

**HEARING LOSS QUALITATIVE ASSESSMENT AMONG
WORK FROM HOME EARPHONE USERS**

JOTHAM NGU ONG HU

**MASTER OF SAFETY, HEALTH AND ENVIRONMENT
ENGINEERING
FACULTY OF ENGINEERING
UNIVERSITY OF MALAYA
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JOTHAM NGU ONG HU

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Name of Candidate: JOTHAM NGU ONG HU

Matric No: S2022753

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EARPHONE USERS

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HEARING LOSS QUALITATIVE ASSESSMENT AMONG WORK FROM HOME EARPHONE USERS

ABSTRACT

Earphones have become a common and trendy hearing device among people in the world. The outbreak of Covid-19 pandemic has caused many workers in Malaysia to work from home. Working from home may prolong the usage of earphones and potentially cause hearing loss among workers and appear as an occupational health hazard. Thus, this research has been carried out to examine the effect of earphones towards hearing loss among work from home workers and investigate the reason and the cause of the hearing loss experienced. A hearing loss qualitative assessment has been generated and 20 respondents participated in the assessment. The qualitative assessment comprises interview questions and 3 tests namely the whispering test, the speech in noise test and the single-sided ear test. The interview analyzes the cause of hearing loss while the tests examine the ear health and detect hearing loss. As a result, the unhealthy respondents have the common characteristics, in which they are all using earphones for more than 5 hours per working day and having their earphone volume more than 65%. Hence, if the workers do not practice good earphones using habit, prolonged earphone usage during work from home possesses risks in ear health. If companies and their workers do not have proper awareness on earphones usage during the work from home period, it will eventually emerge as an occupational hearing health issue in the future.

Keywords: Earphones, Work from home, Hearing loss, Qualitative assessment.

PENILAIAN KUALITATIF KEHILANGAN PENDENGARAN ANTARA PENGGUNA FON TELINGA YANG BEKERJA DARI RUMAH

ABSTRAK

Fon telinga telah menjadi alat pendengaran yang biasa dan bergaya di kalangan orang di dunia. Wabak Covid-19 yang merebak menyebabkan ramai pekerja di Malaysia bekerja dari rumah. Bekerja dari rumah memanjangkan penggunaan fon telinga dan menyebabkan kehilangan pendengaran di kalangan pekerja dan muncul sebagai ancaman kesihatan pekerjaan. Oleh itu, penyelidikan ini dilaksanakan untuk mengkaji kesan fon telinga terhadap kehilangan pendengaran di kalangan pekerja yang bekerja dari rumah dan menyiasat penyebab kehilangan pendengaran. Penilaian kualitatif kehilangan pendengaran telah dihasilkan dan 20 responden mengambil bahagian dalam penilaian. Penilaian kualitatif terdiri daripada soalan temu bual dan 3 ujian iaitu ujian bisikan, ujian pertuturan suara dalam bunyi dan ujian telinga satu sisi. Wawancara menganalisis penyebab kehilangan pendengaran sementara ujian memeriksa kesihatan telinga dan mengesan kehilangan pendengaran. Akibatnya, responden yang tidak sihat mempunyai ciri yang sama, di mana mereka semua menggunakan fon telinga selama lebih dari 5 jam setiap hari bekerja dan kelantangan suara fon telinga mereka melebihi 65%. Oleh itu, jika pekerja tidak menggunakan fon telinga dengan baik, penggunaan fon telinga yang berpanjangan semasa bekerja dari rumah mempunyai risiko kesihatan telinga. Sekiranya syarikat dan pekerja tidak mempunyai kesedaran yang tepat mengenai penggunaan fon telinga semasa bekerja dari rumah, akhirnya ia akan muncul sebagai masalah kesihatan pendengaran pekerjaan masa depan.

Kata Kunci: Fon telinga, Bekerja dari rumah, Kehilangan pendengaran, Penilaian kualitatif.

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LIST OF SYMBOLS AND ABBREVIATIONS

COVID-19	:	Coronavirus disease 2019
WHO	:	World Health Organization
DOSH	:	Department of Occupational Safety and Health
WFH	:	Work From Home
HSPLIHL	:	High Sound Pressure Levels Induced Hearing Loss
EAM	:	External Auditory Meatus
NIHL	:	Noise-Induced Hearing Loss
ISO	:	International Organization for Standardization and American
ANSI	:	National Standards Institute
Hz	:	Hertz
dB	:	Decibel
HHT	:	Home Hearing Test
%	:	Percent
SNR	:	Signal to Noise Ratio
SPSS	:	Statistical Package for the Social Sciences
MCO	:	Movement Control Order

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CHAPTER 1: INTRODUCTION

1.1 Introduction

In the year 2020, the world was struck by a wide-spreading disease – coronavirus disease 2019 (COVID-19). This virus can be easily transmitted when an infected person has close contact with another person. Sometimes, even airborne transmission is also possible. The infection power of COVID-19 is so strong to the extent that it quickly and widely spread to the whole world in the year 2020. The most recommended preventive measure for COVID-19 infection is social distancing. Hence, workers are recommended to work from home to reduce the frequency of physical contact between workers and thus prevent the spread of the virus.

Since the outbreak of COVID-19 in early 2020, it has become the new normal for companies' policies to encourage and even mandate their employees to work remotely from home and most students have also been forced to attend their classes and study via electronic means. Working from home might help protect people and workers from the threat of contracting the virus, but it can also end up exposing them to new workplace safety risks.

Most families in Malaysia have more than one member in their house using a laptop or other device to meet their classmates or colleagues. For example, children at home need to attend classes and their parents need to attend work meetings with their colleagues. In a small area in the house, their sound will interfere with each other. Hence, they need to wear a pair of earphones to focus on their respective classes and meetings. However, the use of earphones for long hours may cause the workers to experience hearing loss. The pandemic has brought in a mass increase of usage of earphones to work and study, which according to a report on The Indian Express (2020), has resulted in doctors observing a rise in the frequency of receiving ear discomfort complaints (P.T.I., 2020).



Figure 1.1: Worker working from home using an earphone

Hearing loss induced by high audio pressure intensity has similar characteristics to occupational noise-induced hearing loss with gradual emergence, progressive, irreversible, sensorineural and bilateral hearing loss. In the beginning, it affects the ear high frequencies receiver and eventually other frequencies (Sharma, 2019). This kind of loss has great potential to develop into a significant community health issue and social disruption since an increasing number of workers have symptoms or signs of loud sounds intolerance, earache, faulty hearing, tinnitus and dizziness. The issue will further extend to other extra-auditive consequences such as insomnia, cardiovascular complications, pressure, anxiety, distress, fatigue, mental stress, nervousness, hypertension etc. According to medical experts, using earphones for long hours in the past have increased such complaints. (Herrera et al., 2016)

According to the statistics released by World Health Organization (WHO) (2017), it is observed that globally there are about 1.1 billion young people having high potential to suffer from hearing loss that is caused by the jeopardous use of personal hearing devices. It was also observed that due to the extensive use of personal hearing devices in first and second world countries, close to 50% of the young people in those countries ageing between 12 to 35 years old are being exposed to jeopardizing levels of sound from using

personal hearing audio devices. Hence, using earphones for a long period of time will most probably harm the ears of most of the workers working from home if they use earphones continuously.

1.2 Problem Statement

With the Covid-19 pandemic forcing professionals to work from home using earphones, doctors are now getting more patients with complaints of pain, irritation and infection in the ears. Excessive earphone use may become an occupational hazard with many adverse effects. As at the date of writing, there is no assessment from Department of Occupational Safety and Health (DOSH) to evaluate or assess the level of hearing loss caused by usage of earphones among the workers in Malaysia.

Moreover, the effect of earphones towards workers who work from home are still unknown. There are no studies or research that examine the effect of prolonged earphones usage towards worker's ear health. The root causes of hearing loss caused by earphone are also unidentified. It is almost impossible to create a solution before the root causes were identified.

1.3 Objectives

The objectives of this project are:

- i. To generate a qualitative assessment for workers in Malaysia using earphones for long periods of time.
- ii. To assess the level of hearing loss among the workers in Malaysia using earphones while working.
- iii. To recommend better alternative methods/tools for work from home workers to reduce hearing loss to a minimum.

1.4 Research Questions

The main research question in this research is:

How did earphones affect the ear health of the workers who work from home?

To answer this research question, several sub questions have to be answered:

- i. Are earphones affecting the ear health of the work from home workers?
- ii. What are the root causes of hearing loss caused by earphones?
- iii. What is the degree of hazard that possess in earphones towards work from home workers who used it?
- iv. How to test the ear health of the work from home workers?
- v. How to reduce the effect of earphones towards work from home workers to minimum?

1.5 Scope of Study

The major focus of this project is to produce a qualitative assessment based on the investigation towards impact of earphone to work from home workers. The assessment generated should be able to provide the assessor a significant indicator of the level of hearing loss experienced by a respondent. Then, better alternative methods/tools can be recommended to the respondent from the list of recommendations according to the level of hearing loss assessed by the assessor.

1.6 Project Significance

The home-based audiological assessment is important to allow any workers working from home get a diagnosis and treat the problem accordingly as early as possible. It may not be as accurate as results derived from using professional instruments and/or visiting an otolaryngologist, but it can provide a general assessment for work from home workers conveniently. After the assessment, the worker will get an alert or notification that they need to see a doctor or an otolaryngologist as soon as their ear feels uncomfortable.

Besides, companies with workers working from home can also get a better instrument to examine their workers' ear health in a greater quantity. It is nearly impossible for a

company to check their workers' ear health by asking every one of them to go through doctor's checking and diagnosis. This assessment provides a possible mean for companies to take care of their workers' ear health so that they can provide aid if any of their workers suffer from ear health problems due to working from home.

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CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Occupational hearing loss caused by long term earphone usage by work from home users has similar characteristics to high sound pressure levels induced hearing loss (HSPLIHL). The use of earphones may be convenient, but it may cause short term or long term irreversible harm to workers' hearing when earphones are excessively used. So, the study of earphone usage among work from home users is essential.

2.2 Structure of an ear

The human ear is separated into three parts, namely the external ear, the middle ear and the inner ear.

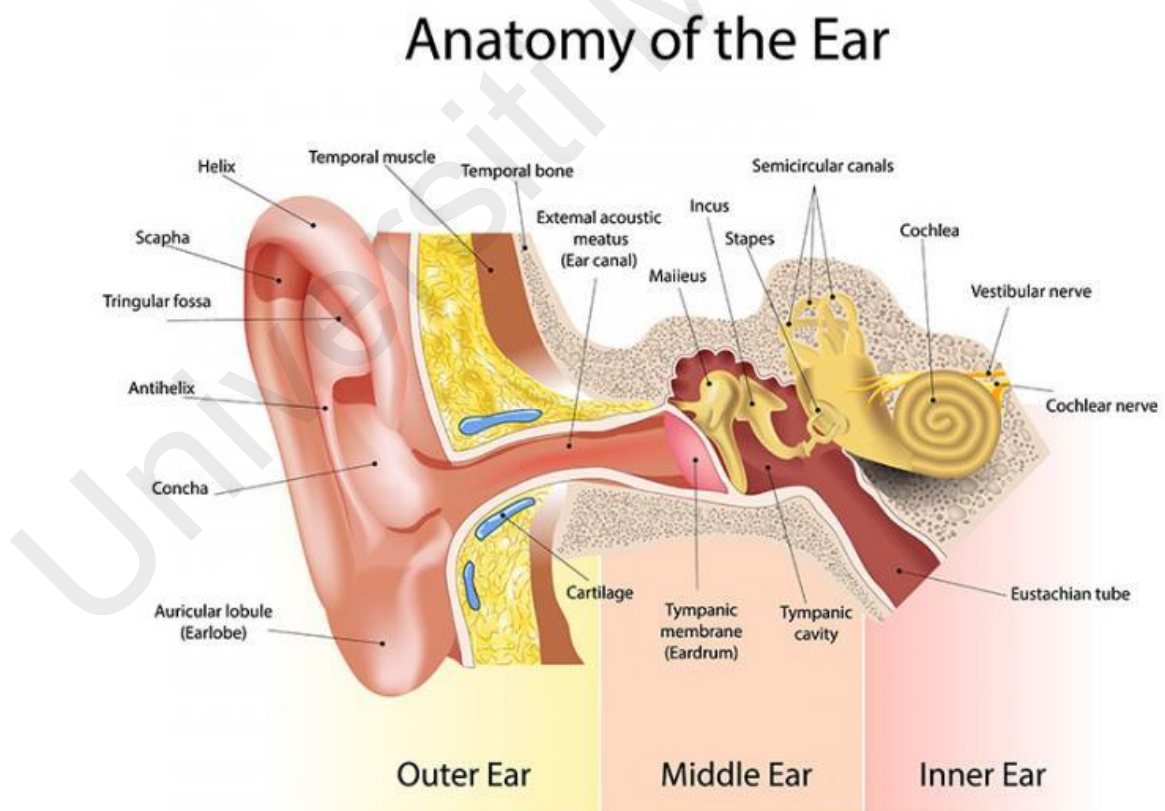


Figure 2.1: Structure of an ear

The outer part of the ear canal, also known as the external auditory canal or external auditory meatus (EAM), is skin bounded with a length of approximately 2.5cm. The external ear is a composition of cartilage; alongside this cartilage is a skin lining that has hair follicles and glands which produce wax. The gland is composed of sebaceous and ceruminous glands.

The middle ear, lying in between the inner ear and the outer ear, majorly comprises of the tympanic membrane (eardrum), tympanic cavity, malleus bone, incus bone and stapes bone. Sound is initially received by the tympanic membrane, which is an air-filled cavity holding three auditory ossicles - malleus bone, incus bone and stapes bone. The malleus bone is responsible in transmitting sound to the incus bone, and the sound is continuously transmitted to the stapes bone. The stapes bone is the innermost part of the middle ear before entering the inner ear.

The ear has a mechanism to guard itself against loud sounds. When a sudden loud sound reaches the ear, the muscles attached to the malleus bone and stapes bone will quickly contract. This will reduce the intensity of vibrations within the ear and protects the cochlea. This muscle response is known as an acoustic reflex. It will occur within a short period -- from the time the ear detects the loud sound to the time the muscles contract is approximately 40 milliseconds. Acoustic reflex protects the ear from sudden events of loud sound. However, it may not protect the ear from continuous loud sound.

The inner ear consists of the cochlea and cochlear nerve, which are responsible for sound detection. Semicircular canals are mainly for controlling and maintaining body balance. The transmission of sound waves to the ossicles from the middle ear will disturb the endolymph in the cochlea, causing vibration of the hair-like projections on the basilar membrane. The vibration of the hairs creates neural impulses, which are transmitted to the human brain through the cochlear nerve (Harkin, 2021).

An average person has approximately 16,000 hair cells in the cochlea. These cells are the core instrument that enables the human brain to detect sound waves. At the moment someone detects hearing loss, the hair cells may be damaged up to 30% to 50%. The destruction of the hair cells is irreversible. Hence, it is serious when someone detects that they have hearing loss.

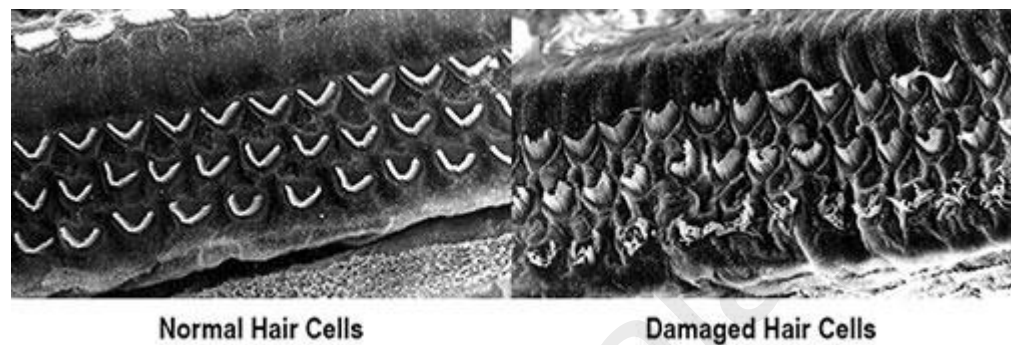


Figure 2.2: Healthy hair cells versus damaged hair cells

2.3 Statistic of Hearing Loss Among Earphone Users

According to a study carried out by Mohammadpoorasl et al., (2018), 28% of their student respondent reported they listen to music louder than recommended sound level. This indicates there are big chances people use earphones with greater sound levels so that they can listen to the music or audio attentively and clearer. Mohammadpoorasl et al. also found that 25.3% of their respondents frequently increase the volume while listening to the earphone and 40.4% of their respondents never reduce the volume of an earphone. Only 27.1% of respondents reported taking a break after a long period of earphone usage time. As a result, 32% of the respondents experience dizziness after using an earphone, while 9.8% of respondents were diagnosed with hearing loss after performing an audiometry test.

2.4 Effect of Wearing Earphone for Long Period of Time

When using earphones, the source of the sound, that is from the earphone directly in or on the ears, is incredibly close to the eardrums, and loud sounds coming from such a

close source is incredibly harmful to the eardrums. The immediate effect is that it can cause permanent damage to the eardrums. There are many other harmful effects, nine of which are discussed below.

2.4.1 NIHL(Noise-Induced Hearing Loss)

Noise-Induced Hearing Loss (NIHL), as the name suggests, is a hearing impairment caused by exposure to not only loud sounds but to the usage of earphones for extended periods. Not only does the volume of the earphones becomes a factor of NIHL, but the long duration of usage of earphones also can become a causing factor of NIHL.

2.4.2 Hearing Loss

When the ear is exposed to loud volumes or volumes close to the ear for long periods, it overworks the auditory hair cells, which can cause the auditory hair cells to die. This will cause the hair cells to bend drastically, causing hearing loss.

2.4.3 Tinnitus

Tinnitus is a condition explaining the experience of constant ringing, roaring or buzzing in one's ears. It can be felt in one or both ears or in the head. It is commonly suffered by people whose auditory hair cells in the cochlea are damaged.

2.4.4 Hyperacusis

It is common for those who experience Tinnitus to also suffer from Hyperacusis. Hyperacusis is a hearing disorder where the person is hypersensitive to normal sounds in his/her surrounding, making normal environmental sounds seem extra loud and unbearable (Santosh, 2019).

2.4.5 Dizziness

In-ear earphones produce sound with immersive feelings by sealing the ears and transmit sound directly into the ear canal. This will increase the pressure in the ear canal and result in dizziness (Bhardwaj, 2021).

2.4.6 Ear Infection

Since earphones seal the ears up, it is blocking the passage of fresh air and increases the chance of ear infections. The continuous and prolonged earphone using cultivates a favourable base for bacteria to grow. If users do not clean their earphones and ear canal regularly, bacteria may easily multiply and potentially become infectious. If there is a wound in the ear, the ear will be infected and get inflamed.

2.4.7 Excessive Ear Wax

Ear wax, also known as cerumen, is produced by the outer part of the ear canal discharged by the glands in the ear. It has both lubricating and antibacterial properties, which protect the ears.

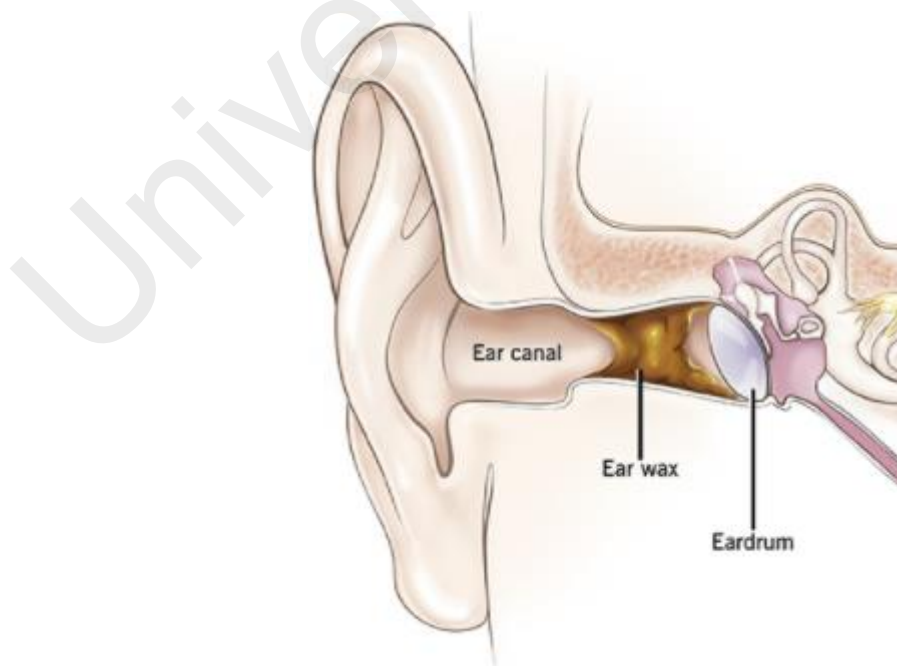


Figure 2.3: Production of Ear Wax

Ear wax buildup can happen to anyone. However, excessive ear wax may lead to blockage, earache, ear pressure and even fever. Excessive ear wax buildup is more likely to happen to someone who uses earphones frequently (Pietrangelo, 2019). One should never attempt to get rid of excessive ear wax by himself; it may cause significant damage to the ears and lead to infection or hearing loss. They should seek help from professionals or doctor that can clean up the ear canal properly.

2.4.8 Ear Pain

Prolonged usage of earphones and poorly fitted earphones will cause pain, and it usually extends to the inner ear and lead to ear soreness. As time passes, it may intensify the effect and precipitate severe discomfort to the ears.

2.4.9 Ear Numbness

Recent studies investigate the effect of individuals that use earphones and headphones to listen to loud music throughout the day (Williams, 2015). These individuals claimed that they felt numbness in their ears. It is a temporary numbness, but it could be potentially harmful and cause deafness.

2.4.10 Brain Affection

Earphones and headphones are generating electromagnetic waves while producing sound. Moreover, Bluetooth wireless earbuds or headphones are the new trendy technologies in the 21st century. These wireless earbuds or headphones are all bounded with batteries. Bluetooth technology and batteries are generating a higher level of electromagnetic waves. Besides, high decibel sound levels may damage insulation from nerve fibres which function as signal-carrying medium from the ear to the brain. Eventually, it will affect brain function severely (Santosh, 2019).

Hence, it is important to protect the ear by having awareness. Everyone can save their ear from serious damage caused by earphones by being aware of the consequences and formulate habitual changes. Volume level exceeding 85 decibels (dB) is potentially causing hearing complications and hearing loss (Vogel et al., 2010). Ideally, earphones usage are not advisable for more than 15 minutes continuously.

2.5 Noise Exposure from Earphones

The main cause for young people to experience noise-induced hearing loss nowadays is listening to loud music (Ralli et al., 2018). Gopal et al., (2019) identified the 2 major risk factors that cause hearing loss are the use of portable hearing devices such as headphones and earphones and attending clubs or concerts. Both activities expose teens to forceful music for long period of time. Portable audio devices related noise exposure is increasing in recent years as smartphones are widely used. Brink et al., (2002) found out there are estimate at least 2 million (up to 10 million) adolescents use MP3 players with excessive volume for more than 1 hour in Europe. This habit is possibly damaging their hearing. In the US, a study claimed that 12.5% of adolescents ranging 6 to 19 years old diagnose to have noise-induced hearing loss symptoms and 15% of college students experience hearing loss (Vogel et al., 2009). The same study stated the root cause of such hearing loss was the improper use of earphones. In particular, frequent use of earphones or listening to music in subway or buses with ambient noise exceeding 80 dB are arising as a risk factor of noise-induced hearing loss (Byeon, 2021).

There are also studies that identified the problem that adolescents experiencing symptoms such as tinnitus, temporary hearing loss and noise-induced hearing loss etc. is insufficient education on the proper use of earphones at safe noise levels and moderate timing for earphones using (Vogel et al., 2009). Hence, workers working from home also at risk to noise exposure from earphones if they are lacking awareness.

2.6 Qualitative Assessment

Qualitative assessment examines and evaluate respondents experience and most often from the standpoint from the respondent's perspective. The data collected from the qualitative assessment are usually used to study normative behaviour and crowd belief. Qualitative research techniques include discussion and interview which seek views from a focused topic. People build up a habit with a reason. In depth, interview is one of the qualitative techniques which understand a condition or experience from a personal perspective. Lastly, analysis of text and documents technique study the interviews and find out the reason for every behaviour. Qualitative techniques are used to explain and reveal reasons and rationales in a descriptive and illustrative way, providing a more comprehensive and explanatory result (Hammarberg et al., 2016).

Qualitative assessment often being used when the general information is sought on personal opinions, attitudes, views, or preferences. If the variables in the assessment can be isolated, defined and linked for the formation of hypotheses before data collection, the qualitative method can be used (Kovacs et al., 2012).

2.6.1 Credibility of Qualitative Assessment

Credibility is the valuation of trustworthy and convincing quality in an assessment. A qualitative assessment is credible when the assessment results are exhibited with adequate context descriptions and are recognizable to people with trustworthiness. The assessment must provide a substantial description and logical interpretation with sufficient analyzed data, which will eventually result in a robust conclusion (Sandelowski, 1986).

2.7 Hearing Loss Diagnosis

There are number of method in diagnosing hearing loss according to current clinical assessment such as physical test, tuning fork test, audiometer test, pure-tone audiometry test etc. The main classifications of these testing are the severity of hearing loss,

functional distinction, age, temporal course, variation of the auditory threshold as a function of frequency on audiograms etc. (Zahnert, 2011).

2.7.1 Tuning Fork Test

Rinne and Weber's tests are the common tests that clinically used tuning forks to test the hearing loss for a patient. These tests examine conductive and sensorineural hearing loss.

Rinne test compares air conduction to bone conduction to evaluate hearing loss. Human's eardrum and ear canal are responsible for air conduction hearing, which involves the air near the ear. Human's specialized nervous system in the ear pick up vibrations through bone conduction.

When a patient suffers from conductive hearing loss, their ear canal, eardrum or middle ear maybe not functioning, blocking or do not conduct sound waves from the middle ear to inner ear. While sensorineural hearing loss is related to auditory nerves, hair cells and cochlea. These are the parts in the human's ear specialized nervous system. Sensorineural hearing loss commonly occurs for the reason of ageing and continuous loud noises exposure. Usually, doctors examine hearing loss with both Rinne and Weber tests. Rinne and Weber benefited doctors a lot as they are easy to perform, simple and efficient. It does not need specialized and complicated equipment or instrument; it can even be done in an office. These tests are normally the first of several hearing loss tests that determine hearing changes or losses at an early stage.

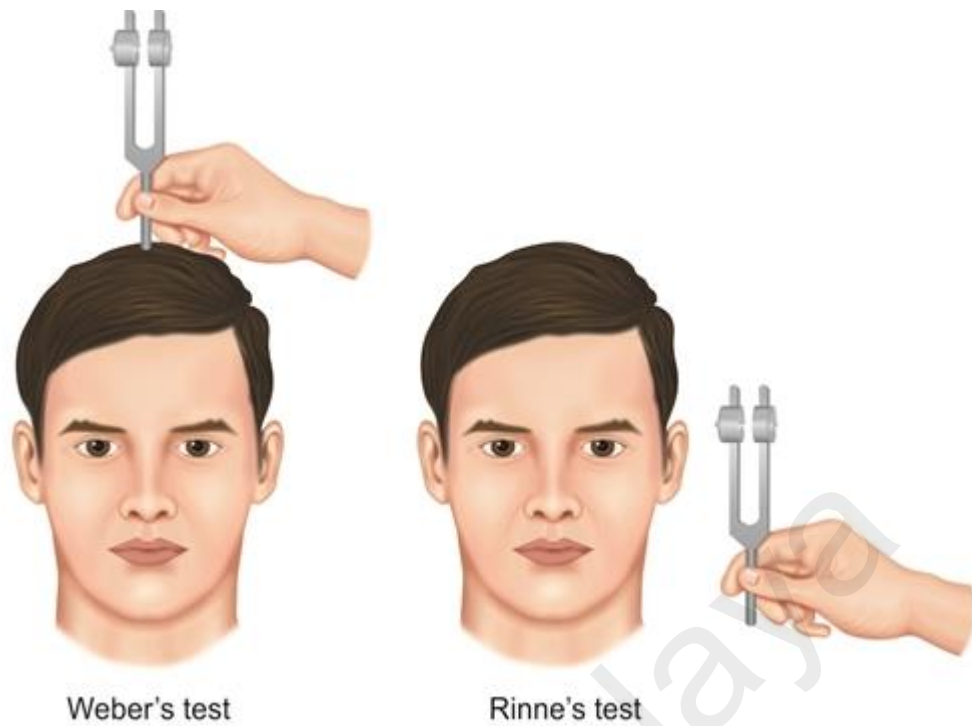


Figure 2.4: Weber and Rinne Test using a Tuning Fork

Rinne and Weber's tests do not associate risk to the patient during and after the examination; they are noninvasive and will not cause pain. It has no side effects for Rinne and Weber tests too (Stubblefield, 2018).

2.7.1.1 Rinne and Weber Tests Methodology

Rinne and Weber's tests are both using a 512-Hz tuning fork as a testing instrument. For the Rinne test, the doctor will strike the tuning fork and place it behind one side of the ear. The patient will tell the doctor straight after he cannot hear the sound. These steps will be repeated for the other side of the ear. The doctor will record the period of time for the patient to hear from each ear for analysis. For the Weber test, the doctor will strike the tuning fork and place it in the middle of the patient's head. The patient will indicate whether the sound is best heard left side, right side or equally heard in both ears. The doctor will record the observation and analyze the results.

2.7.2 Whisper Test

The whisper test is one of the primary hearing tests too to detect hearing loss. It is simple, easy and does not require any professional skills.

A doctor will briefly explain the steps and processes of the test to the patient. The doctor will stand behind the patient at an arm's length (about 1 meter from the patient) to prevent lip-reading. To limit the loudness of whispering, the doctor will do an exhaling before whispering. The doctor will then whisper a series of three letters and three numbers. The patient will be requested to repeat the letters and numbers. If the series of letters or numbers are repeated accurately, the patient is passing the test. If the patient fails to repeat the letters, the doctor will whisper a second group of different letters and numbers. If the patient fails the whisper test, he or she will be requested to do a pure tone audiometry test (Dick, 2018).

2.7.3 Pure Tone Audiometry Test

Pure tone audiometry test is a reliable and major hearing test. It is clinically recognized to identify an individual hearing threshold level, determine the degree and configuration of hearing loss. It provides a basis for hearing diagnosis and recommends treatment to be taken by the patient. This method is recognized by International Organization for Standardization (ISO) and American National Standards Institute (ANSI).

A regular pure tone audiometry test uses tone in the range of 250 hertz (Hz) and 8 kilohertz. A patient will enter a soundproof room to avoid any external interruptions. The doctor will explain the steps of testing to the patient and wear the patient a headphone. The patient will press a button when he hears a beep sound. Then, the doctor will plot an audiogram or the testing instrument will generate the audiogram automatically. The doctor will diagnose the patient according to the audiogram based on the standards set by ISO standards (Musiek et al., 2017).



Figure 2.5: Pure Tone Audiometry Test in a Soundproof Environment

2.8 Degree of Hearing Loss

The degree of hearing loss is defined as the severity of the hearing loss experienced by an individual. There are several classifications of hearing loss, which is mild, moderate, severe and profound. Normal hearing does not perceive any symptoms in hearing loss, which the hearing threshold is in the range of 0 – 25 dB. Mild hearing loss patients face difficulties in hearing a quiet or soft sound. They might find difficulties when talking to someone is soft-spoken or when there is a lot of background noise such as in restaurants or market. Their hearing threshold is in the range of 25 – 40 dB. Moderate hearing loss patient has difficulty in understanding normal speech. They might rise up volume levels while watching television or listening to the radio. People need to raise up their voices while speaking to them. They have a hearing threshold in the range of 40 – 60 dB. Severe hearing loss patients will have a hard time listening and understand people speaking. They need to put their ears very close to the people or the source of the sound. Their hearing threshold is in the range of 60 – 80 dB. A hearing threshold greater than 80 dB is considered profound hearing loss. These patients suffer from great hearing loss in which

they are nearly impossible to hear and understand speech. They might need a hearing aid to hear a sound (Lawrence, 2019).

2.9 Home Hearing Test (HHT)

Home Hearing Test (HHT) is a convenient and efficient way to provide a test to a patient. It can be administered using a smartphone, laptop or computer which contain calibrated sound card. Calibrated sound card make sure the volume produced do not deviated from a range and accurately examine hearing loss (Mosley et al., 2018).

A recent study conducted by Mosley (2018) shows that HHT is a reliable method with the condition where the patient must be in a quiet environment. Margolis (2018) also did a similar study and concluded HHT appears to be a feasible instrument for convenience and increasing access to hearing loss. However, background noise can potentially interfere with the result taking process. The potential background noises are television sound, kids playing around, family members are chatting etc. Hence, eliminating these background noises are crucial to create a conducive quiet environment for HHT.

Many audiologists or medical centres also created online hearing test for individuals to take hearing loss tests at home conveniently (*Online hearing test*, 2021). The online hearing test help their patient to realize hearing loss, but it is not designed for work from home workers. However, these online hearing tests created by professional companies validate the credibility of entry-level convenient online hearing tests.



Figure 2.6: Home Hearing Test

2.10 Recommended Volume for Listening on Earphones

While earphones on the market generically have a maximum volume of 105 dB, Scientists have studied that for prolonged hearing, any volumes louder than 85 dB can cause hearing loss. Hence, it is recommended that the volume should commonly be set at between 60 to 85 dB for safe listening. While it is difficult for individuals to identify the exact decibel to know whether it is too loud, an easy way for the individual to figure out a safe volume range is by studying the specs of the listening device to see the decibel range of the device as stated by the manufacturer. Taking the most common decibel range of earphones which is 0-105 dB, as the benchmark, scientists recommend that for comfortable and safe listening, users should listen at 50% - 70% of the maximum allowed volume, which would reflect on being between 60-80 dB (Matija, 2020).

CHAPTER 3: METHODOLOGY

3.1 Introduction

A home hearing test (HHT) is designed for work from home workers who frequently use an earphone. The design of HHT test is based on the gadgets and devices that usually a work from home worker will use. The most common gadget device that a work from home worker will use is a laptop and an earphone. The current daily usage of hearing device technologies in the world are wired earphones, wireless earbuds and wired or wireless headphones.



Figure 3.1: Wired earphone, wireless earbuds and headphone

A common audiometry test may use a bone oscillator or supra-aural headphones to test external ear abnormalities such as stenosis, atresia, cerumen impaction and exostosis (Mosley et al., 2018). Since this research aims to assess the impact of hearing loss caused by the long period use of earphone during working from home, the test does not require a supra-aural headphone. The respondent will just use the common earphone that they usually use in their work.

3.2 Design of Hearing Loss Qualitative Assessment

The HHT consists of questionnaires and 3 types of audiometry tests that will test the health of the eardrum and the sensitivity of an ear towards sound quality. The respondent will be required to use earphones or headphones instead of computer speakers as computer speakers vary in a big range. Earphones and headphones have a common range of loudness in 100dB to 110 dB. Then, the device is required to be tuned to a volume of 50%. The respondent should be tested in a quiet environment, which does not have any outward factors that affect the test. The audiometry tests are:

- Whispering Test
- Speech in Noise Hearing Test
- Single-Sided Ear Test

3.2.1 Questionnaire

Questionnaires are important for a qualitative assessment for the purpose of gathering information from respondents. These questions are efficient to collect information of a patient's daily habit in using an earphone and one's experience of using an earphone. The information of personal patient habits and subjective experience are significant for a researcher to analyze and relate the sickness or suffering of a patient.

The questions include their age, gender, profession, their habit in using an earphone and their personal experience during their daily usage of an earphone. Their demographic details (age, gender, profession) are important for the researcher to understand the variability caused by ageing and working experience. Then, there is a list of questions that examine the preference and habits of the patient. These questions also include diagnostic queries which will directly examine any suffering or sickness experienced by the patient while using an earphone.

3.2.2 Audiometry test

Audiometry tests are designed to examine and diagnose the hearing loss that experience by an earphone user. The user may not realize they are experiencing hearing loss, but the effect of earphones may have already impacted the patient's ear health. Hence, an audiometry test is essential to examine and diagnose the hearing loss experienced by the user and corrective actions advice can be provided to the user.

The audiometry tests will use a scoring test in which if the user could choose the answer correctly, the user can score the marks given. The marks will be given according to the threshold of each audio test (weightage) which correspond to a different level of severity. A correct answer will receive a zero mark and a wrong answer will receive a negative score. A healthy ear will score zero and the greater the negative score, the greater the severity of hearing loss experienced by the user.

Table 3.1: Scoring system in audiometry test

Score	Hearing Loss
0 - -7	Healthy
-8 - -15	Moderately Severe
-16 - -31	Severe
Greater than -32	Profound

3.2.2.1 Whispering Test

A whispering test is a test that common a doctor will usually start for an audiometry test. The doctor will stand behind the patient and prevent lip reading. The doctor will limit the loudness of whispering by doing an exhaling before whispering. Then, the doctor will

start to whisper a series of three letters and three numbers. The patient will be requested to repeat the letters and numbers (Dick, 2018)..

The whispering test only has pure audio content, which will perfectly prevent lip reading. Then, the whispering sound of a series of three letters or three numbers is recorded using a microphone. The loudness of the whispering sound is then edited in Sony Vegas Pro 18 software. Sony Vegas Pro 18 is a professional video and audio editing software, which is capable of limit the loudness of audio and achieve the effect of whispering.

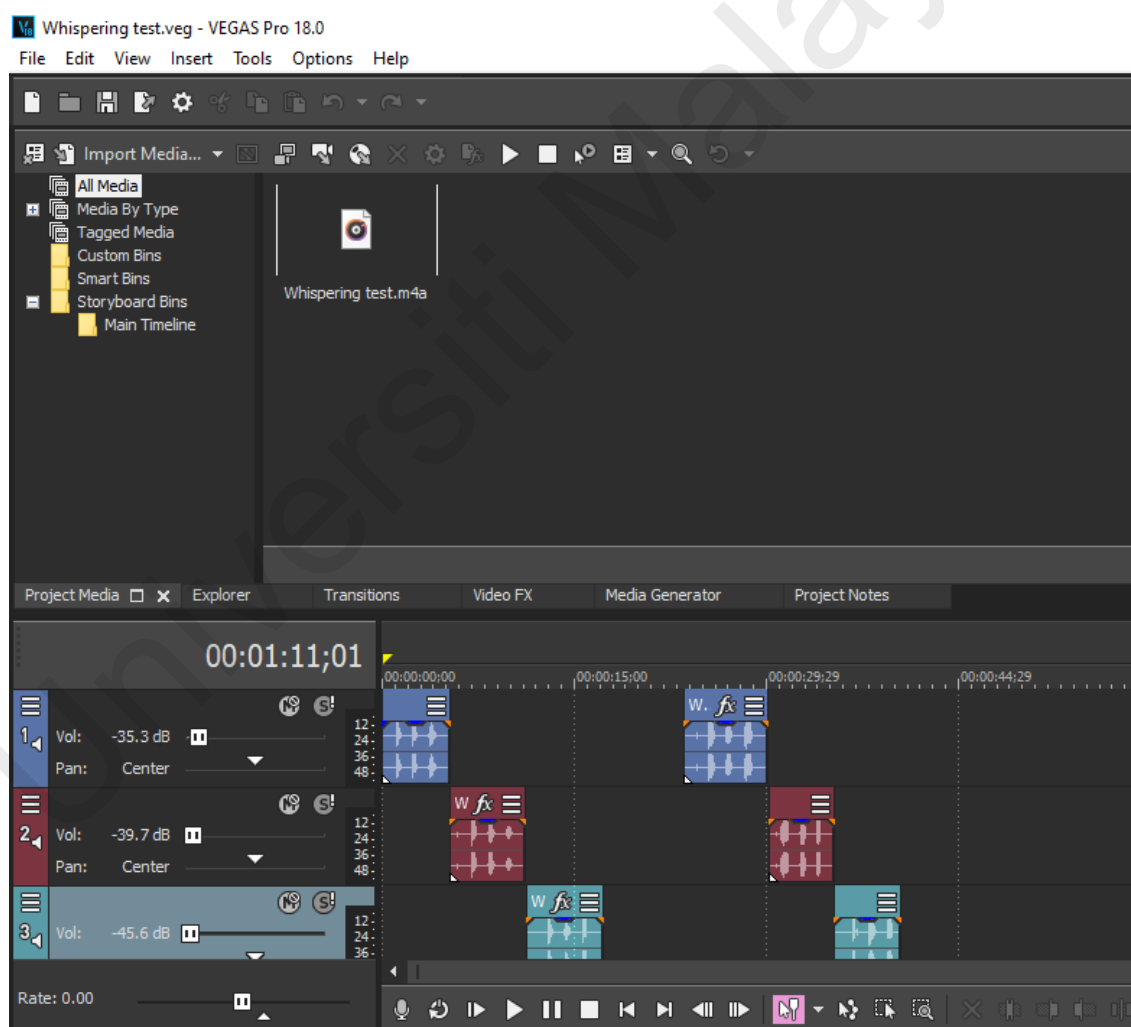


Figure 3.2: Limit audio threshold using Sony Vegas Pro 18 audio editing software

3.2.2.2 Speech in Noise Hearing Test

The speech in noise hearing test is a test that helps a patient to examine signal to noise ratio (SNR) loss. The test is quick and easy to administer, but it is powerful to examine the effect of communication difficulties hearing loss. It is a straightforward percent-correct score test and easy for patient's understanding.

The sound of a series of three letters or three numbers is recorded and merge with a noisy background audio. The threshold of the letters or numbers will be constant, but the noisy background audio will be adjusted to test the severity of the hearing loss experienced by the user. The threshold of the audios is tuned and adjusted using Sony Vegas Pro 18 software.

3.2.2.3 Single-Sided Ear Test

The different ears may experience a different level of hearing loss severity. Hence, a single-sided ear test is also essential to examine the hearing loss experienced by each side of the ear. The test will be carried out for both sides of ears, with each side of the ear tested at one time. Sony Vegas Pro 18 software is capable of adjusting stereo audio output; however, the user may confuse about the side of the earphone. Hence, the user will be required to sit in a quiet environment and wear the earphone for the left ear during the test for the left ear. Similarly, for the right ear, the user will wear the earphone for the right ear in a quiet environment to test hearing loss on the right ear.

3.3 Interviewing Platform and Method

Every worker using earphones who work from home most commonly equipped with a computer connected to the internet and earphones at home. Moreover, most of the people working in Malaysia did install a video conferencing platform. Hence, the interview can be done through these video conferencing platforms. It will be convenient and efficient without the limitation of time and venue.

Microsoft PowerPoint is a presentation program that is capable of presenting words, images, play audio files and combine all these functions on one page. It is convenient and reliable. All the interview questions and the audio file are compiled in the presentation slides and shared through Zoom software.

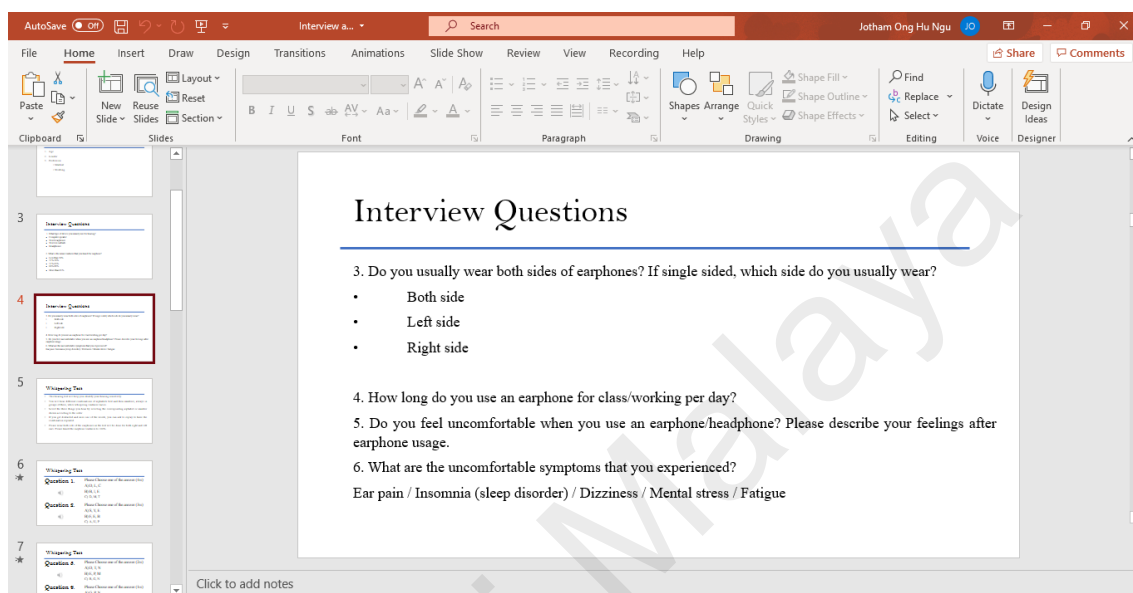


Figure 3.3: Presentation of Interview Questions Using Microsoft PowerPoint Software

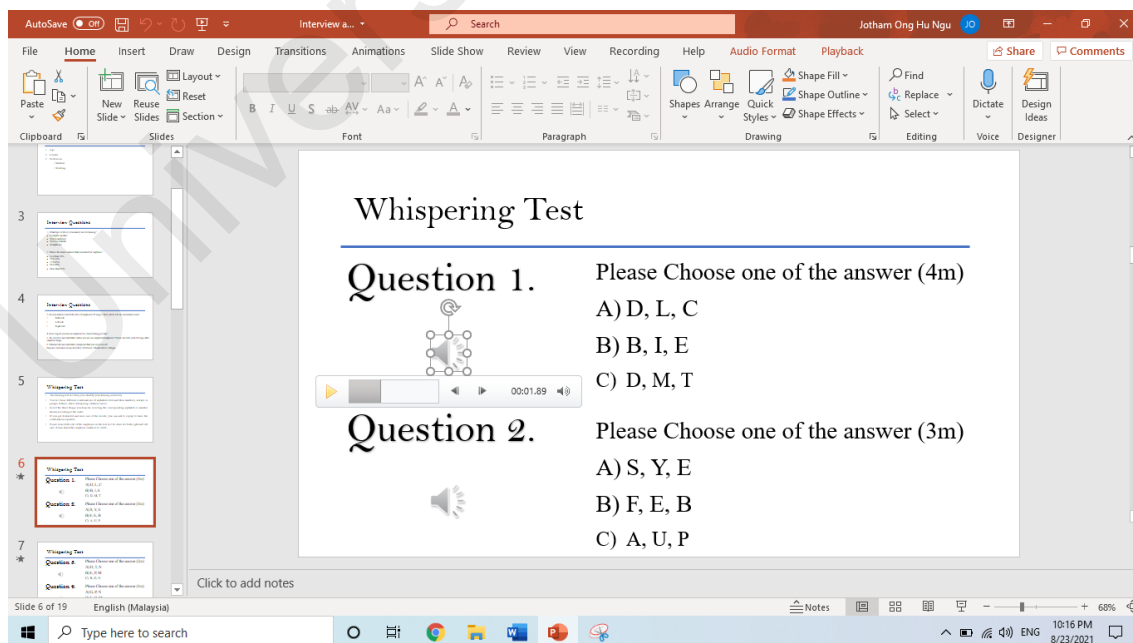


Figure 3.4: Performing Hearing Loss Tests Using Microsoft PowerPoint Software

Zoom software is a reliable video platform that fulfills all the communication needed in this interview. It has the ability to share screen, share original computer sound and record the interview (Antonelli, 2020). Hence, the combination of questions and audio file in Microsoft PowerPoint Software is shared through the function of screen and audio sharing in Zoom platform.

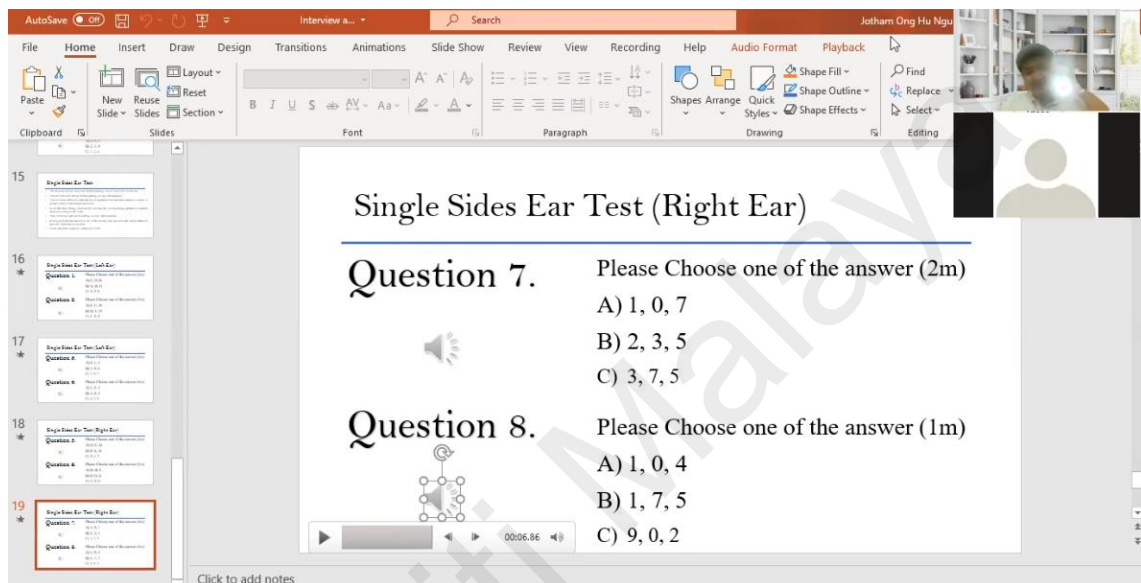


Figure 3.5: Performing Remote Interview and Hearing Loss Test Through Zoom Platform

CHAPTER 4: RESULTS AND DISCUSSIONS

4.1 Introduction

20 respondents participated in the hearing loss qualitative assessment, which includes an interview and three hearing loss tests. To study the hearing loss of workers in Malaysia caused by earphones during work from home more comprehensively, these respondents are chosen from different backgrounds with different earphones using characteristics. The respondents have an age range from 24 to 51 with different job scopes such as banker, insurance executive, marketing executive, lawyer, architect, teacher, auditor, engineer, information technology expert etc. They have different earphone using habits. Their average earphone using time per working day varies too. Hence, interviews in this research supported the qualitative assessment to obtain descriptive and elaborative earphones using experience by work from home workers. These interviews explain and clarify the subjective experience of every respondent.

4.2 SPSS Results

4.2.1 Test Results

From the interviews, the respondents also answered a number of questions that provide numerical data and categorical data. The three hearing loss test also yield categorical data that shows the healthiness of the respondents' ear. These data include the age, average earphone using time per working day, volume of earphone and test marks. Insertion of these data into SPSS software generates relational analysis that helps in better qualitative analyzing the effects of different variables.

The y-axis shows the frequency of the respondents and the x-axis represents the health level of their ears. There is 4 level of ear health in the test which are healthy, moderately severe, severe and profound. The graph shows the number of respondents with respective ear health level.

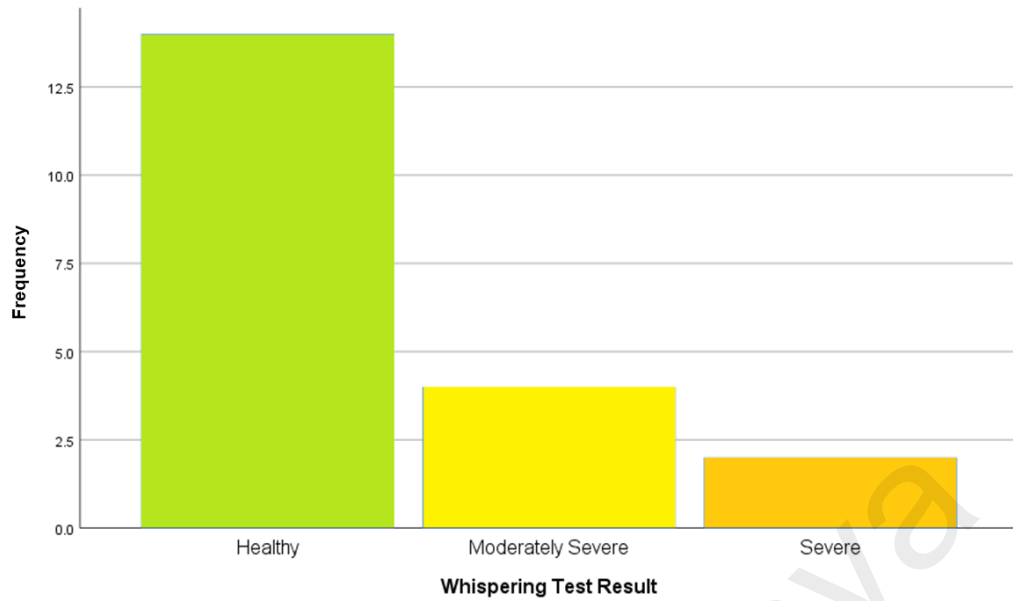


Figure 4.1: Whispering Test Result

The whispering test as shown in Figure 4.1 is a test commonly used to examine hearing loss. In this research, this test has been used to examine hearing loss caused by earphones on a work from a home worker. Most of the respondents have a healthy ear, but there are several respondents who experience hearing loss. There are no respondents who experience profound hearing loss. The respondents who experience hearing loss hardly listen to the pre-recorded audio and some of them do not hear anything from the questions. On the contrary, the healthy respondents could listen to the audio clearly and answer the questions confidently.

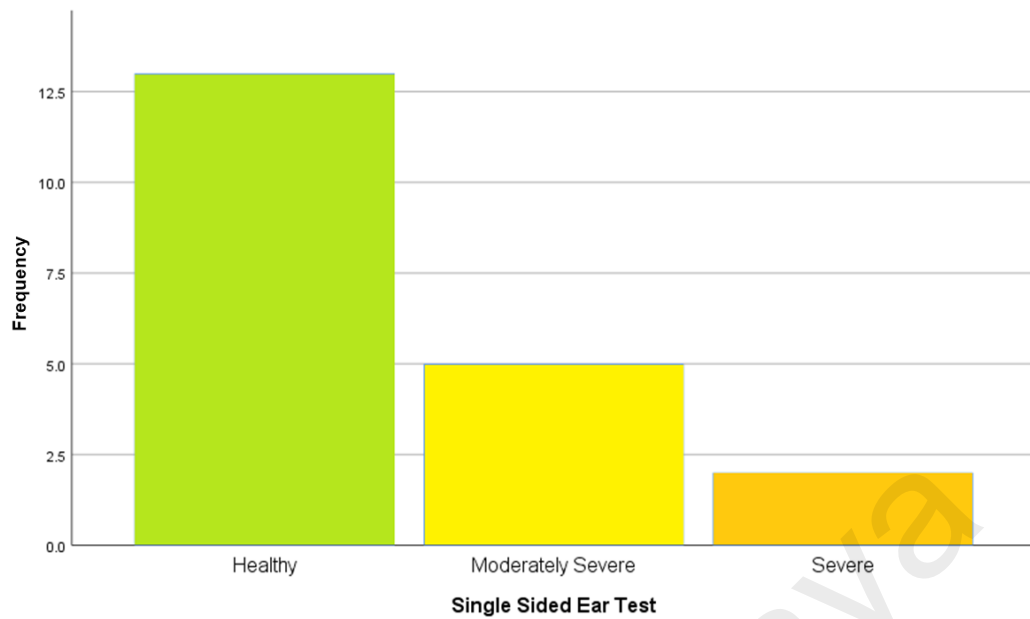


Figure 4.2: Single-Sided Ear Test Result

Figure 4.2 shows that the single sided ear test which examines the hearing loss experienced by each side of the ear. Comparatively, more respondents face difficulties in single-sided ear test than that in the whispering test. Respondents wear both sides of earphones for the whispering test, while single-sided ear test requires the respondents to wear earphones for only each side of the ear per test. Some of the respondents experience unbalance in hearing loss, which means one side of their ear experiences greater hearing loss than the other. These respondents then explained they are more likely to use that side of the ear to wear an earphone to receive phone calls or when they are using earphones single sided.

Respondents face greater difficulties in single-sided ear test than whispering test also indicates that these respondents are experiencing great hearing loss. However, the other side of the ear still can listen clearly. Therefore, they can still answer the question in the whispering test, but they failed single-sided ear test. Failing single sided ear tests is a sign that the respondent is experiencing hearing loss.

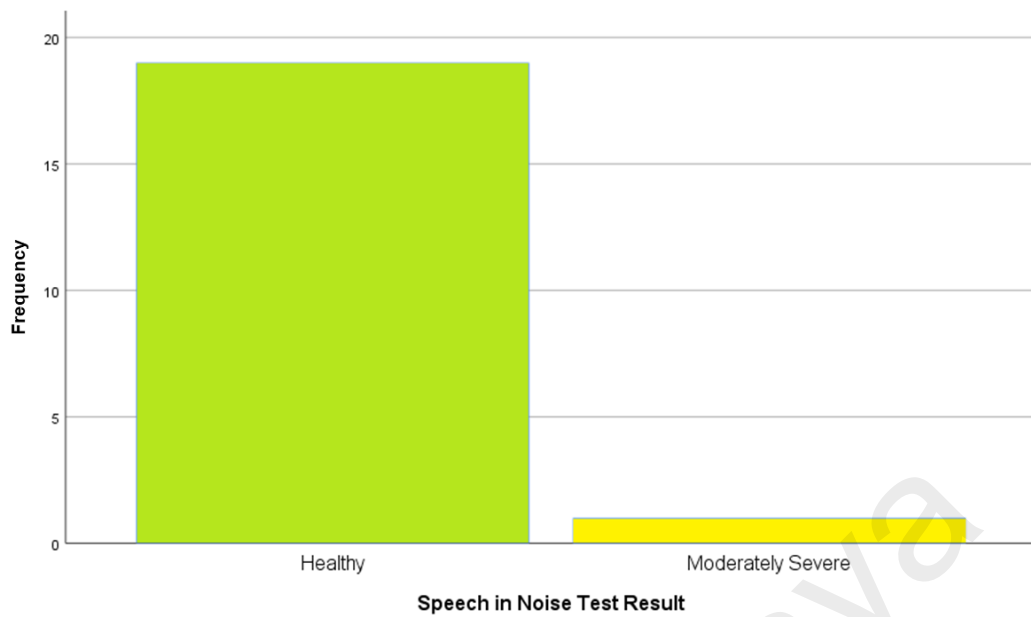


Figure 4.3: Speech in Noise Test

Figure 4.3 is showing Speech in noise test that examines the difficulty experienced by respondents in understanding conversation in background noise. Almost all the respondents passed the test without any hesitation. This shows that wearing an earphone may cause hearing loss towards workers, but it will not affect the ability of a worker in understanding daily conversation.

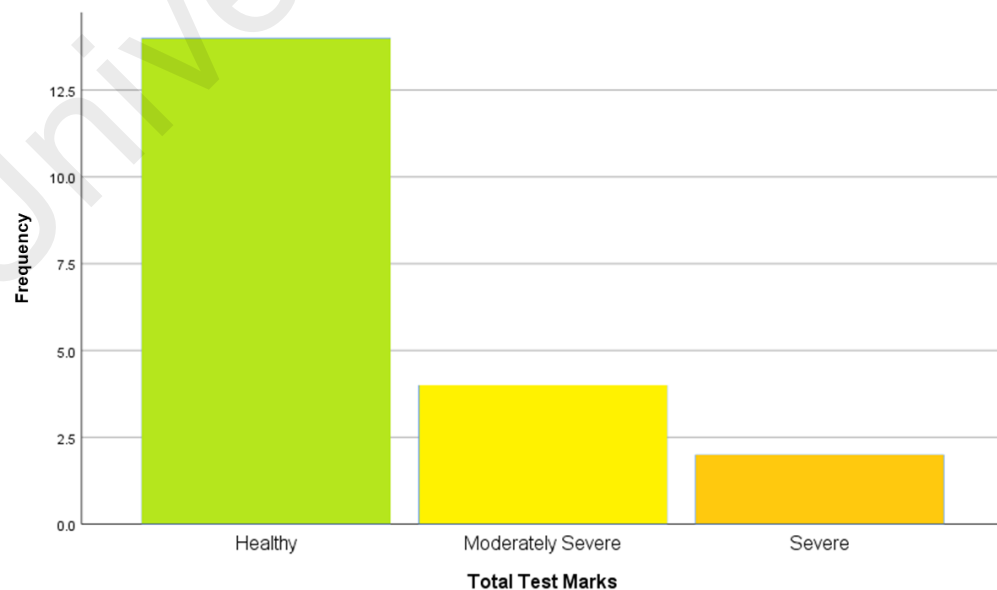


Figure 4.4: Overall Test Marks

Among the 20 respondents from different backgrounds and characteristics, 14 respondents (70%) have a healthy ear. However, there are 6 respondents (30%) that moderately severe or severely experience hearing loss as shown in Figure 4.4. No respondents experience profound hearing loss. Hence, wearing an earphone during work from home period cause an undeniable impact on workers to ear health. Wearing an earphone will not cause severe hearing loss which is categorized under safety issues, but it is a silent potential occupational hazard that risks workers ear health in the long run.

4.2.2 Average Time Using Earphone Per Working Day

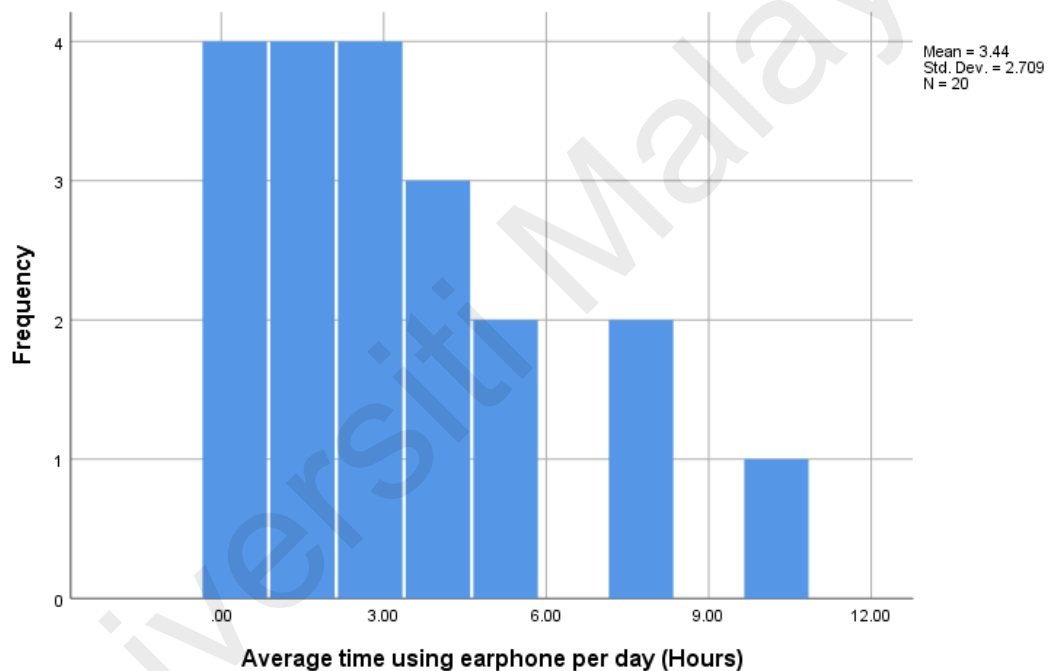


Figure 4.5: Average Time Using Earphone Per Working Time

In Figure 4.5 x-axis indicates the number of respondents and y-axis represents the average time using an earphone per working time. Average time using an earphone per working time varies by different job scope in variable sectors. Figure 4.5 shows Malaysian have approximately 3.44 hours of average time using earphones. From the context of the interviews, the major reasons that drive the respondents to use an earphone are the surrounding environment and personal habits. Most of the respondents use an

earphone because their surrounding is noisy or they are sharing the same space with other family members in the house, so they use an earphone to prevent distraction and suppress the audio from disturbing others. These respondents are also using earphones so that they can focus on the meetings, which is considered as a fulfilment of working requirements. However, some of the respondents use earphones as a habit, especially the younger respondents. They enjoy the immersive hearing experience brought by an earphone or headphone and thus habitually use an earphone or a headphone in their work.

It is shown that most of the respondents are using earphones less than 5 hours per day. Most of the respondents do not like to use an earphone as they feel uncomfortable when they use an earphone for a long period of time. However, there is also a community that is used to an earphone and use it habitually. As a habit, they also plug in their earphone for their work. This scenario extended when these workers work from home.

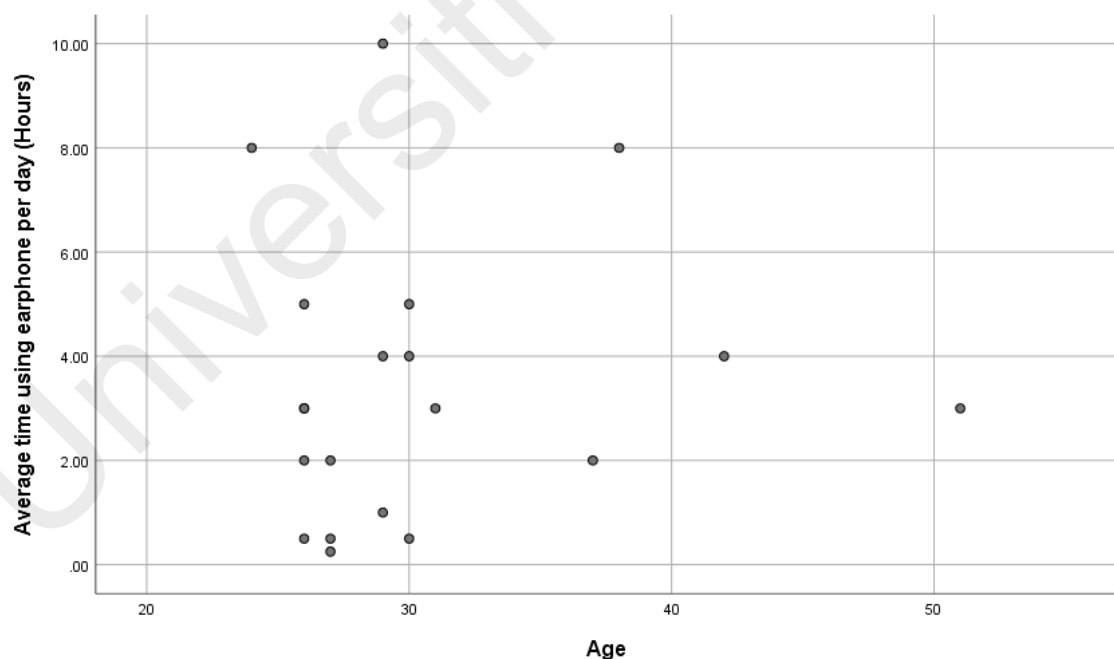


Figure 4.6: The Relationship Between Age and Average Time Using Earphone Per Working Day

The younger generation has less awareness or higher ignorance about the effect of earphones on hearing loss. Most of the respondents who are older are using earphones for

work with a situation without an alternative. Younger generation workers tend to use wireless earbuds for their convenience and using earphones for immersive hearing feelings. From the graph in Figure 4.6 shows that the long period usage of the earphone is mostly from the younger workers. There is an exception in the older age as the respondent explained she uses an earphone for 8 hours per working day as it is a requirement for her as a marketing executive in the interview.

4.2.3 Structure of Hearing Devices

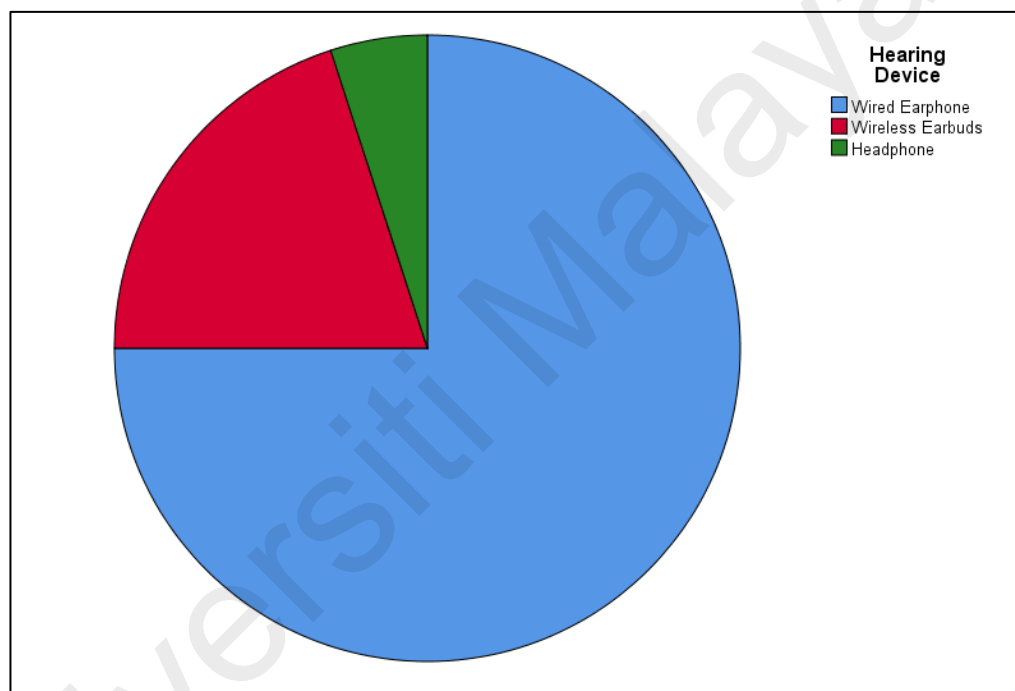


Figure 4.7: Respondents Preference on Hearing Devices

Figure 4.7 shows the type of hearing devices commonly used by the respondents. Blue colour represents wired earphones, red colour represents wireless earbuds and green colour represents headphones. As shown in Figure 4.7, wired earphones are the most common hearing device used by the respondents. The wired earphone is the most common hearing device that can be found in the current market. Wireless earbuds are getting popular in Malaysian society. Wireless earbuds give the freedom to the user to use them. Their head movement will not be restricted by the wires, so it is convenient to

use. Both wired earphones and wireless earbuds have the problem of heating. Some of the respondents responded that earphones are heating up, causing their ear to feel uncomfortable. Hence, there are no distinct differences in effect using a wired earphone or wireless earbuds. Headphones are more expensive, so there are fewer people using a headphone. All of the respondents using headphones recommended headphone over an earphone. They feel more comfortable using a headphone compared to wired earphone or wireless earbuds. It is because it does not pressurize the ear as it has an ear covering shape, which is different from an earphone that plug into an ear.

4.2.4 Effect of Earphones on Hearing Loss

This research studies two major root causes of hearing loss caused by earphone, which are the amount of time using an earphone per day and the loudness of an earphone.

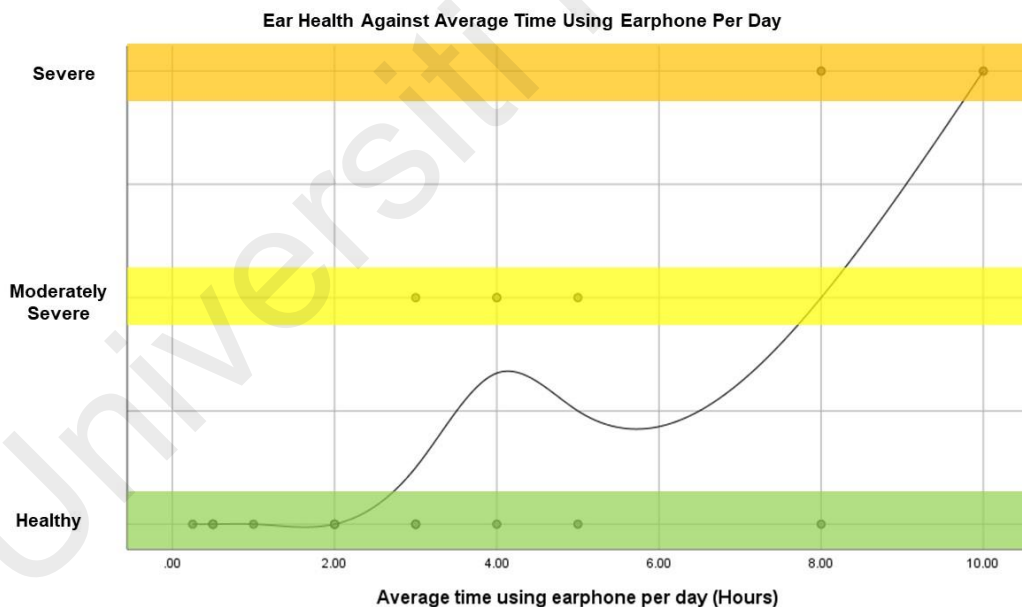


Figure 4.8: Relationship Between Ear Health Against Time Using Earphone Per Day

Figure 4.8 indicates how the amount of time using earphone per day affect the hearing health of respondents. All of the respondents did the same test through the same platform (Zoom platform); the respondents with fewer hours using earphones per day can pass the tests. On the contrary, the respondents with severe hearing loss are usually the ones who

use earphones for more than 5 hours per day as shown in Figure 4.8. The usage of earphones for 3 – 5 hours per day continuously may hurt the ear. But some of the respondents still have healthy ears even they use earphones for long period of time per day. There is one exception as mentioned previously that uses 8 hours of earphone per day and remain healthy ear. It is because the respondent tuned her earphone volume to less than 30% in her daily usage. Hence, the volume of an earphone also greatly affect hearing loss.

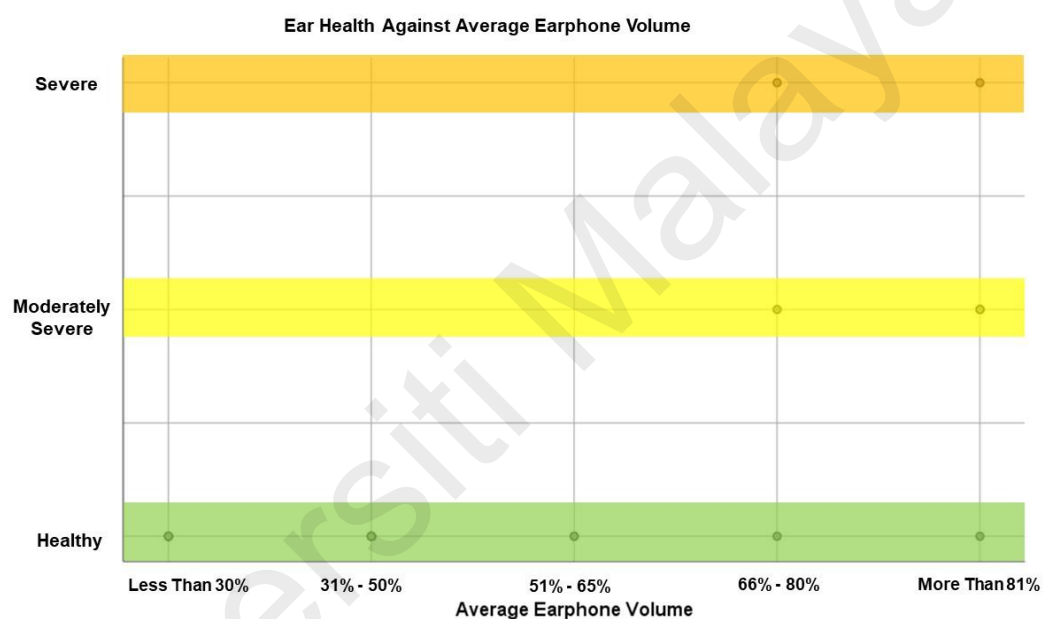


Figure 4.9: Relationship Between Ear Health Against Earphone Volume

One of the major findings in this research is the earphone volume is the main cause of hearing loss. It significantly affects the hearing ability of the respondents towards soft sound. The respondents who usually tune the earphone to more than 66% with less earphone usage time still remain healthy ear. However, the respondents who tuned the earphone to more than 66% of the volume with a longer period of time experience hearing loss during their tests. Figure 4.9 shows that all of the respondents who tuned their earphone volume to less than 65% have healthy ears. These respondents, especially the respondents who usually tune their earphones to less than 30% can hear the softest sound

in the test clearly. They do not have any difficulties in hearing sound in the tests. Hence, earphone volume is a crucial matter that affects hearing loss.

4.2.5 The Study of Earphone Volume

Earphone sound level is a subjective preference for every user. Some of the respondents claimed that they turned the volume to the maximum because it is clearer. However, some of the respondents were shocked when they are required to tune their earphone volume to maximum level during the tests. It is because they commonly tune their earphone volume to minimal. Hence, their ears are very sensitive to loudness.

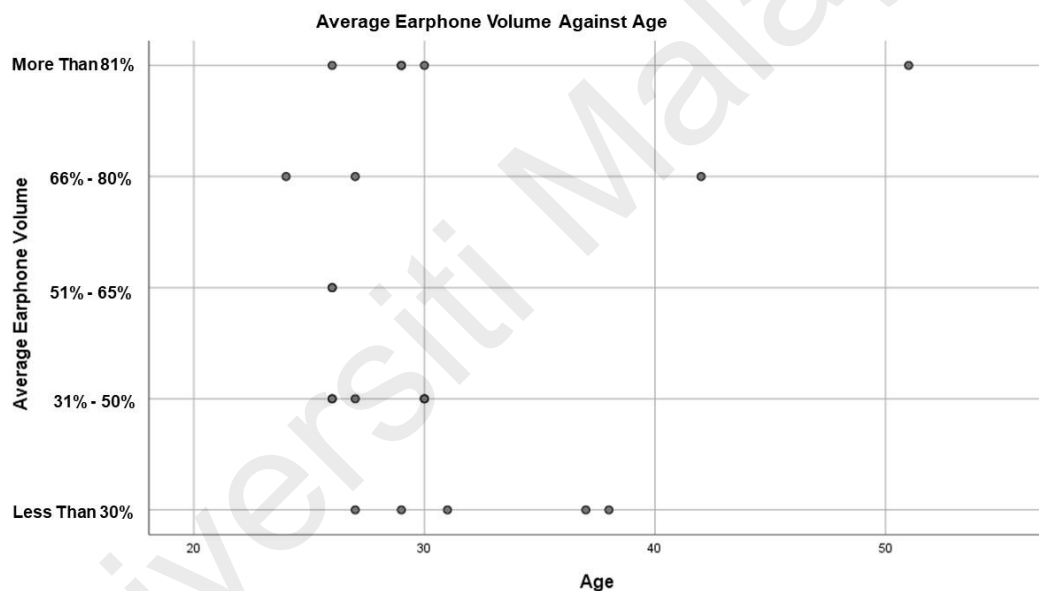


Figure 4.10: Relationship Between Average Earphone Volume and Age

Figure 4.10 shows the relationship between average earphone volume and age. From the statistic shown in Figure 4.10, the age of a user does not have a direct effect on earphone volume preference. There are older respondents who tune their earphone volume louder and there are also respondents with variety age tune their volume to minimal. Some of the elder respondents were claiming they cannot listen clearly if the earphone volume is too low. However, some of the older respondents claim that they used

to tune lower volume, so they can hear it clearly. Hence, age does not affect the level of earphone volume tune by a user.

Although the level of earphone volume is subjective to personal preference, average time using earphones may affect the level of earphone volume tuned by a user.

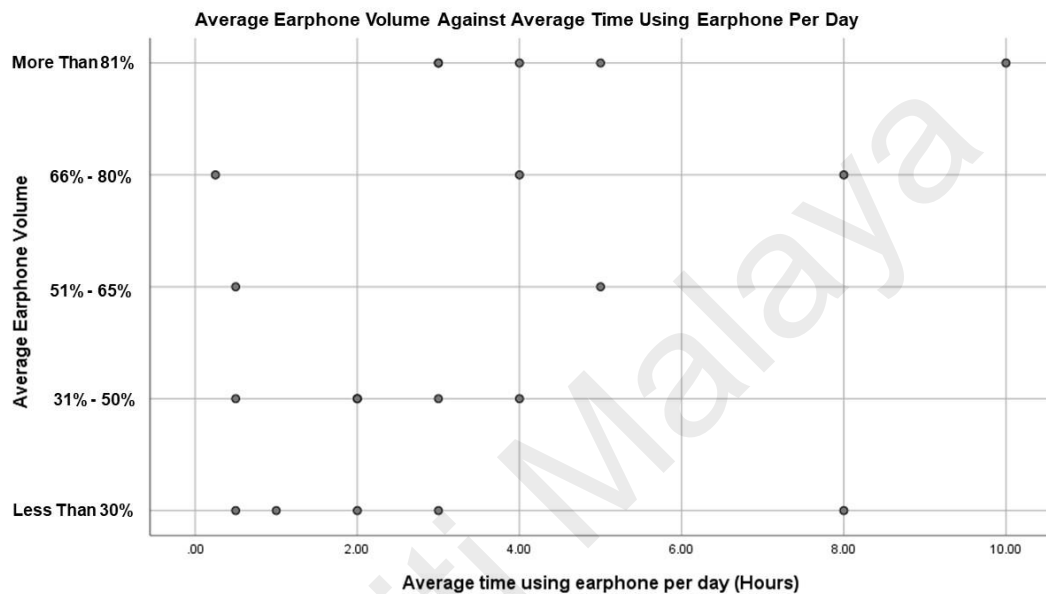


Figure 4.11: Relationship Between Average Earphone Volume and Average Time Using Earphone Per Day

Figure 4.11 shows a trend that the respondents who have longer period of time using earphone tend to tune earphone volume higher. From the interview, the respondents responded their experience and there are some findings from the interviews.

People who enjoys the immersive feelings brought by an earphone tend to tune their earphone volume to a higher level. So, their ear is used to louder sound. When a company follows the work from home policy, they need to work from home and the amount of time using an earphone increase. When they use their earphone, they are used to tune their earphone volume to a higher level regardless of hearing music or doing their work. Thus, their ear is exposed to an extensive level of loudness for a longer period of time. Although earphone is not categorized as a hazardous source, prolong usage of earphone with

extensive earphone volume has exceeded Noise Exposure Level (NEL). According to Malaysian Department of Occupational Safety & Health (2019), every employer should ensure that none of his employee is exposed to daily noise exposure levels exceeding 85dB. A common earphone has the ability to reach out 100 – 105dB when it is tuned to the maximum volume. When an earphone volume level is tuned more than 85%, it is producing a sound that exceeds 85dB. The respondents who are using an earphone more than 81% with an extensive period of more than 8 hours a day, are using an earphone exceeding daily noise exposure level.

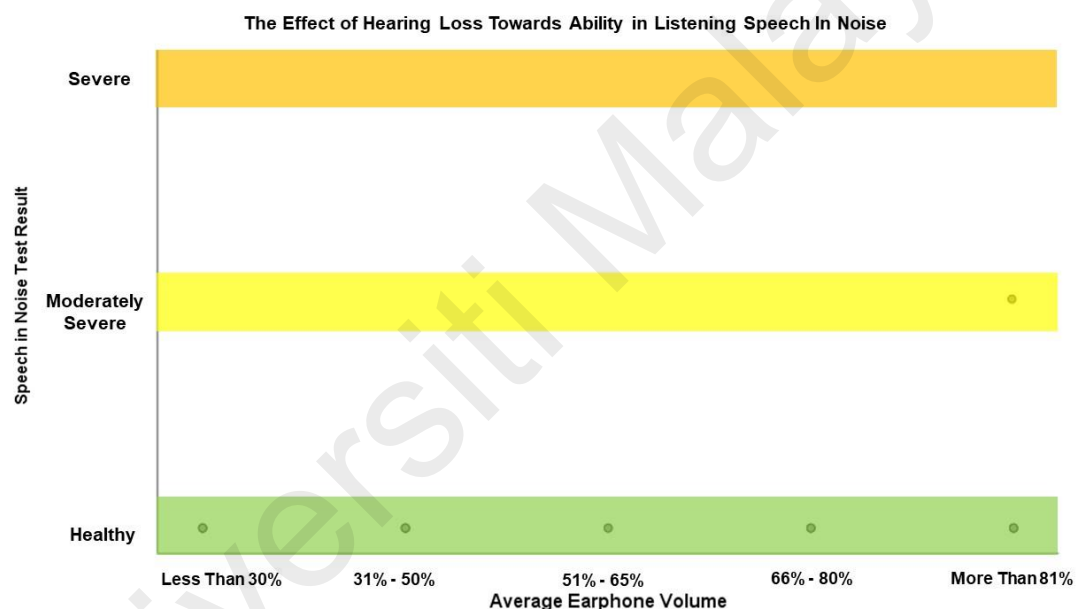


Figure 4.12: The Effect of Hearing Loss Towards Ability in Listening Speech in Noise

High earphone volume level has a significant effect on hearing loss, but the hearing loss do not affect the ability of respondents in listening speech in noise as shown in Figure 4.12. Speech in noise test examines the ability of a respondent's ear to focus. If someone fails a speech in noise test, he will face difficulties in listening speech. Figure 4.8 shows that volume does not have a significant effect on speech in noise listening ability. Although these respondents experience hearing loss as portrayed in Figure 4.8 and Figure 4.9, they do not show any serious sign of losing their ability to listen to speech in noise.

Hence, wearing an earphone extensively at work will not affect the ability of a worker in their mind concentration and hearing focus.

4.3 Interview Findings

In this research, statistics have been used to illustrate the impacts of the chosen variable condition towards workers hearing loss and their relations in different aspects. However, the respondents also responded with their subjective and personal experience of wearing earphones for working and the description of their feelings.

4.3.1 Healthy Ear Respondents

Most of the respondents with a healthy ear do not like to wear an earphone. They only wear an earphone in an unavoidable situation. So, these respondents have mostly average earphone wearing time less than 4 hours per day. However, there is an exception in which a 38-year-old healthy ear respondent who wears an earphone for the whole working hours as she is a marketing executive. From the interview, she explained her situation. She is aware of the effect of wearing an earphone which might cause her hearing loss. Hence, she tuned her earphone volume to a minimal (around 10%) as long as she can listen clearly. For the whole day long using an earphone, she did not feel uncomfortable for using an earphone. In a similar situation, all of the respondents with earphone volume less than 30% do not complain of eardrum pain. However, some of the respondents with minimal earphone volume did complain the structure of the earphone and the heat come from the earphone discomforted their earphone wearing experience. It may not cause hearing loss, but the user may feel uncomfortable after a long period of time using an earphone.

From these healthy ear respondents, some of them tuned their earphones to the maximum while using the earphone. They usually feel uncomfortable after they use an earphone for half an hour. So, they will take off their earphone when they feel

uncomfortable. The shortening of time using an earphone keeps their ear healthy, although they have a high earphone volume level.

4.3.2 Unhealthy Ear Respondents

Respondents who scored lower marks in the tests are considered as unhealthy ear respondents. Their hearing ability is obviously weaker than the healthy respondents. This situation worsened when they did single-sided ear test. They barely hear anything or some of them completely cannot hear anything for difficult questions. Fortunately, no one from the respondents fails to answer the easy questions. So, there are no respondents who experience profound hearing loss as shown in Figure 4.4, which may affect their daily conversation.

All of these unhealthy ear respondents have similar characteristics in which they tuned their earphone volume to more than 66% and have average daily earphone usage time for more than 5 hours. All of the respondents experience ear pain and some of them have other symptoms such as fatigue and mental stress. Although they feel uncomfortable in their ear, they claimed that they would not take off the earphone until the work or meeting is done. They may take off one side of their earphone to relieve the stress of their ear and interchange the single-sided earphone to relax their ears. Some of them claimed that they would ignore the discomfort feelings until their work is done. Ear pain is a symptom of cells damage. However, these respondents forced themselves to concentrate in the virtual meetings by wearing the earphone as a responsible employee. This situation caused hearing loss to their ear.

These respondents explained their reason to use an earphone. They use an earphone so that they could concentrate on the work. Some of them claimed that they have other family members or housemates in the house, so they need to wear an earphone to prevent

any background noises and prevent the computer sound from disturbing other members in the house.

There is also a special case from the respondents who arise a potential threat in work from home earphone wearing situation. The respondent is a kindergarten teacher. She taught and gave lessons to the children through online meeting platforms. Some of the children may shout at the microphone when they get excited at answering questions or interaction section. The volume will suddenly spike and cause harm to her ear as the shouting amplified when the kid is too near to the microphone. She usually felt a prickling in the eardrums after the spike of the volume.

4.4 Discussions and Recommendations

The results indicate that no respondents experience profound hearing loss from using an earphone during work from home period. This indicates that earphones do not arise ear-related safety issues. However, it has affected the heavy users and caused hearing loss to them. Earphone is a kind of headphone design that became widespread and universally popular in the year of 2001 (Losse, 2017). Many people started to use an earphone and the number of users is constantly increasing. In the year 2020, the Malaysian government had announced the Movement Control Order (MCO) which urged most of the workers in the country to work from home to prevent the spreading of Covid-19 disease. This situation had intensified the usage of earphones during work. It may not severely affect the workers ears in a short time, but it may cause severe hearing loss when this generation ages.

From the context of the interviews and the response of the respondents, there are several recommendations that could be taken to minimize the effect brought by an earphone.

4.4.1 Awareness

Most of the healthy ear respondents have a kind of thinking that overusing an earphone will hurt their ears. So, they will try their best to reduce the time to use an earphone and reduce the volume to minimal.

On the contrary, the unhealthy ear respondents think that it is a norm to wear an earphone and used to wear an earphone. Some of them even though it is trendy to use earphones or wireless earbuds. All the advertisement in the market is promoting earphone as a marketing strategy and hardly find anyone arising the awareness of the effect brought by the earphone at the 2010s. It has become a trend and the awareness is passing up. Hence, raising awareness in a company especially for the workers working from home, is important for employee's ear health. This will prevent community ear health problems in Malaysia in the coming ages.

In this research, all of the respondents with a volume level of less than 65% are healthy. Vogel et al., (2010) stated in their journal that a volume level exceeding 85 dB could potentially cause hearing complications and hearing loss to the users. As stated previously, 85 dB is approximately 81% of an earphone volume. Hence, workers are recommended to tune their earphone volume not exceeding 81% at all times and most ideally tune the earphone volume less than 65%.

4.4.2 Recommended Policy

Awareness is the key to lead a healthy working environment. However, Department of Occupational Safety and Health (DOSH) Malaysia and companies in Malaysia also can implement several policies which can help to reduce risks in hearing loss induced by earphones.

Doctors recommend the 60%/60-minutes rule (Inverso, 2015). It means the volume of the earphone should be no more than 60% and the amount of time using earbuds should limit to 60 minutes. However, it is impossible for a company to conduct meeting in less than one hour per day. According to the statistic from this research, 4 hours of earphones usage is still considered safe. Hence, during the working from home period, a company should not conduct virtual meetings or conferences for the workers more than 5 hours per day. For each meeting or conference, there must be a break for at least 15 minutes in any continuous 1 hour so that the workers can rest their ears.

Moreover, companies should mandate their employees to attend hearing loss tests after working from home for more than 1 year. If there is hearing loss present in that 1 year period, the worker should be designated to ear health counselling.

Some of the companies gave earphones for workers to work from home. There are respondents who gave feedback that the earphone provided by the company does not fit nor suit their ears. The earphone discomforted the respondents during work from the home period. It may be a budget problem. However, companies can consider implementing an earphone cost subsidy program instead of buying earphones for their workers. The subsidization with a fixed cost give the freedom to the workers to choose the earphone that suit themselves. Thus, the workers can use an earphone comfortably.

CHAPTER 5: CONCLUSION AND RECOMMENDATION

5.1 Summary

The covid-19 pandemic has caused many countries to lockdown including Malaysia who imposed the Movement Control Order (MCO) since March 2020. Since the outbreak, many workers in Malaysia have been forced to work from home while others are highly encouraged to do the same where practicable. As many factors in the home environment may cause a distraction to a worker who is on the job, a tendency for workers working from home to wear earphones to block out such distractions is high. Wearing earphones for a long period of working time has great potential to increase hearing loss risk among the workers. Hence, it may become an occupational ear health issue.

This research has been designed and conducted in consideration of the above-mentioned issues. With the aim to examine hearing loss among work from home earphone users, a hearing loss qualitative assessment has been designed to assess the level of hearing loss among earphones using workers in Malaysia. The qualitative assessment comprises an interview of earphones using experience and three hearing loss tests. The interview asks for the user earphone using habits such as average earphone usage time per working day, level of earphone volume and type of earphone used etc. The interview also examines the reason for every user choose earphones over speakers or other alternatives as well as their experience towards a long period of earphones usage. These interview questions provide a means for the researcher to understand and diagnose the problem in a qualitative and comprehensive way. The three hearing loss tests include the whispering test, speech in noise test and single-sided ear test. The whispering test examines the hearing health of the respondents by limiting the audio level. The speech in noise test examines the hearing loss experienced by respondents, which causes communication difficulties. Single-sided ear tests diagnose the hearing loss experienced by each side of the ear.

Ideally, a healthy ear will score zero marks. Wherever the respondents cannot listen to the audio and answer the question, the marks will be deducted with respect to corresponding scores according to the level of audio loudness. Each test score and the total score will be categorized into 4 levels, which represents 4 degrees of hearing loss which are healthy, moderately severe, severe and profound.

The qualitative assessment, which comprises interview questions and 3 tests (whispering test, speech in noise test and single-sided ear test) are compiled in Microsoft PowerPoint. Whispering test examine hearing loss caused by earphones on a work from a home worker. Speech in noise test examines the difficulty experienced by respondents in understanding conversation in background noise. Single-sided ear test examines the hearing loss experienced by each side of the ear. Then, the qualitative assessment is shared through the Zoom platform. Zoom platform is able to share screen and sound as well as record the interview. 20 participants with different age, job scope and working environment gone through the assessment. Their interview and test results are recorded and analyzed.

From the qualitative assessment done by the 20 respondents, there are several findings. There are approximately 2/3 of the respondents pass through the test with score marks in the healthy category. 1/3 of the respondents failed to answer some of the questions and score marks in the range of moderately severe and severe. No respondents score marks in the category of profound. This indicates earphone is a safety device that will not cause hearing safety issue, but earphones are affecting and causing hearing loss among work from home workers who may eventually cause hearing health problem.

The interviews show habitual differences between healthy and unhealthy ear respondents. The healthy ear respondents either use earphones for less than 4 hours per day or tune the earphones volume to less than 65%. On the contrary, the unhealthy

respondents have the common characteristics, in which their average earphone using time per day is more than 5 hours and their earphone volume are more than 65%. There is a respondent who uses earphones for more than 5 hours per day but is diagnosed as a healthy respondent. It is because the respondent tuned her volume to less than 30%. She did not experience ear pain at all, even using an earphone for a long period of time. Hence, forceful volume with extended earphones using time will pressurize the ear and eventually cause hearing loss.

In addition to the findings, working from home may influence and affect the earphones wearing the habit of a worker. Earphones are common in the 21st century and it becomes a normal and trendy device that will be used by many people. People nowadays tend to use earphones as it is convenient and can prevent the user from distracting and get distracted from others. Some of the respondents also claimed that they usually use earphones to listen to music as earphones can bring them immersive feelings. They will gradually tune the earphones volume higher as these people are used to use earphones with higher volume levels, working from home prolonged their unhealthy earphones usage. Using earphones while working from home does not directly cause hearing loss, but the unhealthy habit conjoin to prolonged earphones using time during work from home aggravate the hearing loss.

Therefore, awareness and policies are both important to prevent the worsening of hearing loss experienced by the workers. Workers should always tune the earphones level not exceeding 81% at all times and ideally tune the earphones less than 65% for daily working use. For company policies recommendations, a company should not conduct virtual meetings or conferences for the workers more than 5 hours per day. For each meeting or conference, there must be a break for at least 15 minutes in any continuous 1

hour so that the workers can rest their ears. Companies should also examine their employee's ear health for working from a home period more than 1 year.

5.2 Conclusions

In short, a hearing loss qualitative assessment has been generated. The assessment comprises interview questions and 3 hearing loss tests. Interview questions analyze earphones using habits and investigate the root cause of hearing loss. Hearing loss tests include whispering test which examines hearing sensitivity, speech in noise test which assess conversation understanding ability and single-sided ear test which diagnose the hearing loss in each side of the ear. The assessment had been done through online video conferencing platform (Zoom Software) which is capable to share assessment contents. The assessment had successfully diagnosed hearing loss in respondents who do not practice good earphones using habit.

20 workers with different working backgrounds in Malaysia participated in the assessment. 30% of the respondents were identified to experience moderately severe and or severe hearing loss. These respondents have the common characteristics of using earphones for more than 5 hours per working day and usually tune their earphones volume above the level of 65%.

Based on the results and feedback from the respondents, there are several methods to minimize the hearing loss caused by earphones on work from home workers. Workers should be aware that prolonged earphones usage with volume levels exceeding 81% during work from home is causing hearing loss. Companies should raise awareness among work from home workers towards ear health knowledge and impose company policies that prevent prolonged and continuous earphone use. This will prevent community occupational health problems in the future.

5.3 Recommendations

Although the tests are well-calibrated using audio editing software and tested by different users, the tests can be reviewed or improved through physical instruments such as a sound level meter. Due to time constraint and movement control order in Malaysia, the results of the report are limited and reaches the extend. However, the test can be compared to clinical tests so that this home hearing test will be more reliable and credible.

This research is taking qualitative results, finding root causes and studying subjective hearing loss experiences from some of the work from home workers. In the future, researchers can also collect quantitative results from more Malaysians, which can identify the widespread hearing loss problem caused by earphones among work from home workers.

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