sup>

### Saliva and Mobile Phone

Human saliva plays a vital role in maintaining oral homeostasis and acts as a primary defensive line against microbial invasion. It has been observed that the location of largest salivary glands, parotid gland is behind the ramus of the mandible and in front of

the ear is in close proximity to the mobile phones during its usage.

In a study done by Goldwein and Aframian, in 2010, aimed to observe all the physiologic changes in the parotid gland, located on the dominant side (the side on which mobile phone was customarily held), in terms of rate of secretion and protein estimates in the saliva. In 2014, Khadra *et al.* concluded that there is an increase in the activity of SOD and decrease in that of amylase in the saliva on usage of mobile phones and apart from that salivary antioxidant biomarkers, and the number of calling minutes was directly associated.<sup>[9]</sup>

### Salivary Glands and Mobile Phone

Two population-based case-control studies, one in Denmark and one in Sweden, Lönn *et al.* were done, to test that there is an increased risk of parotid gland tumors with long-term mobile phone use. Acar *et al.*, in 2009, examined on the effects of thermal microwaves from mobile phones to facial nerve and because of increase in temperature of the surrounding soft, even they will not function properly.<sup>[9]</sup>

### Dental amalgam filling and mobile phone

Dental materials may act as antennas and collect harmful EMWs. In dentistry, the most commonly used material are amalgam fillings containing approximately 50% mercury have been used for almost 200 years and release mercury at low level ranging about 2–5 µg/day (Spencer 2000). The half-life of mercury accumulates over the time of exposure (Mutter *et al.*, 2007). New studies have shown that mercury may cause nephrotoxicity, oxidative stress, autism, and skin and mucosal alterations.<sup>[10]</sup>

### Dental Braces

Orthodontics, the most demanding branch of dentistry use nickel-containing alloys oftenly in metallic brackets, archwires, and bands. In a new peer-reviewed study done on 50 adult patients who wore dental braces (i.e., fixed orthodontic appliances), comparison was done when they did not use their cell phones for a week, and the result was concluded as patients who spoke more on their cell phone, there was an increase in concentration of salivary nickel which is a known toxic and carcinogenic metal. It may also cause metal-induced contact allergic dermatitis. One study stated that females speak averaged 53 min during the week they used their cell phones, whereas the males averaged 23 min; therefore, female prevalence found on the adverse effect of radiation due to release of nickel.<sup>[11]</sup>

### How to Reduce the Risk?

- Use hands-free set
- Hold it from the bottom
- Do not talk for a longer time and if possible use regular phones
- Do not ever sleep with a mobile under pillow

- Get in the best signal position
- Lift the phone do not drop your neck.

## Conclusion

This article highlighted on the effects of the usage of mobile phones on human health ranging from mild local warmth to possible tumor induction, EMWs have been suspected of involvement in many health concerns.

However, the implication of these studies and their possible aspects cannot be overlooked in the future.

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