Review Article

The repercussions of your cell phone on your heart- The current evidence and the future

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ABSTRACT

The use of mobile phones has become widespread in recent years, with many individuals using them for extended periods daily. With the advancements in technology, smartphones have been equipped with features to aid in monitoring heart rate, blood pressure, and even recording ECGs. However, there is also a potential concern regarding its negative effects on heart rate, blood pressure, and heart rhythm, and it may elevate the chances of arrhythmias in individuals with pre-existing heart conditions. While the convenience and connectivity provided by mobile phones are undeniable, there are concerns about their potential impact on cardiovascular health. Current studies suggest the cardiovascular effects of electromagnetic waves, but they only look at the short-term effects of mobile phone usage. This paper aims to discuss the impact of using cell phones on cardiovascular health.

Key words: Mobile phone usage, cardiovascular effects, electromagnetic waves, heart rate variability, mobile health

On April 3, 1973, Martin Cooper, the general manager of Motorola's Communications Systems Division, made the first mobile phone call. Since then, a tremendous demand for cutting-edge mobile devices with potent processors has dramatically accelerated "cellular" technology, laying the foundation for the creation of modern smartphones [1]. Today, there are more than six billion smartphone subscriptions globally, and in the following years, that figure is expected to increase by several hundred million [2].

As shown in Figure 1, the top three countries for smartphone usage are China, India, and the United States [3]. 89 percent of adults in urban regions in the United States own a smartphone, making them the most popular areas for smartphone ownership. Ownership is less prevalent (at 80%) in rural areas [4]. Apple and Samsung are the top two smartphone manufacturers in the United States, with market shares of 48 percent and 30 percent, respectively, as of the second quarter of 2022. Lenovo and OnePlus come in third and fourth, with market shares of 9% and 1%, respectively, behind Apple and Samsung [5]. In the United States, younger age groups have the highest rates of smartphone ownership. A smartphone is owned by 95% of persons between the ages of 18 and 49, but just 61% of adults 65 and older have one [6].

Smartphones are becoming increasingly significant prospective tools for health and medical research due to their expanding ubiquity and functionality [7]. The concept of using mobile devices, such as mobile phones, tablets, and smartphones, in healthcare and public health is referred to as "mHealth" [8]. As the number of mobile phone users is increasing, so is the mHealth platform, and by 2017, an estimated 325,000 mobile health apps were available on the app marketplaces [9]. Self-monitoring of one's health has been made possible through the combination of mobile apps, wearables, and external sensors [10]. When connected to a smartwatch, mobile phones are now being used to record steps, the distance traveled, monitor heart rate, and even record an ECG. In remote and low-resource settings, mobile phones can be used to access healthcare through telemedicine.

The use of apps in mHealth has been linked to improving health outcomes among those living with chronic diseases through better symptom control [11]. The study conducted by

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Indraratna et al. suggests that mobile phone technology may improve medication adherence in patients with ischemic heart disease, Blood pressure in individuals with hypertension, and hospitalization rates in patients with heart failure [12]. Additionally, it has been suggested that low-cost mHealth systems can even be utilized to detect pneumonia [13].

While the benefits of mobile phones are well known, there are yet undiscovered detrimental impacts. The adverse effects of mobile phones have been related to the duration of their usage. Studies have shown that the improper use of mobile phones can harm the human body [14]. Cell phone use has been linked to negative health effects, including changes in brain activity, reaction times, and sleep patterns [15]. Also, spending too much time on screens is linked to issues such as poor sleep, high blood pressure, obesity, low good cholesterol, difficulty regulating stress, and insulin resistance, which are all risk factors for cardiovascular disease [16]. Mobile phones emit Electromagnetic radiation, and this radiation has been classified by the International Agency for Research on Cancer as a possible human carcinogen (group 2B) [17]. There have also been concerns about the cardiovascular effects of these electromagnetic radiations. Although the majority of people use Mobile Phones, the impact of these devices on the heart has only lately been researched, and there is still much to discover about this topic.

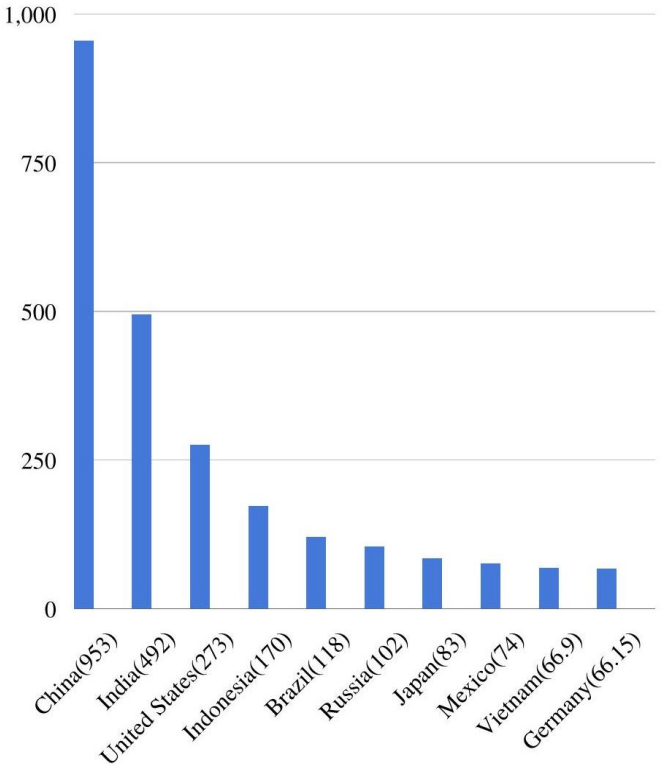

***Figure 1*- Number of smartphone users by top 10 countries in 2021 (in millions) [3].**

Mechanism

The use of electrical devices has gradually increased throughout the last century, and recent evidence has suggested that electromagnetic waves (EMW) generated by such devices have harmful effects on the heart. Electromagnetic waves generated by mobile phones contain both electric and magnetic components. When an electric charge remains static, an electrical field is created around it, and when an electric charge is moving, a magnetic field is created around it. When electromagnetic waves (EMW) come into contact with a tissue surface, some of the energy is reflected, and some is absorbed into the body. As the EMW energy enters the tissue, its speed and wavelength change depending on the electrical properties of the tissue environment. Cardiac muscle cells, which are responsible for the electrical and mechanical activity of the heart, are particularly sensitive to these changes.

These cells have four important physiological features, including inducibility, contractibility, autonomy, and transmissibility, which can be affected by external stimuli such as EMF [18]. This can lead to changes in the contraction and rhythm of the heart. It is possible for EMF to affect heart function by influencing these physiological features and also inducing oxidative stress. Oxidative stress of cellular components such as lipids, proteins, and nucleic acids is caused by excessive ROS production and an unbalanced oxidant/antioxidant system [19]. Acute exposure to cell phone radiofrequency fields may influence the formation of free radicals and oxidative stress by boosting lipid peroxidation and decreasing the activity of free radical scavenging enzymes like superoxide dismutase (SOD) and glutathione peroxidase [20].

Another study looking at the impact of cell phone radiofrequency on the heart showed that radiofrequency emitted by cell phones disrupts the cardiac conduction system and the voltage criteria. It's postulated that this is due to the well-established impacts of radiofrequency of mobile phones on human tissues leading to heating, disruption of action potentials, and disruption of the electrophysiological machine record [21]. The Thermal effect of mobile phones, where heat waves are absorbed into the human tissues and lead to alterations in gene and protein expression, has sparked public worry about the potential health impacts of electromagnetic energy exposure [22].

In another study, normal-weight and obese normotensive medical students were compared on how the radiofrequency electromagnetic field (RF-EM) from a cell phone affected the electrical activity and autonomic regulation of the heart. Overall, it showed that normal-weight and obese medical students' heart rate variability (beat-to-beat variation) decreased when their phones were kept in their chest pockets, amplifying the negative effects of fat on sympathetic activation. An increased risk of heart disease and mortality is predicted by longitudinal studies by a decreased heart rate variability [23]. To fully comprehend how exactly mobile phones impact the heart, more studies are needed.

DISCUSSION

The average mobile media usage in the United States is approximately 4.5 hours per day [24]. With the expansion of the usage of mobile phones and their necessity in our lives, we tend to overlook the adverse effects associated with them. The widespread usage of cell phones, along with their embedded wearable sensors that are developed around real-time connectivity and recent developments in communication, make this technology an attractive tool for enabling continuous and remote heart health monitoring for a tiny incremental cost [25]. Globally, e-health and mobile health (mHealth) are becoming increasingly popular as a platform for changing the way that healthcare is delivered. These findings encourage additional research into novel, patient-centered mobile health strategies as complements to conventional clinical practice and have the potential to provide health benefits to millions of people around the globe [26, 27].

Smartphone-connected devices such as wearable and wireless devices, smartphone health apps, handheld ultrasonogram technology, and miniature sensor-based technologies are some of the breakthrough technological advancements in the field of medicine [28]. However, mobile phones emit non-ionizing radiation, operating at a frequency of 450 and 2700 MHz and peak power ranging from 0.1 to 2 watts, only when the handset is turned on and in use [29]. The Specific Absorption Rate (SAR) (W/Kg) is the number used to limit the harmful effects of radiation, and it is different based on national standards. The United States has set up a SAR of 0.08 for the whole body, 1.6 for the head and trunk, and 4 for the limbs [30]. An objective method to assess the radiation effects on the heart is the Heart rate variability (HRV) and Heart rate acceleration (HRA), which measures the neuroendocrine effects on the sinus node [31].

HRV in longitudinal studies is known to measure the beat-to-beat variation in heart rate, and a reduced HRV is a predictor of an increased risk of cardiovascular disease and mortality [23, 31]. In a prospective study conducted in Iran, the autonomic effect of mobile phones was studied in the age group of a significant negative association between Systolic and Diastolic blood pressure and duration of mobile phone use [32]. The location and the distance of the mobile phone from the heart have an important role to play as it is known to reduce the HRV [23]. The radiation from the phones is studied to affect ventricular repolarization as studied by the increase in QTc interval [21]. The ratio of low frequency (LF) and high frequency (HF) changes with the change in the duration of phone usage, which has a direct negative correlation on HRV [32].

Some medical devices, such as pacemakers, implantable defibrillators, and hearing aids, may experience operational interference if mobile phones are used close to them, and therefore, patients are advised to increase the distance of cell phones from the device and decrease the contact time [15, 33]. WHO recommends the use of hands-free devices to keep a safe distance between the head and the phone, using phones in areas of good reception for transmission of low power, and usage of landline devices for a long duration of phone calls.

CONCLUSION

Mobile phones are an integral part of our daily lives, and life is unimaginable without them. With the continued advancement in technology, mobile phones have the potential to help in the medical field. Although using a mobile phone is more common in urban areas than in rural areas, network access is still an issue in both. This can hamper access to healthcare in resource-limited areas. The accessibility of medical services remotely can be significantly aided by better mobile phone and internet connectivity among the general public. As the number of mobile phone users is increasing, so is the concern for their possible detrimental effect on the human body. Electromagnetic waves from a mobile phone can have negative consequences on the heart. Although some studies have shown the cardiovascular effects of electromagnetic waves, current studies only look at the short-term effects of mobile phone usage.

To further comprehend the effects on the cardiovascular system, long-term studies are required. We need to create new technologies with lower electromagnetic radiation emissions. Future cell phone usage will undoubtedly increase, so additional research is required to demonstrate how electromagnetic fields affect the heart. As per the WHO recommendations, mobile phones should be used in locations with good reception to ensure low power transmission, and using hands-free devices is encouraged to maintain a safe distance between the head and the phone. We have to conclude that the mobile phone is inseparable from humans, and if used rationally within a time-limited manner, it can be a boon in both preventing and treating cardiovascular illnesses.

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