Report On

HEALTH RISK OF USING WIRELESS HEADPHONES AND EARPHONES

Sample Report

Submitted to

Professor: Masoumeh Kazemi Zanjani

1515 Saint Catherine St W, Montreal, Quebec H3G 2W1

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[redacted]

Department of Mechanical, Industrial and Aerospace Engineering

Concordia University

ABSTRACT

Nowadays, in our society, we see many individuals of all ages using wireless Bluetooth headsets and earphone devices as a form of communication and pleasure. It has become a trendy fashionable device that allows users to enjoy their music without the concern of cords getting tangled and with minimum noise emitted from the surroundings. Bluetooth devices uses electromagnetic fields (EMF) technology, which is associated with potential health risk. The purpose of this report is to explore the health risk of using wireless headphones and earphones devices and see how these may differentiate from the latest new device that has entered the markets, ear buds. This will be done by looking at several literatures and highlighting their findings.

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LIST OF ACRONYMS

EMF – Electromagnetic Field

WHO – World Health Organization

DNA – Deoxyribonucleic acid

RNA – Ribonucleic acid

ADD – Attention Deficit Disorder

SAR – Specific absorption rate

BIAP – Bureau International d'Audiophonologie

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1. INTRODUCTION

There are many different audio technologies that is used today as a mean of communication and listening to music. To clearly distinguish between them, each technology will be briefly explained. Headphones consist of two speakers that are connected by a band. The band is worn across the individual head with the speakers placed over the ear. Earphones also known as in-ears or in-ear headphone, are more compact compared to headphones as it does not have a band, nor does it have on-ear speakers. Instead, it is inserted in the ear canal as an in-ear speaker [1]. The latest trend has been the earbuds, which are worn outside the ear canal, specifically, it is place on the concha ridge at the center of the outer ear.

Bluetooth and wireless headphone are often used to describe an audio accessory, although there's a distinguish difference between them. Both Bluetooth and wireless are both used for standard wireless communication. It is important to note that all Bluetooth devices are wireless, however, not all wireless device run on Bluetooth technology [1].

Bluetooth technology is used widely today, this wireless technology connects device through radiofrequency waves without any means of wires or cables. This technology is used to send and receive information through Bluetooth-enabled devices. For these devices to connect to another, it requires a pairing connection which will enables the devices to sync to each other. This is also how Bluetooth headphone are paired with mobile phone to allow users to experience listening to music in a wire free environment. The sounds are transmitted to the headphone from the device through codec. Codec are programs that compresses data and decompresses it when its

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time for use [1]. Therefore, when playing audio from mobile phones, codec compresses the audio signal from the phone and transmits it to the headphone. However, both devices must support the same codec for it to work properly [1].

Wireless headphone uses either infrared or radiofrequency wave. It requires a base unit that allows connection from the wireless headset to the device, this can be in the form of an adapter or a dongle. The transmission signal for infrared waves ranges approximately to 7 meters [1]. For infrared waves to functional well, it requires a clear line with no interference in the work of slight. However, radiofrequency waves are much more powerful, which can range up to 300 feet [1].

For the purpose of this paper, when referring to wireless, we are considering headset that use any sort of electromagnetic waves. The importance of this topic is due to the popularity of the usage of headphones daily by individual of all ages. Whether if its for their commute, jog, gym, focus or to eliminate the noise around their surroundings, headphones are used for multiple hours in a day. The constant exposure of radiofrequency waves to our body can cause significant health concerns. It is important to be aware of the potential risk associate with this technology and to make an inform decision before using them.

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2. MOTIVATIONS AND OBJECTIVES

The literature studies will be focusing on overall health associated with high level of radiation exposure caused by using technologies. The use of wireless headphones has significantly increased over the years and as previously mentioned, it is important for us to be aware of the potential health risk associated with them. The motive of this research is to have a comprehensive learning

experience in order to make informed decisions and to recommend solutions by adjusting the way technologies are currently designed to reduce the risk associated with them.

The following are the objective of report and will be discussed in the upcoming paragraphs:

- Highlight the effects of radiation on the human body
- Investigate the impact on hearing

3. LITERATURE SURVEY

3.1 Highlight the effects of radiation on the human body

As previously mentioned, Bluetooth is a wireless technology that uses pulsed radio frequency signals. It is said that this type of radiation transmits a frequency level approximately in the 2.4GHZ band, which is the same as a microwave. This applies that we are dealing with electromagnetic field (EMF). According to the World Health Organization (WHO), any type of wireless technology is considered an exposure to a field of microwave radiation.[2]. Therefore, if an individual is using a Bluetooth device such as a headphone that is connected to their cell phone, then, they will be exposed to the radiation from the Bluetooth as well as the radiation from the cell phone. This is double the exposure of microwave radiation. To truly understand the impact of this type of radiation on the human body, we must explore the side effect over a long duration as shown in Figure 1.

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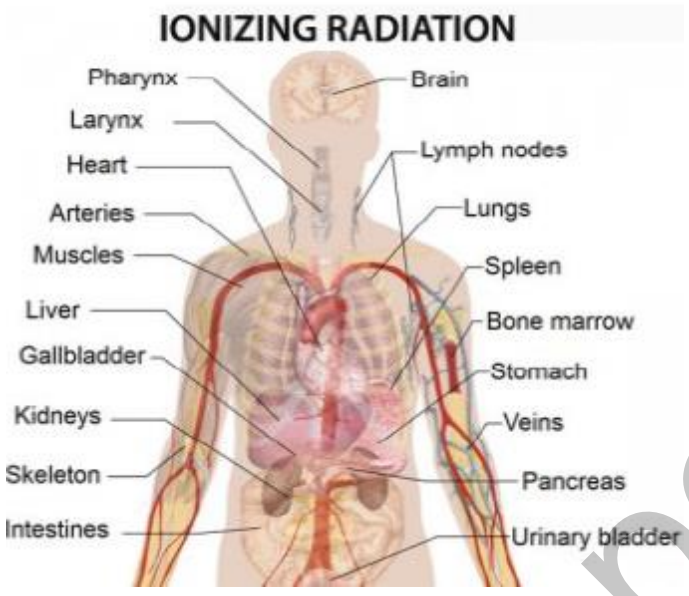


Figure 1: How radiation affects our body

Microwave radiation can cause harm to the body on a cellular level, it can cause damage to an individual's genetics in both deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) which increases the chances of it being passed down to offspring [2]. However, cellular damaged caused by microwave radiation is directly related to the intensity and length of exposure. It is identified that long term exposure to microwave is linked to severe headaches, cancer, leukemia, brain tumors, Alzheimer, autism, attention deficit disorder (ADD), miscarriages, birth defects, autoimmune illness, multiple sclerosis, hair loss, and suicide [2].

A study was conducted in 2015 which consisted of cell phone radiation exposed inside a car near a Bluetooth device. The purpose of this study was to obtain quantitative measurement in terms of power density and specific absorption rate (SAR). The author states that these two parameters are used to express radiation exposure levels. The power density of the cell phone was measured by using a handheld portable electro-smog meter [3]. Multiple readings were conducted

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in this study by alternating the placement of the phone and the Bluetooth device. Readings were done inside and/or outside the car with the phone alone or the phone + Bluetooth together. The Bluetooth device that was used in this study was an in-ear headset which is worn as a substitute for holding the phone to the ear when communicating with an individual. Since this Bluetooth device is worn on the ear while talking, the power density measuring tool was placed near the device. The phone was initially placed close to the Bluetooth but was then placed further away as shown as Figures 2 and 3, as in reality, the phone is usually kept 6 inches to 18 inches away from the Bluetooth [3].



Figure 2: Phone kept close to Bluetooth and measuring device [3]

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Figure 3: Phone is moved away while the Bluetooth and Measuring device is stationary [3]

The author explains that a local SAR had been estimated at a point of the brain as an absorber. The power density measurements obtained by the electro-smog meter was then used to estimate SAR using an equation. The findings in this study states that the increase in radiation power density with the Bluetooth device is observed to be 313% higher when compared to the phone alone when measured outside the car [3]. In the case that the cellphone and Bluetooth were together inside the car, the power density increased to 393% [3]. Lastly, it was observed that when the Bluetooth and cell phone were placed in close proximity, the power density values were significantly higher than when the devices were farther apart.

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This literature study allows us to have a better understanding of the risk of having in-ear devices in close range of a cell phone device in a closed environment such as a vehicle. Many individuals are now driving with the latest trend, airpods, that were recently released in the market by Apple Inc. and followed by many other competitive companies. The idea of these ear buds is essentially the same as the in-ear Bluetooth device used in this literally review. In such a closed environment such as a vehicle, the radiation has no where to escape. As a result, it is circulating until it hits its target which in this case is the human body.

3.2 Investigate the impact on hearing

Individuals start using headphones at a young age, it can be used for many different reasons such as for leisure time, during commute on public transportation, during physical activities, to have conversations on cell phones hands-free, to allow pure focus by eliminating noises from surrounding and many more. However, having direct sound waves in the ear canal can potentially cause harm to an individual hearing. A study conducted in 2013 investigate the correlation between headphones and hearing loss. The study consisted of 81 young adults between the ages of 16 to 25 who claim to listen to music using their headphone [4].

The author explains that among these 81 individuals, 47 young professionals were working in industries that requires them to use audio equipment's, such as sound engineers, classical musicians or music academy students. The participants were given a questionnaire form to fill out to understand their headphone usage and exposure to direct sound waves. The results obtained from the questionnaires stated that the participants listen to music very loudly with the use of their headphones for approximately 3.2 hours per day which results in a weekly exposure of more than

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22 hours [4]. From this, an audiometric test was conducted for each of the participants. The graph in Figure 4 shows that the hearing thresholds for the left and right ear of the tested population. The author states that according to the classification of Bureau International d'Audiophonologie (BIAP), the participants belong to the group of normal hearing, however, the shift in the hearing points states the beginning of permanent hearing damage [4].

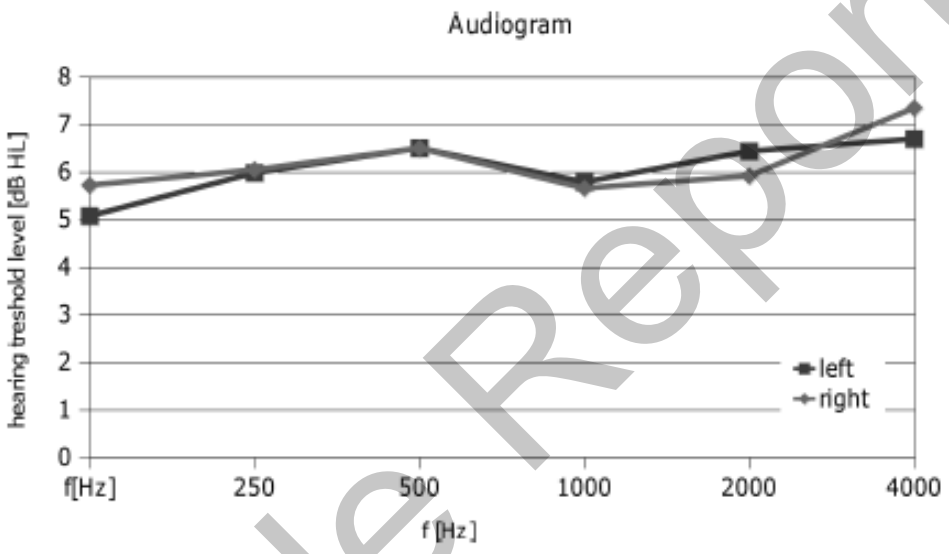


Figure 4: Average hearing threshold values for the tested population [4]

The authors wanted to analysis if the type of headphone used had an influence on the impact of the participants hearing. The different types of headphone used in the study consisted of in-ear, open, closed, and semi-open. Open headphones are designed to allow some outside noise rather than closed headphone which isolate outside noise completely [5]. Semi-open headphones allow individuals to enjoy both open and close design features.

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The results obtained from the different types of headphones are shown below in Figure 5. From this, we can see that the most unfavourable for hearing are in-ear earphones. To understand why this is, we must understand the anatomy of the ear. Sound travels through the ear canal which is a natural protection from high sound pressure. By placing this kind of earphone inside the ear, the length of the channel is reduced and as a result, the sound travelling in the ear canal increases causing the natural protection to be less effective [4].

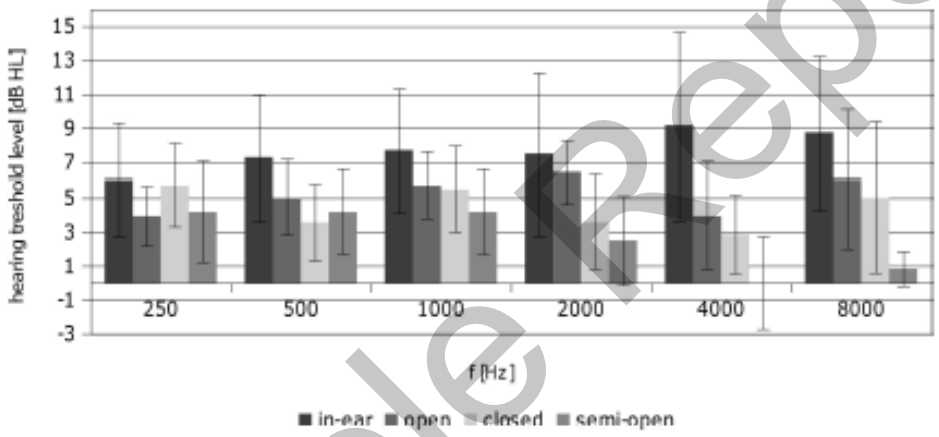


Figure 5: Influence of different kind of headphones on the threshold of hearing [4]

When choosing between what type of headphone to purchase, the author recommends the most preferred type of headphone to be used are semi-open. This is due to the design of semi-open headphones as it allows protection of high sound pressures acting directly on the ear membrane while eliminating a small amount of outside noise [4]. Headphones should be used with cautious measures by listening to music at a moderate volume level as well as a daily usage of no more than 8 hours per day to ensure safety and healthy hearing levels.

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4. CONCLUSION AND RECOMMENDATION

Listening to music using wireless devices has become very popular amongst countless young individuals. Many wireless devices use Bluetooth technology, however, there are long-term health concerns and risks associated with type of technology as it uses electromagnetic field (EMF) such as microwaves radiation. The damage caused by this radiation is related to the intensity and length of exposure. Other factors such as type of headphone, daily usage time and the volume level can also contribute in the overall health of the ear.

In a recent study, an audiometric test was conducted to a group of young adults between the age of 16 to 25 years old. The results obtained stated that the participants are at the high risk of permanent hearing damage due to the loud exposure of their music while using their headphone. As there are many advantages for the use of headphone, it is also important to take precautious when used. It is less recommended to use in-ear earphone as it causes the length of the ear canal to reduce therefore, the natural protection becomes less effective which leads to potentially damaging our hearing. Therefore, it is wiser to choose a headphone that is placed over the ears instead of in-ears. Also, when using headphones, it is important to monitor the duration of the usage and ensure not to exceed a daily recommended limit of 8 hours. Lastly, enjoy listening to music at a moderate volume level by respecting the sensitivity level of the ear to promote long term healthy hearing levels.

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