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OCCUPATIONAL NOISE EXPOSURE AND NOISE-INDUCED HEARING LOSS AMONG ARMY PERSONNEL AT FIRING RANGE IN BUKIT JUGRA, SELANGOR

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BY

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ABSTRACT

OCCUPATIONAL NOISE EXPOSURE AND NOISE INDUCED HEARING LOSS AMONG ARMY PERSONNEL AT FIRING RANGE IN BUKIT JUGRA, SELANGOR

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Introduction: Noise is considered as one of the occupational risk factors which could lead to serious problem in every workplace. Hearing loss and tinnitus prevalence of military population is higher than in public **Objective:** To determine the effect of noise exposure level in firing range towards noise induced hearing loss among personnel in Malaysia. **Methodology:** A cross sectional study were carried out which is designed to ascertain the risk factors and the outcome of interest at Bukit Jugra Firing Range. The study population for this study were 80 male military personnel from different ethnic groups which is employed in different work sector throughout the military camp. The study were using questionnaire for socio demographic assessment, sound level meter for area noise survey, dosimeter for personal noise survey measurement and audiometric threshold test. **Results and discussion:**. A total of 72(90%) claimed that the working environment that they work on daily basis are exposed to high level of noise exposure in which only 30(37.5) use protection devices. The worker experienced hearing problem in which 26(32.5%) claimed that they have tinnitus. The Time Weighted Average (TWA) for area noise survey was at 89.3(+-1.7) dBA. The personal noise measurement that were recorded for the time period was at 90.2(+-1.5) dBA in which the peak(Lcpeak) reading for the shooting period was at 144(+-0.2). The prevalence for hearing loss was at 18.8% in which 15 persons of them have change in threshold level >25dBA. Most of them 12(15%) have hearing loss at 4000Hz for left ear. **Conclusion:** This study shows that noise exposure and duration of employment in the army is one of the risk factors that results in hearing loss. This can be seen whereby most of the military personnel that have hearing threshold >25dBA are exposed to loud noise and employed for longer duration of years. It is recommended that the workers are given proper instruction and training in the usage of Hearing Protection Devices.

Keywords: Noise, Noise-Induced Hearing Loss, Military, Hearing Threshold, Hearing Protection Devices

ABSTRAK

PENDEDAHAN BUNYI PEKERJAAN DAN BUNYI AKIBAT KEHILANGAN PENDENGARAN DALAM KALANGAN ANGGOTA TENTERA DI TEMPAT TEMBAK DI BUKIT JUGRA, SELANGOR

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Pengenalan: Bunyi bising dianggap sebagai salah satu faktor risiko pekerjaan yang boleh membawa kepada masalah serius di setiap tempat kerja. Kehilangan pendengaran dan prevalens tinnitus populasi tentera adalah lebih tinggi daripada orang awam **Objektif:** Untuk menentukan kesan tahap pendedahan bunyi dalam jarak tembakan terhadap kehilangan pendengaran akibat hingar di kalangan kakitangan di Malaysia.**Metodologi:** Kajian keratan rentas telah dijalankan yang direka bentuk untuk memastikan faktor risiko dan hasil kepentingan di Lapang Tembak Bukit Jugra. Populasi kajian bagi kajian ini adalah peribadi tentera lelaki sepenuh masa daripada kumpulan etnik yang berbeza yang bekerja di sektor kerja yang berbeza di seluruh kem tentera. Kajian ini menilai latar belakang sosio demografi, tinjauan hingar kawasan, pengukuran tinjauan hingar peribadi dan ujian ambang audiometri.**Keputusan dan Perbincangan:** Sebanyak 72(90%) mendakwa bahawa persekitaran kerja yang mereka bekerja setiap hari terdedah kepada tahap pendedahan hingar yang tinggi di mana hanya 30(37.5) menggunakan peranti perlindungan. Pekerja tersebut mengalami masalah pendengaran di mana 26(32.5%) mendakwa mereka mengalami tinnitus. Purata Wajaran Masa (TWA) untuk tinjauan hingar kawasan adalah pada 89.3(+-1.7) dBA. Pengukuran hingar peribadi yang direkodkan untuk tempoh masa adalah pada 90.2(+-1.5) dBA di mana bacaan puncak(Lcpeak) untuk tempoh penangkapan adalah pada 144(+-0.2). Kelaziman kehilangan pendengaran adalah pada 18.8% di mana 15 orang daripada mereka mengalami perubahan dalam tahap ambang >25dBA. Kebanyakan mereka 12(15%) mengalami kehilangan pendengaran pada 4000Hz untuk telinga kiri. **Kesimpulan:** Kajian ini menunjukkan pendedahan bunyi bising dan tempoh bekerja dalam tentera merupakan salah satu faktor risiko yang mengakibatkan kehilangan pendengaran. Ini dapat dilihat di mana kebanyakan anggota tentera yang mempunyai ambang pendengaran >25dBA terdedah kepada bunyi yang kuat dan bekerja untuk tempoh yang lebih lama. Adalah disyorkan bahawa pekerja diberi arahan dan latihan yang betul dalam penggunaan Alat Bantu Pendengaran.

Kata kunci: Bunyi Bising, Hilang Pendengaran, Tentera Ambang Pendengaran, Alat Bantu Pendengaran

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LIST OF ABBREVATIONS

NIHL	Noise Induced Hearing Loss
NITS	Noise Induced Threshold Shift
TTS	Temporary Threshold Shift
PTS	Permanent Threshold Shift
STS	Standard Threshold Shift
dBA	A weighted Decibel
dBC	C weighted Decibel
OSHA	Occupational Safety And Health
PEL	Permissible Exposure Limit
HI	Hearing Impairment
HL	Hearing Loss
HZ	Hertz
TWA	Time Weighted Average
WHO	World Health Organization
DOSH	Department of Occupational Safety And Health
NIOSH	National Institute of Safety and Health
HPD	Hearing Protection Devices
PPE	Personal Protective Equipment
PTA	Pure Tone Audiometry
ASHA	American Speech Language Hearing Association
CHMS	Canadian Health Measure Survey

CHAPTER 1

INTRODUCTION

1.0 Introduction

Sound is a form of energy generated through vibration which can be characterized by their intensity and frequencies. Sound is classified as wanted and unwanted sound in which the unwanted sound is considered noise. Various level of sound can cause serious health effects to people (Chepesiuk, 2005). Noise is considered as one of the occupational risk factors which could lead to serious problem in every workplace. In the occupational settings, the machines, transportation, gun fire, and other could causes problems in hearing which in turn could lead to serious problem. Excessive exposure to noise level or longer duration could causes damages to hair cells of cochlea which could causes Noise-Induced Hearing Loss (Zaw et al., 2020).

Measurements of a person's hearing sensitivity is basically described as pure-tone threshold audiometry at specific audiometric frequencies of 500, 1000, 2000, 3000, 4000 and 6000 Hz. The threshold of hearing is assigned at 0 dBA which corresponds to the intensity of 10^{-12} W/m2. The increase in threshold of hearing with the intensity level with the presence of noise exposure is called Noise-Induced Threshold Shift (NITS). If by chance the threshold shift returns to pre-exposure level, it called Temporary Threshold Shift (TTS). If it doesn't return to pre-exposure level of threshold, it is then called Permanent Threshold Shift (PTS). The National Institute of Occupational Safety and Health (NIOSH) suggested the Standard Threshold Shift (STS) as an increase of 15 dB in hearing threshold level at 500, 1000, 2000, 3000, 4000 and 6000 Hz in both ear which is determined by two consecutive audiometric

tests. When there is shift in STS which is 10dB or greater change from the STS level at different frequencies with the presence of sound exposure it would lead to decrease in hearing which is called Noise Induced Hearing Loss. The hearing loss caused by threshold shift could in turn lead to degraded ability to differentiate sound in noisy environments (Ryan et al., 2016)

According to World Health Organization in 2021 states that by 2050 about 10% of people over 700 million people would experience hearing loss disability. Although, hearing ability would deteriorate by age, there are also a few risks factor that would lead to hearing loss. There are also medical conditions that are linked with hearing loss such as diabetes, stroke, brain injury and high blood pressure but their effects were strongly shadowed by the age. However, hearing loss can be treated if it is addressed earlier to avoid irreversible damage from threshold shift (Lin et al., 2011).

Based on Occupational Safety and Health Act 1994 (OSHA 1994), people working on merchant ships and armed forces are not covered. People that are working in armed forces as stated in the Armed Forces Act 1972 which included regular forces or volunteer forces are exempted to be covered under OSHA 1994. According to OSHA 1994 under the Noise Regulation 2019 the permissible exposure level (PEL) at 85dbA in which if the exposure level of the worker exceeded that, the employer needs to carry out engineering control or provide personal protective equipment to reduce the noise exposure that the worker is exposed.

In the army camp, the military personnel experience impulsive loud sound exposure due to the usage of firearm usage and explosion. Every armed force would have been to firing range for firing practices in which they would expose to impulsive noise for a short period of time which could causes threshold shift either temporary or permanent. According to Yong & Wang (2015), hearing loss and tinnitus prevalence

of military population is higher than in public. Every army personnel whether it be soldier, sailor, airman or marine had experience hazardous noise exposure at some point in their career. Within the infantry, weapons emit a loud noise level which could in turn cause threshold shift that would lead to NIHL. But there is lack of information available to determine the prevalence of hearing loss among army personnel in Malaysia.

The armed forces are exempted from the OSHA 1994 which results in little to no protective measures that were provided to the armed forces as there is lack of research to help distribute the findings among army personnel to practice protective measures to reduce the risk of NIHL. This leads to fundamental of why this research need to be carried out to distribute findings to army personnel on the risk of NIHL and to distribute findings to help them have proper protective measure while carrying out their duty.

1.2 Problem Statement

Hearing is the most fundamental and important element for every person due to the need for communication with other person, hearing sound that is important and also to stay oriented with the surroundings. Noise had become one of the important workplace hazards due to invention of new machines and engineering processes that emit sounds. Due to the excessive noise exposure in the workplace, hearing loss has become of the major workplace injury. About 22 million of workers in the United States are estimated to be exposed to dangerous noise level at their workplace (CDC. 2013). A hearing conservation program should be implemented by employers as suggested by OSHA when noise exposure level at that workplace exceed or at 85dB averaged over 8

working hours but most of the workplace exceed 85db. As an example, about 66.4% workers in the Textile Mill in Myanmar were exposed to >85dB of noise exposure in which the hearing loss prevalence was at 25.7% (Zaw et al., 2020).

In Malaysia, occupational noise-induced hearing disorders (which include NIHL, hearing impairment and Permanent Standard Threshold Shift) was the highest reported occupational disease compared to other diseases in the year 2016 with 2876 cases (74.5%) (DOSH, 2017). Many factors have been suggested contributing to the NIHL such as age, smoking, gender, race, individual susceptibility, sound pressure level or noise intensity, the duration of noise, daily exposure period, total exposure period, existence of ear disease, working conditions, distance to noise source, direction of sound waves and the position of the ears and poor usage of hearing protection devices (Cruickshanks et al., 2003). A total of 220 workers were eligible, and 181 (response rate of 82.3%) took part in the study. All the subjects were males. Noise exposure was measured at 86.9 dB(A) for 8-hour time-weighted average. On average the workers were exposed to noise for 67.3 minutes per day. The prevalence of NIHL among the worker was 26.7%. Based on the World Health Organization grading for hearing loss, 20 (41.6%) workers had mild hearing loss (25-40 dB), 2 (4.2%) had moderate hearing loss (41-60 dB), and 1 (2.1%) had severe hearing loss, calculated based on their hearing levels at 0.5, 1, 2, and 3 KHz. Twenty-five (52.1%) of the workers had no hearing loss, neither did anyone have profound hearing loss. (Masilamani et al., 2012)

Personnel in the army camp are usually exposed to high level of noise exposure due to the noise generated by machines, firearm, explosives, and military vehicle. The noise that was generated could be as form of machinery noise, the impact of explosion, the firing of the gun and the noise generated by vehicle engine. To be precise, the source of noise could be from the vibrations of motor, exhaust sound and chemical reaction

of explosives. Weapons that were used in firing range emits noise from the process of gun fire in which propelled the bullet out of the gun barrel in which different weapons have different complexity of weapons and different level of noise that were emitted.

Sources of impulse noise include firing weapons or artillery, as well as detonation of explosive devices. A study conducted in Finland reported that combat and firing exercises can reach peak noise levels of 180 dB, (Paakkonen & Lehtomaki, 2005) and researchers at the US National Institute for Occupational Safety and Health have stated that, "firing a weapon poses a significant risk of noise-induced hearing loss, if hearing protection is not worn". (Murphy et al., 2011)

Army personnel would practice in firing range in which they would practice by using different types of guns either 9mm Pistol or 5.56 M4 Carbine. The different kind of firearms that were used is the small arms and big arms and the different kinds of arms that were used emit different level of noise level. During a firing practice about 10-12 army personnel would shoot side by side with a few meters apart in a firing range in which they would shoot continuously for 5-10 minutes. The process of the firing exercises is according to number of bullets that they have in which they would shoot to a marker that were placed on a hill with no personal protective equipment being worn throughout the practice. The army personnel are exposed to impulsive noise exposure for a short period of time with no personal protective equipment which in turn could damage their hearing.

When this pressure and shockwaves that were created is strong enough and within audible frequency spectrum, a sensation of hearing is produced. The sound waves that were created would then produce electrical impulse that were transmitted via the auditory nerve to the cerebral cortex. The sound transducers in our inner ear are hair cells. The hair cells may be severely damaged when hair cells are overstrained with

sound. When there is cellular overstimulation causes a type of temporary and reversible damage which is known as TTS as the cells stop functioning normally for a while. But after 16-48 hours, the cells will generally recover if the condition is right, and the damage is not too severe. If the hair cells cannot recover after certain period, the damage is permanent which is known as PTS and producing NIHL.

When the hearing is impaired significantly until the level of speech and communication is affected, the social interaction, employment, recreational activities, and other activities could be seriously affected due to hearing loss. Permanent hearing loss also associated with psychosocial, physical problem and in serious issue it can lead to loss of employment, social isolation, and depression. Although rehabilitation steps were taken, this symptom would persist. Thus, workers should not experience hearing loss due to workplace exposure, but it is not possible to determine whether the worker NIHL is due to occupational noise alone. It is due to the level of threshold shift among workers is greatly affected by individual difference and all workers are not exposed equally. However, the percentage of population with NIHL highly depends on the level and duration of exposure. The higher the noise levels and duration of noise exposure, the higher percentage of worker exposed to the noise may develop NIHL.

This can be seen in tobacco, textile, wearing apparel, paper, refined petroleum, sheet glass and fabricated metal factories whereby about 70% of the factories were exposed to noise level at 86-90dBA while in wooden pallet and automotive industries were exposed at 91—140 dBA. (Tahir et al., 2014). A total of 4612 (40%) people working in noisy environment more than action level in which of this, 8% out of 4612 people working in the noisy environment were diagnosed as NIHL cases in which it affected more male workers (89%) than female (11%). (Tahir et al., 2014)

However, to the best of author knowledge the study on noise exposure level of army personnel in Malaysia is still low and this leads to low level of awareness of preventing work related noise-induced hearing loss among army personnel in Malaysia. Therefore, it is important to carry out to research to determine the noise exposure level and the prevalence of noise-induced hearing loss among army personnel in Malaysia.

1.3 Study Justification.

This research studies the noise exposure and the prevalence of noise induced hearing loss at firing range among army personnel. Although, high level of noise exposure is well associated with serious adverse health effects, but we find it important to address the disadvantages of dangerous noise exposure in workplace. The serious health effects that arise from noise exposure is NIHL which is irreversible ear damage that defects hearing mechanism of the inner ear. NIHL usually involves with frequency ranges and interferes with spoken communication. The effects of NIHL varies from social isolation to serious economic burden.

Usually, people do not notice hearing loss until it is impaired significantly. Thus, it is importance to detect hearing loss as early as possible to promise better prognosis of the damage. Therefore, it is also important that more research is being carried out to study the significant impact of noise level in various workplace sector and to extent of to which hearing is impaired. The result that was obtained from the research that has been carried out can be utilized to evaluate the effectiveness of hearing conservation programme that are existing and to detect signs of hearing loss among workers to preserve workers hearing ability.

Apart from that, the noise exposure and noise-induced hearing loss among army personnel are usually neglected which can be seen through lack in numbers of studies being carried to address the army personnel in Malaysia in which this led to the importance of this study being carried out.

Last but not least, since army not covered under OSHA 1994, so it is important to conduct this study to identify pattern of NIHL cases and their impact to army personnel in which this data would help future research or future stakeholder reference.

1.4 Research Question

1. What are the sociodemographic and lifestyle factors of the respondents that contribute to hearing loss?
2. What is the prevalence of hearing loss among army personnel in Malaysia?
3. What is mean hearing threshold level that correlate with noise exposure level in firing range among army personnel?
4. What is the difference prevalence of hearing threshold between left and right ear of the respondents at all frequencies?
5. To determine the factor(s) that correlate with the prevalence of hearing loss among respondents after confounders are controlled?

1.5 Research objectives

1.5.1 General objectives

To determine the effect of noise exposure level in firing range towards noise induced hearing loss among army personnel in Malaysia.

1.5.2 Specific objectives

The objectives of this research paper are:

I. To determine sociodemographic and lifestyle factors of the respondents that contribute to hearing loss.
II. To determine the prevalence of hearing loss among respondents
III. To compare prevalence of hearing threshold between left and right ear of the respondents at all frequencies
IV. To determine the correlation between the mean hearing threshold level and noise exposure among respondents.
V. To determine the factor(s) that correlate with the prevalence of hearing loss among respondents after confounders are controlled.

1.6 Study hypothesis

I. There is significant correlation between sociodemographic and lifestyle risk factor with hearing loss among army personnel.

II. There is a significant difference in hearing threshold shift in left and right ear of army personnel at all frequencies.

III. There is significant correlation between mean hearing threshold level and noise exposure among army personnel.

1.7 Defining variables

1.7.1 Conceptual definition

1. Noise

   Noise is defined as unwanted sound and nuisance which in turn results in disturbance of normal functioning and loss of life enjoyment, loss of sleep and fatigues. (Fink, 2019)

2. Hearing threshold level

   A sound or tone which can be heard in intensity level at specific frequencies (Staff, 2014)

3. Hearing threshold shift

   An increase in hearing threshold for a particular sound frequency (Ryan et al., 2016)

4. Hearing loss

   Loss of sound sensitivity at partial or total which is produced by the abnormality or damages anywhere in the auditory pathway (Ryan et al., 2016)

1.7.2 Operational definition

1. Noise

   Sound level of above or as same as 85dB(A) in personal noise measurement measured using noise dosimeter at certain position which is most closely approximates with the noise levels at the head position of the army personnel during working hours.

2. Hearing threshold level

   The lowest level at which responses occur in at least half of the ascents with a minimal three responses required at a single level.

3. Hearing loss

   Hearing threshold of an individual which is shifted by 25dB or more at frequencies of 0.5k, 1k, 2k, 3k, 4k and 6k Hz compared to the standard audiometric reference level.

1.8 Conceptual framework

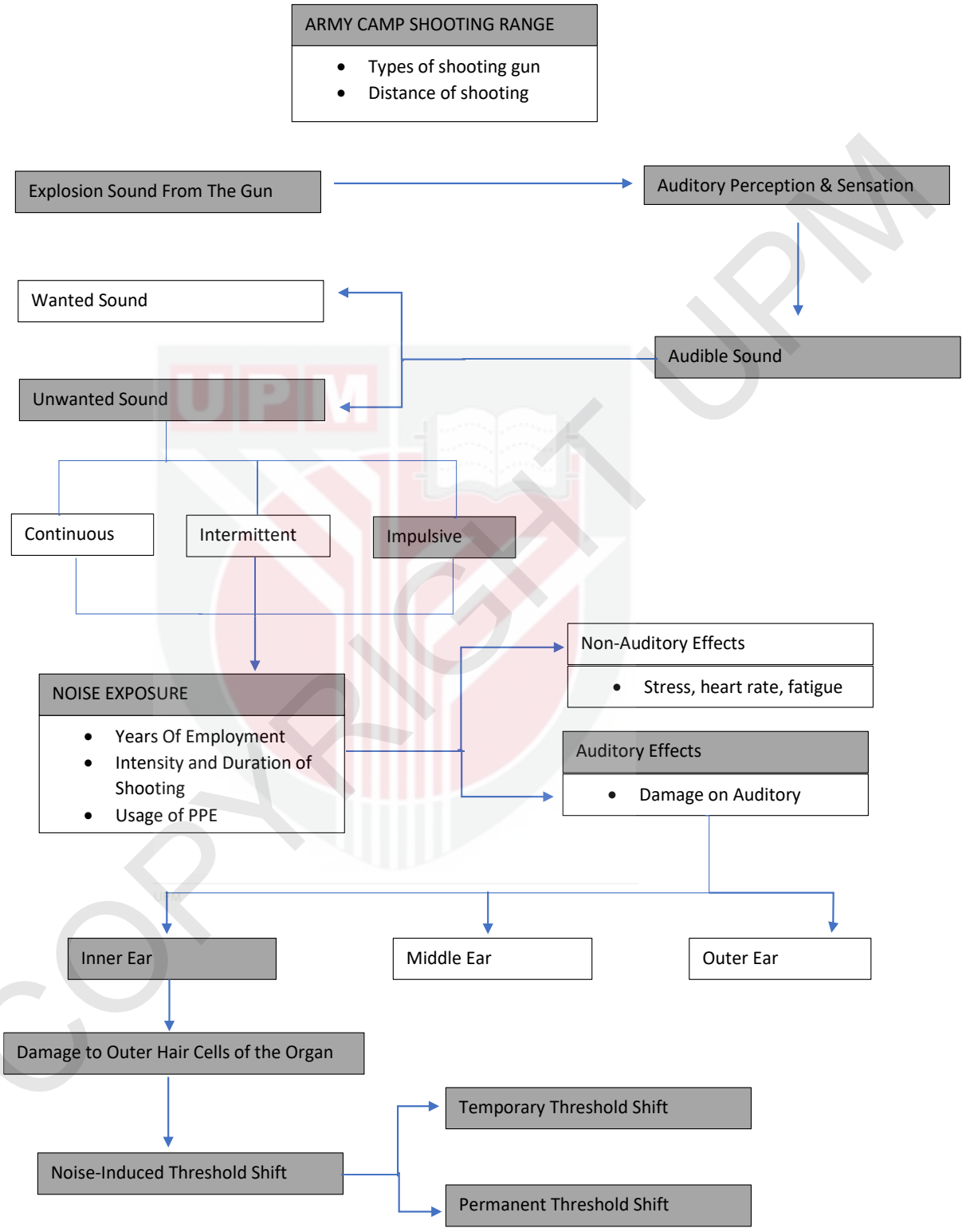

Figure 1.8

1.9 Research flowchart

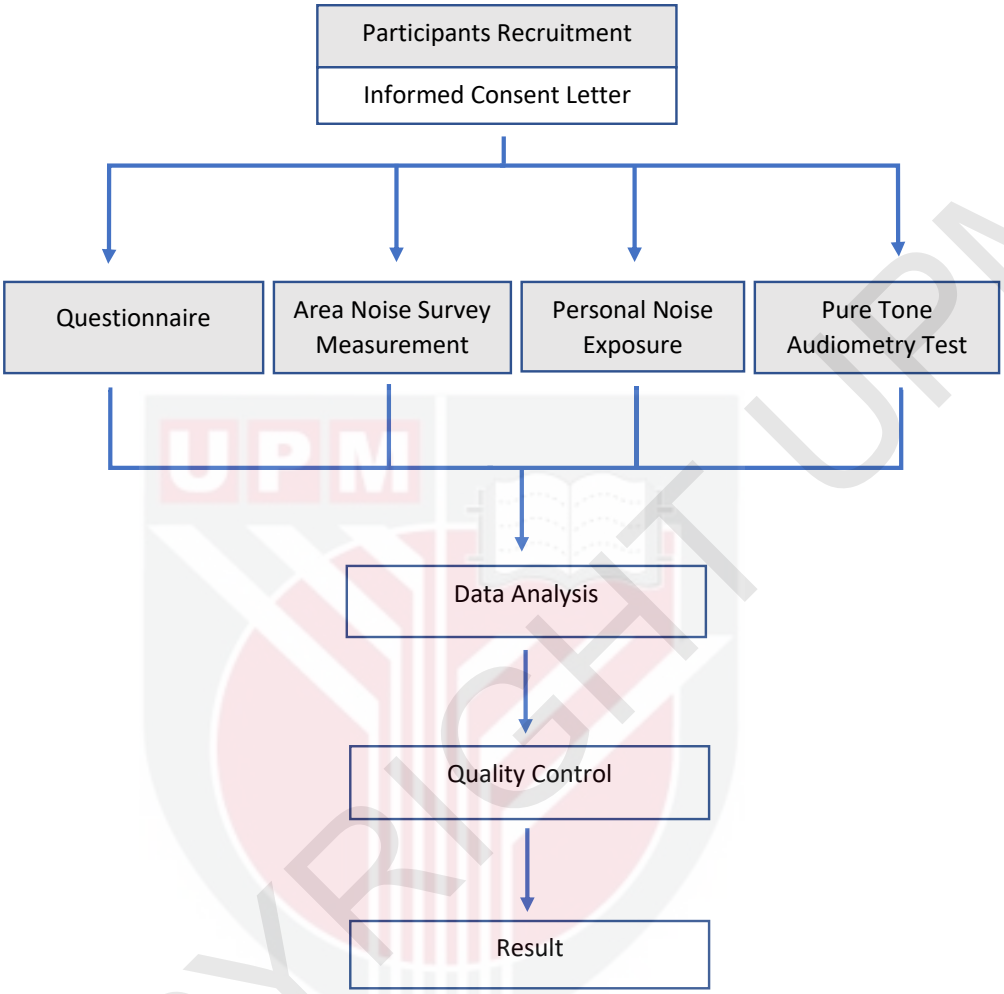

Figure 1.9

CHAPTER 2

LITERATURE REVIEW

2.1 Anatomy and physiology of human ear.

The human ear is divided into three parts which is the outer ear, middle ear and inner ear which have different characteristic and functions. The outer ear consists of the visible portion called auricle or pinna which can be seen from the side of the head. Then, the tube that connects the outer ear to the inside or middle ear is called external auditory canal and the tympanic membraned (eardrum) that divides the external ear from the middle ear. The middle ear (tympanic cavity) consists of ossicles which three tiny bones(malleus/incus/stapes) that are interconnected to help in transmitting sound waves to the inner ear. Then, the middle ear also consists of eustachian tube which is a canal that links the back of the nose with middle ear in which it helps stabilizing pressure in the middle ear. Stabilized pressure is important to ensure proper transfer of sound waves. Finally, the inner ear consists of cochlea which haves the nerves for hearing, vestibule which contains receptors needed for balance and semi-circular canals which also contains the receptors for balance (Sánchez & Savita Lasrado, 2021).

The outer ear of human ear is lined with hairy skin which contains sweat glands and oily sebaceous glands which acts together and form ear wax which serves as protective barrier and disinfectant. The ear canal has a slight bend where the outer cartilaginous part joins with the bony thin skinned inner part which acts as protective mechanisms of ear and bringing foreign objects to a halt from reaching the tympanic membrane (W. Alberti, n.d.) The middle ear transmits sounds from tympanic membrane to inner

ear. The outer part of the middle ear is tympanic membrane while the inner wall of the middle ear is cochlea. The thin tube in middle ear which is called the Eustachian tube is bony when it leaves the ear but when it reaches the nasopharynx, it consists of cartilage and muscle (W. Alberti, n.d.).

The inner ear has the bony cochlea which houses the hearing organ which is called the membranous labyrinth which is surrounded by fluid and called perilymph. The cochlea has a volume of 0.2 of a millilitre in which this space lies about 30000 hair cells which transduce vibrations into nerve impulses and about 19000 nerve fibres which transmits it to brain. In summary, the ear consists of sound conducting mechanism and sound transducing mechanism in which the sound conducting mechanisms consist of two parts which is the outer ear and middle ear while inner ear is sound transducing part (W. Alberti, n.d.).

The outer and middle ear serve to amplify the signal of the sound. The pinna of the outer ear presents large surface area and funnels sound to the smaller tympanic membrane in which the tympanic membrane surface area is larger than stapes of foot plate in which there is a hydraulic amplification. Moreover, the ossicular chain is a lever system which amplifies the sound. Thus, middle, and inner ear from the exterior and to interior, it amplifies the sound on it passage by about 30dB (W. Alberti, n.d.).

The inner ear functions as transducers of vibration into nerve impulses. In doing so, it also analyses the frequency and intensity of the sound. Sound level information is conveyed to brain by the rate of nerve firing which is at 200 times per second. They can also fire up acoustic signal in locked phase up to about 5kHz. Group of nerve fibres firing in locked phase with an acoustic signal convey information about frequency to the brain when the frequency is lower 5kHz. Above 5kHz, information that is conveyed to the brain is based on the place of stimulation on basilar membrane.

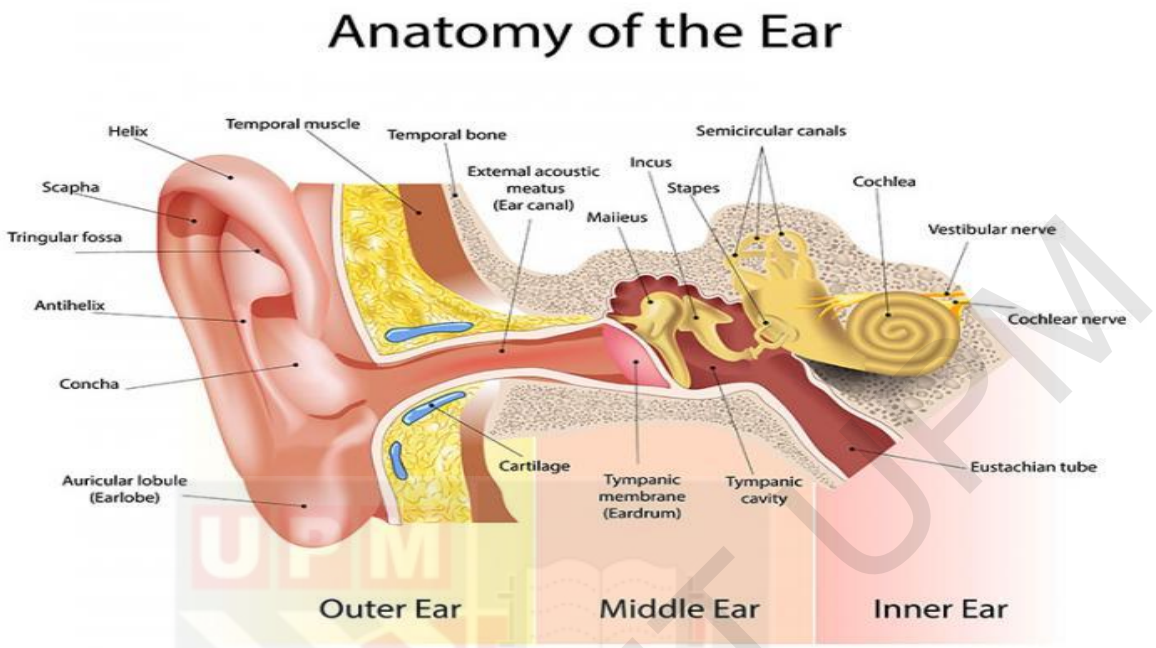

Figure 2.1 Anatomy of the Right Ear: Cross-Section Medical Illustration, Human Anatomy Drawing. This drawing depicts the outer, middle, and inner ear.

(Source: Ear Anatomy and Hearing Loss - Beltone Tristate. (2019, May 2). Beltone Tristate. https://beltonetristate.com/ear-anatomy-and-hearing-loss/)

2.2 Characteristic of noise and decibel scale

Noise is considered as unwanted sound that are too loud and irritating which it sources can varies from a loudspeaker, vehicle engine, machinery motor and others. The important characteristic of sound or noise is frequency and loudness. When sound travels through a medium which is air the atmospheric pressure differs periodically in which the number of pressure differences per second is the sound frequency which is usually measured in Hertz (Hz). The higher the frequency of the sound is produced, the higher the pitch is perceived from the sound. The human ear response to sound is dependent on the sound frequency (Canadian Centre for Occupational Health and Safety, 2019).

Another property of noise is loudness. Larger pressure variation is usually for loud noise while weak noise has a smaller pressure variation. The variation in pressure and pressure usually measure in Pascal (Pa) but to express sound in Pa is hard because it can vary from number as small as 20 until as big as 2000000 Pa, so the loudness commonly expressed in terms of decibel(dB) (Canadian Centre for Occupational Health and Safety, 2019).

Human ear response to sound is dependant to frequency of the sound that is emitted which lead to weighting scale. In the weighting scale, the sound pressure for lower and high frequency sound usually reduced by certain amounts before they are combined together to give one single sound pressure level which is usually designated as dB(A) (Canadian Centre for Occupational Health and Safety, 2019). It is used because it reflects more accurately the frequency response of human ear. Soft noise has low dB or dB(A) value and loud noise has a high one.

In order for a person to hear a sound, the sound has to be above certain level which is called the auditory threshold or the hearing threshold (Hearing loss and deafness: Normal hearing and impaired hearing, 2017). The hearing threshold of human is 0dB which means that sound with higher pressure levels are loud noises. If people are exposed to sound above 90dB all the time can lead them to chronic hearing damage and sound above 110dB, the hearing would become uncomfortable and when it is above 130dB it becomes painful.

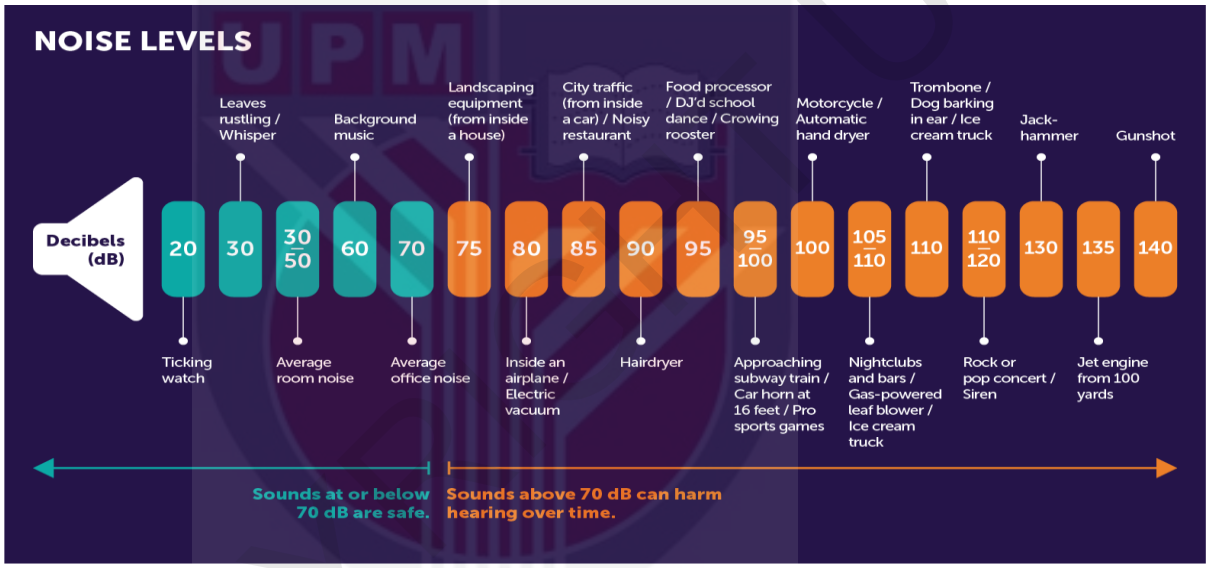

Figure 2.2 depicts the decibel scale of sound

(Source: Keep. (2014). Hearing Health Foundation. Hearing Health Foundation. https://hearinghealthfoundation.org/keeplistening/decibels)

2.3 Types and causes of hearing loss

Hearing loss is an injury that affects people with any ages which have many varieties of factor. There are supposedly four categories of hearing loss which are sensorineural hearing loss, conductive hearing loss, mixed hearing loss and auditory neuropathy spectrum disorder (CDC, 2021). These four different categories have different places and severity of its injury. Sensorineural hearing loss usually occurs when the hearing nerve inside the inner ear becomes damaged whereby this kind of hearing loss usually occurs when some of the hair cells are damaged within the cochlea (Tanna et al., 2021). Patients with sensorineural hearing loss have a lack of sensitivity towards sound or clarity of sound which would causes difficulties in speech understanding when there is sound or noise at the background. They usually have better hearing sensitivity for low toned sound compared with high pitched sounds. It is one of a common hearing loss that could be results of aging, exposure to loud noise, injury that affects hearing parts, disease or infection that infects the hearing, certain drugs and genetic. Sensorineural hearing loss are usually irreversible. Thus, it can't be treated medically or surgically but they can still use hearing aids to help with hearing. There are also some cases of sudden sensorineural hearing loss which usually occurs out of sudden or in a course of a few days. It is important to pay a visit to ear doctor as soon as possible because any delay in the seek of medical diagnostic would significantly decrease the chance in improving the problem with the help of medications and treatment.

The second categories for hearing loss are conductive hearing loss which it usually happens at the outer or middle part of the ear. As the word conductive suggest, this kind of hearing loss happens due to the sound waves are unable to be transmitted to

the inner ear. The sound waves that need to be transmitted to inner ear might be blocked by earwax or foreign materials that houses the ear canal (Thushanth Sooriyamoorthy & Orlando De Jesus, 2021). The space in middle ear could also somehow impacted by fluid that enters the ear, bacterial or virus infection that affects the ear canal or bone abnormality or it could also be due to eardrum being damaged (Thushanth Sooriyamoorthy & Orlando De Jesus, 2021). However, conductive hearing loss is better compared with sensorineural hearing loss because conductive hearing loss usually reversible with the intervention from medical or surgical. Usually, children are the one that effected with the conductive hearing loss because they might have recurrent ear infections, or they insert foreign material inside their ear canal.

Next, mixed hearing loss. As the word suggest, the mixed hearing loss have the synergistic effect from the two types of hearing loss that are mentioned earlier which is conductive hearing loss and sensorineural hearing loss. It can happen when the patients already have sensorineural hearing loss, but they mistakenly push the earwax inside their ear, or some foreign material entered their ear which in turn could causes conductive hearing loss (American Speech-Language Association, 2022). Thus, hearing test is critical for everyone have problems with hearing to identify what kind of hearing loss that a person have. This in turn would help to determine which health care solution are the best for their hearing. The last categories which is neuropathy spectrum disorder in which the sound isn't organized when it reached the brain when even though the sound enter the ear normally (CDC, 2021).

Hearing loss among people above 50 years old are common because they usually experience hearing loss gradually over the course of years in their ear or auditory nerve due to age-related changes. The term for age related hearing loss is called presbycusis which causes a person can't tolerate with loud noise or hearing what other person says. Other factors that usually causes hearing loss among adults are loud noises that happens at the workplace or social life, genetic factors, injury to head, infection that affects the ear or auditory nerve, illness such as swimmers' ear and problems that relates with blood circulation such as high blood pressure.

Most adult usually had their ear or hearing tested when they are still in school, so it is important to conduct a more recent hearing test to become our baseline test. This baseline test would help audiologist a lot to compare current hearing with the baseline and assess the severity of hearing loss that adults have. It is important as it would help in treating the hearing loss appropriately.

2.4 Prevalence and incidence of noise-induced hearing loss

Noise exposure at workplace has been one of the most important health problems worldwide which is usually called occupational noise induced hearing loss (Noise-Induced Hearing Loss, 2019). Occupational noise exposure doesn't usually relate with mortality cases but usually classified as morbidity through deafness. It usually considered as one of the occupational injuries. It is estimated that about 1.3 billion people suffered from hearing loss worldwide in which 16% of the cases are the sole result from occupational noise exposure. (Chen et al., 2020) Thus, it shows that occupational noise induced hearing loss causes in disability. There are four grades of hearing loss that were classified by WHO which slight(20-40dB), moderate(41-60dB),

severe (61-80) and profound (81dB or greater). For an 8h time weighted average (TWA), the permissible exposure limit (PEL) that is stated by OSHA for occupational noise exposure is 90dB.

The 30-59 years age groups are usually at high risk when exposed toward occupational noise exposure. In Malaysia, there have been 1047 cases of NIHL that has been reported in the course of 2012-2014. Majority of occupational noise induced hearing loss comes from operators ate 23%, supervisor at 22%, mechanic at 16%, technician at 11% and general workers at 4% (Mazlan et al., 2018). From the data, it shows that machine operators have high prevalence of NIHL which also signifies that they are exposed to loud noise from machines for greater period of time.

In Malaysia, occupational noise-induced hearing disorders (which include NIHL, hearing impairment and Permanent Standard Threshold Shift) was the highest reported occupational disease compared to other diseases in the year 2016 with 2876 cases (74.5%) (DOSH, 2017). Based on a study, the prevalence of hearing loss and hearing impairment stood at 73.3% and 23.3% respectively in which the comparison between gender showed that male workers had higher prevalence than female workers for hearing loss where male had 63.0% and female at 36.4% (Hisam and Anua, 2018). This shows that male have higher possibility to have hearing loss depending on the risk factor that could accompany the loud noise exposure. The other possible reason for greater hearing loss among males can be due to greater noise exposures in workplace which could be because men operate machines that emits loud sound. It could also be due to genetic of the males for hearing loss or certain drugs that affects the cochlear response towards noise. Apart from that, age of the respondents that were included in the study were also controlled below 65 years to avoid presbycusis (Hisam and Anua,2018). This is controlled to avoid age related hearing loss that usually

deteriorates by age. Finally, duration of employment also plays a major role whereby prevalence of bilateral and unilateral hearing loss of workers varies with duration. Worker with 0-10 years of working have 68.5% prevalence compared to 11-20 years with 81.8% and 21-30 years at 81% (Hisam and Anua, 2018). This shows that the prevalence of hearing loss correlates with duration of exposure. The higher the duration of exposure, the higher the prevalence for hearing loss.

NIHL is one of the most common workplace injuries in manufacturing industry because this industry has a lot of machineries that emits loud noise exceeding 85dB for a prolonged period, but other sector also could have the same exact exposure to hearing loss such as soldier when they fire a gun in firing training. In military, hearing plays major roles in terms of commands understanding and communication. It is also important to stay aware with surrounding during war. Among 263 respondents of technicians at Royal Military Airforce Malaysia about 119 of the respondents which is at 45.2% have hearing loss with a threshold of >25dB(A) at all frequency, while 24.3% were analysed to have NIHL and 7.6% were having hearing impairment (Zamri, M.D. et al, 2017). This shows that aircraft technician also experiences hearing loss which means that not only machine operators are exposed to loud noise level. This shows that, sound level that are emitted by aircraft were higher than recommended exposure level. Fighter planes noise level usually varies form 97-104 dBA and in jet trainers, the sound level were at 100-106 dBA (Kuronan, P. et al, 2004).

Pure tone audiometry test is a test carried out to test hearing sensitivity. It is assessed using air conduction method in which the examiner would determine the magnitude of hearing loss of the patients' hearing deviates from the normal hearing level which is at 0dB. The hearing sensitivity is assessed at octave frequencies between 250 and 8000Hz. Pure tone air conduction testing provides magnitude of hearing loss indicator

and the configuration of hearing loss as a function of hearing frequency (Saunders et al., 2021). Other than bone conduction hearing test is also carried out to distinguish sensorineural hearing loss and conductive hearing loss which utilized comparative measures of bone and air conduction. They have similar procedure for measuring except there are vibrotactile simulator which transduces the signal.

2.5 Hearing conservation and prevention

Despites noise induced hearing loss are usually irreversible, but the further progression of hearing loss would stop if the damaging noise level were discontinued. This is why an early detection using audiometric screening is important. But the education and prevention programme are also important to cultivate awareness about noise induced hearing loss and to reduce hearing loss injury. This intervention programme more important in workplace setting in which most of the noise induced hearing loss injury are prevalent due to loud noise during machine operation or other workplace noise exposure. Hearing conservation programme that were suggested by OSHA and NIOSH is generally comprises of all hazard protection strategy in which it includes engineering controls, personal hearing protection devices (HPD) and administrative scheduling to limit the duration spend in loud noise workplace and reduce the loud noise exposure.(Occupational Health and Safety Administration, 2002) Hearing loss has one of the most reliable predictors which is demonstrated by time percentage of hearing protection is worn and proper fitting of the protection.

In addition, hearing protection usually extends the limit of allowable exposures by reducing decibel level at the ear which in turn would allow the worker to experience a more intense and longer duration of exposures than without wearing hearing protection

(Reducing Noise Exposure: Personal Protective Equipment, 2022). However, poor compliance in use of HPD which is due to communication difficulties and comfort issues in wearing the HPD causes the failure of hearing conservation programme. Thus, the hearing conservation programme is significant in workplace to seek in increase of compliance and effectiveness of the hearing protection protocols through early and repeated intervention on hearing and hearing loss. Factors that associated with hearing loss should also addressed with the perception of individuals of vulnerability, the seriousness of the threat hat hearing loss possess and the benefits of participating in hearing conservation programme.

An effective hearing loss conservation programme consist a wide audits which is performed to determine the needs of work environment for the programme, the assessment of noise exposure in workplace, engineering and administrative controls of noise exposures, audiometric evaluation and monitoring of hearing, education and motivation, proper use of personal hearing protection devices, record keeping and evaluation of the programme effectiveness (Occupational Health and Safety Administration, 2002). There also should be adequate amount of programme needed for explanation of the normal auditory function, type and factors of hearing loss, dangers of excessive loud noise exposure, the NIHL warning signs and hearing loss prevention strategies.

2.6 Legislative requirements on noise exposure control

Factory and Machinery (Noise Exposure) Regulation 1989 had stipulated legislation requirements on occupational noise exposure in Malaysia in which Malaysia has adopted a permissible noise exposure (PEL) exposure limit at 90dBA with a 5dB trading relationship to control the excessive noise exposure in industry. A hearing

conservation programme is needed in the workplace setting when time weighted average (TWA) is set at 85dBA as an “action level” (United States Department of Labor, 2022). When employees that are involved in noise exposure above noise “action level”, they are needed to be included in hearing conservation programme which requires noise monitoring, audiometric testing, hearing protection, employee training and record keeping. A baseline audiogram is required to be taken within six months of the employees first exposure above the action level and subsequent audiograms are used to compared. Every employee that are exposed above the “action level” needs an annual audiogram testing and appropriate actions are needed to be taken by the employer according to the provision of law to response in the change of hearing sensitivity from the baseline audiogram to ensure continued protection of hearing of the employees.

2.7 Duty and Training of Army

Malaysia's Armed Forces or called as Angkatan Tentera Malaysia (ATM) protects country from internal and external threats. They serve in various situations such as helping civil authorities in addressing domestics threats, maintaining public security, providing aid following the onset of natural disasters, and assisting in national development programs. (Hays, 2013)

The Malaysian Armed Forces is comprised of three branches of service:

1. The Malaysian Army (RMA) safeguards the nation against land-based threats.
2. The Royal Malaysian Navy (RMN) protects Malaysia's coastlines, territorial waters, and economic zones from trespasser or illegal activity.
3. The Royal Malaysian Air Force (RMAF) maintains and operates a capability to project aerospace power to secure Malaysia's airspace and protect our country national interests.

The Malaysian Armed Forces serve as the country's security backbone, protecting it from any foreign danger via air, sea, or land. There are two sorts of military personnel in the Malaysian Armed Forces: officers and other ranks. The Seri Paduka Baginda Yang Di-Pertuan Agong commissioned the officers. Cadet officers, graduate officers, cadets who graduated from the Malaysian Defence University, and professional duty officers were among those commissioned into the crafts. Other ranks do not have commissions. Non-Commissioned Officers (NCOs) start at the rank of Corporal (or equivalent), and Senior Non-Commissioned Officers (SNCOs) start at the rank of Sergeant (or equivalent). Officers (SNCO)

In 2005, the army was thought to have 26 light tanks, 186 reconnaissance vehicles, 111 armoured personnel carriers, 130 105mm towed artillery, 34 155mm towed artillery, 232 81mm mortars, 18 multiple rocket launchers, 60 antitank guided weapons, 584 rocket launchers, 260 recoilless launchers, 60 air defence guns, 48 surface-to-air missiles, 9 helicopters, and 165 assault craft (Hays, 2013). Four frigates, 41 patrol and 24 coastal fighting vessels, four mine warfare vessels, one amphibious vessel, four support vessels, and six armed helicopters make up the navy. 73 combat aircraft, 59 fighter and ground attack aircraft, 19 reconnaissance aircraft, 35 transport aircraft, 40 transport and search-and-rescue helicopters, 3 reconnaissance unmanned aerial vehicles, 20 training aircraft, and 13 training helicopters are among the air force's arsenal (Hays, 2013). The air force also has air-to-air and air-to-surface missiles; however, the exact number is kept secret. France, New Zealand, Poland, Russia, and the United Kingdom have all provided Malaysia with military gear since the mid-1990s. Malaysia has British-built Lekiu-class frigates, which are Southeast Asia's most technologically advanced warships. Malaysia has bought three submarines from France and Spain, partly in order to stay up with Singapore, which possesses submarines as well. Malaysia has 18 MIG-29s, Russian fighters that look like F-16 fighter jets and have two powerful engines that allow them to take off almost vertically like a rocket. Pilots wear sight-and-shoot helmets that let them to launch laser-guided missiles beneath the wings simply by staring at an enemy target for two seconds (Hays, 2013).

2.8 Prevalence of Hearing Loss and Associated Risk Factor Among Army

There are few studies in foreign countries that study on the prevalence of hearing loss among army personnel and veterans. The studies and findings were distributed in the Table 1.

Table 2.8(a):Prevalence of Hearing Loss

Title	Prevalence
Prevalence of Hearing Disorders in Singapore Military Conscripts: A Role for Routine Audiometry Screening?	The prevalence of hearing loss of more than 25dB hearing threshold in either one or both ears is 36.7 per 1,000 in young adult Singapore males. All subjects with hearing loss were sensorineural in nature with no cases of conductive hearing loss detected. Of 30 subjects with slight to profound hearing loss, 19 (63.3%) were in the high frequency range, 7 (23.3%) in the low frequency range and 4 (13.4%) in both ranges (see Table I). Seventeen (56.7%) had unilateral slight to severe hearing loss, while 13 (43.3%) had bilateral hearing loss.
Hearing loss associated with US military combat deployment	According to the sub analysis, 1069 people who deployed and completed the 2007-2008 questionnaire acknowledged being close to a bomb, with 144 (13.5 percent) reporting new-onset hearing loss. Combat-related head trauma was

	reported by 54 deployers, with 21 (38.9%) reporting new-onset hearing loss. Participants who had had combat-related head injuries were six times more likely to develop new-onset hearing loss. Participants who had been exposed to a blast were also more than twice as likely to develop new-onset hearing loss.
Hearing impairment in military personnel in Eastern Saudi Arabia	The prevalence of hearing loss was significantly higher in patients aged 35–44 and 45–60 years, with 80.4% and 85.3%, respectively, compared to younger individuals aged 20–34 years, with a prevalence of 58.2%. Furthermore, participants with longer service lengths of 15–24 and 25–35 years had significantly greater rates of hearing loss at 85.1% and 75.0%, respectively, compared to 61.4% of those with shorter service durations of 1–14 years.
Noise-induced hearing injury and comorbidities among postdeployment U.S. Army soldiers: April 2003-June 2009	The number of significant hearing threshold changes (i.e., worsening of hearing thresholds from baseline tests) has been reported to have increased from 0.02% at the start of the conflict to 5.0% in 2009.

Table 2.8(b): Associated Risk Factor of Hearing Loss

Title	Associated Risk Factor
The Prevalence and Factors Associated with Hearing Impairment in the Korean Adults The 2010–2012 Korea National Health and Nutrition Examination Survey (Observational Study)	This study suggests that individuals with cardiovascular risk factors, such as smoking, hypertension, diabetes, increased total serum cholesterol, and decreased eGFR are particularly at risk of hearing impairment, and may benefit from hearing loss screening. These risk factors are exacerbated in groups like those of advanced age, low socioeconomic status, and/or occupational noise exposure.
Hearing Loss – Symptoms and causes	Aging, loud noise, heredity, occupational noises, recreational noises, medication, and illness are some of the risk factors.
Hearing Loss Among Military Personnel in Relation to Occupational and Leisure Noise Exposure and Usage of Personal Protective Equipment	In our analysis we found a statistically significant effect of being in a noisy environment, working with noise-producing equipment, riding in an armoured personnel carrier (PASI) or a tracked articulated all-terrain carrier (Bandvagn), and firing with blanks on the prevalence of HL. Respondents' previous health problems, music-listening habits, and exposure to loud noise in non-military environments were not independently associated with HL, but in several cases, they increased the RRRs together with military exposure.

Chapter 3

METHODOLOGY

3.1 Study design

A cross sectional study were carried out which is designed to ascertain the risk factors and the outcome of interest within given July 2022 to October 2022.

3.2 Study location

This study was carried out on a firing range located at Jugra Firing Range, Selangor whereby every army personnel would have annual firing training.

3.3 Sampling

3.3.1 Study population

The study population for this study were full time military personal from different ethnic groups which is employed in different work sector throughout the military camp.

3.3.2 Study sample

The study sample were selected from military personnel who is registered personnel of the Malaysian Military Force and employed in the military camp according to inclusion criteria.

i. Current registered personnel at the military camp for at least 1 month to ensure the exposure are due to noise
ii. 18-50 years old
iii. Male
iv. Operates in firing range training for at least 1 month
v. Have not been exposed to significant personal noise exposure in the last 12 hours.
vi. Have no medical history of ear infection, history of treatment with ototoxic medicine, and major ear operation or head injury.

3.3.3 Sampling frame

The personnel's name list that fulfils the inclusion criteria for this study were obtained from the Human Resources Management of the military camp. The lists that were given includes the full name, details of the personnel in the different sector of the military camp.

3.3.4 Sampling method

The sampling method that was employed for this study was simple random sampling. The personnel were chosen from all of the employed sector with exposure to noise in firing range until the required number of personnel needed for this study is reached. The personnel were selected based on the inclusion criteria.

3.3.5 Sample size

The sample size for this study was calculated based on Kirkwood (1998). The formula is given as below.

$$N = \frac{p(1-P)}{e^2}$$

Where,

N = Sample size

P = 26% (prevalence of hearing loss according to Morata et al. (1993) on workers exposed to noise

= 0.26

e = Standard error (0.05)

Therefore, the sample size is,

$$N = \frac{p(1-P)}{e^2}$$

$$= \frac{0.26(1-0.26)}{0.05^2}$$

$$= 76.96$$

The calculated sample size was increase by 5% margin to account for standard error, thus only 80 participants are needed for this study population.

3.4 Instruments and data collection

3.4.1 Questionnaire

A questionnaire was structured in Bahasa Melayu and English and adapted from (Amstutz,2010) to obtain comparable and quantifiable background information of the respondents based on employee recall in a semi structured interview. This questionnaire consists of four section which is personnel's personal information, workplace information, information about current health status and description of experience regarding perceived hearing handicap (Appendix 1).

3.4.2 Amplivox Model 260 Diagnotic Audiometer

This model offers air conduction, bone conduction and speech audiometry in which this audiometer were used to determine pure hearing threshold level of the respondents at test frequencies of 500,1000,2000,3000,4000 and 6000Hz. The pure tone that was produced by the audiometer is presented through TDH-39 type earphone and is equipped with a handheld response switch. Amplivox Model 260 Diagnostic Audiometer are as figure 3.4.2.

Figure 3.4.2

3.4.3 Control Room

A control room in which it is similar to sound attenuated audiometry booth station is used in the Pure Tone Audiometry Threshold level testing in the Kajang Army Camp. The control room were set up by the army and provided for the testing to be carried out.

3.4.4 Quest SoundPro Model SE/DL Sound Level Meter

A Quest SoundPro Model SE/DL Sound Level Meter was used to compute various noise descriptors for the measurement of noise level that the workers are exposed to in terms of equivalent continuous sound level (L_{Aeq}), max sound pressure level (L_{ASmax}) min sound pressure (L_{ASmin}) and peak sound pressure level (L_{Apk}). The Quest SoundPro Model SE/DL Sound level Meter are as figure 3.4.4.

Figure 3.4.4

3.4.5 CR: 110AIS doseBadge Personal Noise Dosemeter

CR: 110AIS doseBadge was used in conjunction with RC:110A reader unit to measure and record personal noise exposure in terms of the:

i. Average sound level over the measurement period (L_{avg} dBA)

ii. Equivalent continuous sound pressure level (L_{Aeq} dBA)

iii. Average of the measured L_{avg} over an eight-hour period (TWA dBA)

iv. A percentage of fixed dose value (% Dose)

v. Peak sound pressure level with "C" frequency weighting (L_{Cpeak} dBC)

CR: 110AIS doseBadge Personal Noise Dosemeter are as figure 3.4.5.

Figure 3.4.5

3.5 Data collection

Structured Questionnaire

i. The questionnaire was administered through online in which the respondents were briefed and given enough time to answer the question before audiometry testing were carried out at Army Camp. The researchers would be present when they were answering the questionnaire to help if the respondents require and to avoid bias in data collection.

ii. The questionnaire used were an adapted version of questionnaire from previous study(Amstutz,2010) that were carried out for noise exposure level and noise induced hearing loss.

iii. A adapted question was used to obtain quantifiable and background information of the personnel on their socio-demographic status, past medical, drug and occupational history, environmental and recreational noise exposure, perceived experience of hearing handicap and information on hearing protection devices.

Pure tone audiometry test

i. Respondents were briefed about the procedure before the audiometric test were performed and the respondents were tested before normal shift.

ii. Amplivox 260 diagnostic audiometer which is already calibrated were used to determine the threshold level by pure tone audiometry (PTA)

iii. This test was performed in sound attenuated booth station in a secluded path nearby the firing range.

iv. Through a calibrated TDH 39 type earphone, a pure tone was presented, and each ear were tested separately at test frequencies of 0.5,1.0,2.0,3.0,4.0 and 6.0kHz.

v. Result was then recorded in audiogram forms (Appendix 4). Each test took 10 minutes to be completed.

Area noise survey measurement

i. A Quest SoundPro Model SE/DL Sound Level Meters were reset and calibrated before use and a windshield approved by the manufacturer were used.

ii. 4 strategic locations were chosen as representative of the personnel locations during firing training at closest proximity to the sound source for measurement. The locations were set at 1.5m above the ground, and whenever practical, 3.5m distant from walls or other sound reflecting structures.

iii. The sampling method was based on a single sample taken 30 minutes interval during peak hours and measurements were carried out at each measuring location on three separate days. The arithmetic mean value given by these measurements constitute the results.

Personal noise exposure measurement

i. CR:110 AIS doseBadge were reset and calibrated before being used

ii. Before issuing the unit, the personnel were instructed about the use and care of the doseBadge

iii. The equipment would only be handled by the researcher in which the army personnel are not allowed to play or adjust the equipment while firing to ensure safety of the equipment.

iv. The doseBadge were firmly secured onto the shoulders of the personnel dominant hand using the mounting clips.

v. Each session was started using the RUN key and respondents were requested to perform their daily routine work task as usual during firing training. After eight hours of measurement period, the session was stopped using the STOP key.

vi. The doseBadge session data was transferred into the reader unit memory using READ key.

vii. These data were subsequently download to Cirrus Research plc computer-printer software and hard copies were printed for analysis.

3.5.1 Researcher's Safety

1. Researcher would be provided earplug by the army camp while assessing the personal noise exposure of the army at the firing range.
2. Researcher would be accompanied by army personnel while doing the noise assessment at the firing range.
3. Researcher would only assemble the dosimeter on the army personnel at the army preparation location which is far from the firing range area radius.

4. Researcher wouldn’t be in the firearm range and would be included in the safety briefing of the army.

3.6 Quality Control

i. Pre-test of the questionnaire was performed on 10% of the sample size to maximize the reliability of the questions. A reliability test using Cronbach's alpha test was conducted.

ii. All of the instruments were calibrated before use. The battery is replaced for a new battery for the instrument that operate using battery and for the instrument units that required charging were charged fully before data collection.

iii. The Standard Operating Procedure (SOP) for the instruments based on the manual book were followed.

iv. To minimize bias, the respondent was guided on how to use the instruments based on ASHA Pure Tone Audiometry Testing Manual.

3.7 Data analysis

Statistical analysis was carried out using the Statistical Package for Social sciences (SPSS) Statistical Software, version 27 (SPSS Inc., Chicago, IL). The data were tested for normality based on Kolmogorov Smirnov and statistical analysis were carried using parametric test for normal data and non-parametric test for data that is not normal. P value < 0.05 were classifies as statistically significant.

Table 3.7: Statistical Analysis

Objectives	Data Collection	Statistical Analysis
To determine sociodemographic and lifestyle choices of the respondents in hearing loss.	Questionnaire	Descriptive statistic
To determine the personal noise exposure of the respondents	Personal Noise Exposure Measurement	Descriptive statistics
To compare prevalence of hearing threshold between left and right ear of the respondents at all frequencies	Pure Tone Audiometry Test	Independent Sample T-Test/Mann Whitney U Test
To determine the prevalence of hearing loss among respondents	Pure Tone Audiometry Test	Descriptive statistic.
To determine the correlation between the mean hearing threshold	-	

level and noise exposure among respondents.		Pearson Correlation Test/Spearman Rho Correlation Test
To determine the factor(s) that influence the prevalence of hearing loss among respondents after confounders are controlled.	-	Independent Sample T test.

3.9 Study ethics

i. Ethical clearance is requested from Medical Research Ethics Committee, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia was approved.

ii. Permission to conduct data collection at army camp were submitted toward the management of army camp.

iii. Participation is voluntary and informed consent form is briefed signed beforehand.

iv. Provision was made for arrangement to uphold the confidentiality and discretion of the information obtained, at every phase of the study. Individual response and outcome of the results was kept confidential.

CHAPTER 4

RESULTS

4.1 Sociodemographic characteristic of the respondents.

Table 4.1(a) represent the socio-demographic characteristics of the respondents in which a total of 80 participants responded to questionnaire with 100% response rate. Respondents were entirely male (100%), from Malay ethnicity(81.25%) and married(72.5%). The median age was 32.5(+-6.0) years old ranged between 20 to 43 years old. The median age for attaining formal education was 11(+-1.3) years old, with some of them completed until Peperiksaan Menengah Rendah(PMR) (7.5%) and 10(12.5%) of them completed tertiary level education.

Table 4.1(a): Sociodemographic characteristic

Demographic Characteristic	No. of Respondent, n (%)
Age (years old)	
20-29	38(47.5%)
30-39	33(41.25)
40-49	9(11.25)
Gender	
Male	80(100)
Marital Status	
Single	22(27.5)
Married	58(72.5)

Ethnicity	
Malay	65(81.25)
Non-Malay	15(18.75)
Education Level	
Completed Penilaian Menengah Rendah	6(7.5)
Completed Sijil Pelajaran Malaysia	64(80)
Completed Sijil Tinggi Persekolahan Malaysia or higher	10(12.5)

Table 4.1(b) shows the environmental and recreational noise exposure of the workers. A total of 63(78.8%) employers claimed that they were living in the noise vicinity area as their residence. For recreational activities, all of the respondents 80(100%) participated in the NIHL activities in their leisure time in which 66(82.5%) of them participated in one activities, 8(10%) of them participated in two activities while 6(7.5%) of them participated in three activities or more. The median exposure time for the recreational activities was at 120 minutes.

Table 4.1(b): Residential area and recreational activities

Variable	No. of respondents, n(%)
Reside in noise vicinity	63(78.8)
Busy streets/highway/traffics	46(57.5)
Construction sites	17(21.3)

Partake in recreational activities	80(100)
1 Activities	66(82.5)
2 Activities	8(10)
3 Activities or more	6(7.5)

4.2 Perceived Hearing Handicap Experience

Table 4.2 shows personal experience related to perceived hearing handicap that the respondents experienced in which most of them has problem understanding woman voices 53(66.3%) and 22(27.5%) of them claimed that they have the needs to speak louder.

Table 4.2: Hearing handicap of respondents

Perceived experience of hearing handicap	No. of respondents, n(%)
Have trouble hearing women voices	53(66.3)
Have to speak louder	22(27.5)
Have to change body position	19(23.8)
Need to raise TV volume up	17(21.3)
Request friend to repeat	17(21.3)
Received complaints about hearing problems	17(21.3)
Problem with group discussion	8(10)

4.3. Employment background, noise exposure and medical history.

Table 4.3(a) represents the employment background of the workers. A total of 62(77.5%) of respondents were working as regular military, 10(12.5%) of them are working as a gunner, 6(7.5%) of them working in logistic or automotive and 2(2.5%) as a clerk. For the duration of employment, 50% of them were employed for 10-19 years with median of 11.5 years. A total of 72(90%) claimed that the working environment that they work on daily basis are exposed to high level of noise exposure in which only 30(37.5) use protection devices.

Table 4.3(a): Employment background of respondents

Variable	No. of respondents, n(%)
Job Section	
Military	62(77.5)
Logistic/Automotive	6(7.5)
Gunner	10(12.5)
Clerk	2(2.5)
Duration of Employment(Years)	
1-9	37(46.3)
10-19	40(50)
20-29	3(3.8)
Exposure to noise in working	
Yes	72(90)

No	8(10)
Usage of protection devices	
Yes	30(37.5)
No	50(62.5)

Table 4.3(b) shows the medical condition that the worker experienced in which 26(32.5%) claimed that they have tinnitus. A total of 1(1.3%) of respondents claimed that they have suppurating ear, fluid draining from ear and loss of hearing respectively but all 80(100%) claimed that they had never undergoes ear treatment or took ototoxic medicine.

Table 4.3(b): Hearing problems of the respondents

Hearing Problems	No of Respondents, n(%)
Tinnitus	26(32.5)
Suppurating Ear	1(1.3)
Loss of hearing	1(1.3)
Fluid draining from ear	1(1.3)

Table 4.3(c) shows the participation frequency in shooting training every 6 months in which all of them 80(100%) of them participated. A total of 48(60%) only involved once in shooting training and only 3(3.7%) are involved more than 3 times in the span of 6 months. Only 50(62.5%) of respondents stated that they use hearing protection devices while commencing in the shooting training.

Table 4.3(c): Firing range training

Variable	No. of respondents, n(%)
Participation in shooting(Every 6 months)	80(100)
1 Times	48(60)
2 Times	29(36.3)
3 or more Times	3(3.7)
Usage of Protection Devices	50(62.5)
Yes	30(17.5)
No	

Table 4.3(d) shows the hearing problems that the respondents experience after shooting training in which 29(36.3%) of them claimed that they have reduced hearing ability, 24(30%) of them claimed they have buzzing ear, 19(23.8%) have disruption on communication and 8(10%) of them reported increased heart rate or stressed after shooting training.

Table 4.3(d): Hearing problem after noise exposure

Hearing Problems after Noise Exposure	No of Respondents, n(%)
Reduced hearing ability	29(36.3)
Ear buzzing	24(30)
Disruption in communication	19(23.8)
Increased Heart Rate/Stressed	8(10)

4.4 Noise Exposure Level at the Firing Range

Table 4.4(a) represents the area noise measurement level which were conducted at the Firing Range in Bukit Jugra using Sound Level Meter(SLM). The findings demonstrated the arithmetic mean of Time Weighted Average (TWA) exposure for approximately 2 hours with 30 minutes interval sampling duration for 4 readings, which was at 89.3(+-1.7) dBA, with an equivalent continuous sound level(LAeq) ranged between 57.4 to 119.5 dBA.

Table 4.4(a): Area noise survey

Area	n(%)	L_{Aeq} dBA		Average	Average
		L_{ASmin}	L_{ASmax}	TWA dBA	L_{apeak} dBA
	4(100)	57.4	119.5	89.3(+-1.7)	136.9(+-2.0

Table 4.4(b) presents the personal noise exposure level of respondents which partake in the training at Bukit Jugra Firing Range. The measurement was taken for a 8 minute period in which the respondents partake in a shooting training. The mean measurement that were recorded for the time period was at 90.2(+-1.5) dBA in which equivalent continuous sound level (LAeq) ranged between 60.3 to 122.8 dBA. The peak(Lcpeak) reading for the shooting period was at 144(+-0.2)

Table 4.4(b): Personal noise exposure measurement

Personal	n(%)	L_{Aeq} dBA		Mean TWA dBA	Mean TWA(8H) dBA	Mean L_{cpeak} dBC
		L_{ASmin}	L_{ASmax}			
Findings	80(100)	60.3	122.8	90.2(+-1.5)	108.7(+-1.1)	144.0(+-0.2)

4.5 Average hearing threshold level of both left and right ear

Table 4.55 presents an average hearing threshold level of the respondents of both ears. The highest hearing threshold level was identified at 500Hz in both left and right ear at 14.0dBA and 14.1dBA respectively. The lowest hearing threshold level was identified at 3000Hz for left ear and at 6000Hz for right ear at 9.4dBA and 9.8dBA respectively.

Table 4.5: Average hearing threshold

Frequency(Hz)	Average Threshold Level (dBA)	
	Left Ear	Right Ear
500	14.0(+-4.3)	14.1(+4.2)
1000	13.4(+-5.2)	12.7(+-4.7)
2000	11.6(+-5.1)	11.4(+-5.6)
3000	9.4(+-4.4)	9.9(+-7.2)
4000	10.8(+-9.3)	10.5(+-9.3)
6000	9.9(+-7.3)	9.8(+-9.2)

4.6. Prevalence of Hearing Loss

The prevalence for hearing loss was at 18.8% in which 15 person of them have change in threshold level >25dBA. Most of them 9(11.3%) have hearing loss at 4000Hz for left ear and only 1(1.3) have hearing threshold level above 25dBA at 2000Hz. 10(66.3%) over 15(100%) of them have bilateral hearing loss.

Table 4.6: Prevalence of hearing loss

Frequency(Hz)	Threshold Level (dBA)			
	Left Ear, n(%)		Right Ear, n(%)	
	<25	>25	<25	>25
500	80(100)	0(0)	80(100)	0(0)
1000	80(100)	0(0)	80(100)	0(0)
2000	80(100)	0(0)	79(98.8)	1(1.3)
3000	80(100)	0(0)	76(95.0)	4(5)
4000	71(88.7)	9(11.3)	79(98.7)	1(1.3)
6000	80(100)	0(0)	80(100)	0(0)

4.7 Comparing between hearing threshold between left and right ear.

Table 4.7 shows the comparison between hearing threshold level of both left and right ear at all test frequencies. The Mann Whitney U Test were carried out in which it shows that there is no significance difference between left and right ear at all test frequencies.

Table 4.7: Hearing threshold comparison

Frequency(Hz)	Average Threshold Level (dBA)		Z	P
	Left Ear	Right Ear		
500	14.1(+4.2)	14.0(+-4.3)	-0.052	0.958
1000	12.7(+-4.7)	13.4(+-5.2)	-1.510	0.131
2000	11.4(+-5.6)	11.6(+-5.1)	-0.533	0.594
3000	9.9(+-7.2)	9.4(+-4.4)	-0.463	0.643
4000	10.5(+-9.3)	10.8(+-9.3)	-0.320	0.749
6000	9.8(+-9.2)	9.9(+-7.3)	-0.996	0.319

4.8 Correlation between hearing threshold level and noise exposure level.

Table 4.8 shows the correlation between hearing threshold level and noise exposure level. Spearman Rho correlation test were carried out to test the correlation between hearing threshold level and noise exposure level. There was a moderate, positive correlation(r=0.441, p=0.001) at 4000Hz frequency for left ear.

Table 4.8: Correlation between hearing loss and noise exposure level

	Left Ear		Right Ear	
Frequency(Hz)	r	P	r	P
500	-0.060	0.594	-0.158	0.161
1000	-0.003	0.980	0.048	0.673
2000	0.200	0.075	0.199	0.077
3000	0.285	0.010*	0.250	0.025*
4000	0.441	0.001*	0.201	0.074
6000	0.186	0.099	0.216	0.055

4.9 Correlation between hearing threshold level and duration of employment.

Table 4.9 shows the correlation between hearing threshold level and duration of employment. Spearman Rho correlation test were carried out to test the correlation between hearing threshold level and duration of employment. There was weak and positive correlation at 4000Hz for left ear (r=0.357, p=0.001) and 3000Hz for right(r=0.320, p=0.004) and left ear(r=0.270, p=0.015).

Table 4.9: Correlation between hearing loss and duration of employment

Frequency(Hz)	Left Ear		Right Ear	
	r	p	r	p
500	0.239	0.033*	0.049	0.666
1000	0.219	0.051	0.059	0.602
2000	0.160	0.155	0.175	0.121
3000	0.320	0.004*	0.270	0.015*
4000	0.357	0.001*	0.163	0.148
6000	0.195	0.083	0.212	0.059

4.10 Factor(s) that influence the prevalence of hearing loss among respondents.

Table 4.10(a) shows the association between possible influencing factor(s) and hearing loss. Pearson chi square test were administered to assess the association between possible influencing factor. Hearing loss and usage of HPD(X^2=4.600, p=0.032) were shown to have significant association meanwhile residency area and recreational area were not shown to have significant association.

Table Of Association		
Category	X^2	p
Hearing loss and HPD usage	4.600	0.032
Hearing loss and residency	5.562	0.062
Hearing loss and recreational duration	0.734	0.392

CHAPTER 5

DISCUSSION, RECOMMENDATION AND CONCLUSION

5.1 Discussion

5.1.1 Socio-demographic characteristic, working background, noise exposure and medical history among respondents.

Occupational Noise Induced Hearing Loss was one of the highest reported occupational disease in Malaysia in 2016 with 2876 cases which stands at 74.5% of the occupational disease reported.(DOSH,2017) In the world view, about 16% of hearing loss among adults were due to occupational noise(Nelson et al., 2005). This study comprises of 80(100%) of study population which is male and male are most more affected by the noise exposure than females in all subregions(Nelson et al., 2005) in which this study aligns with it.

The median age of this study was at 32.5 years compared to a study by Collée et al. in 2011in which the median age was at 36 years old among the Belgian Military Worker. The difference in median age may well explain the difference in prevalence of hearing loss among military which is low (18.8%) compared to the study by Collée et al., in 2011 which the prevalence of hearing loss was at 55.8%. In a study conducted by Canadian Health Measure Survey(CHMS) indicates 40% of adults aged 20 to 79 experienced slight hearing loss in which 78% of older adults(60-70 years old) have hearing loss compared with younger adults(40 to 59 years old) at 40% and 20 to 39 years old at 15%(Canada, 2012). But the higher percentage of hearing loss in older adults could be due to presbycusis which is hearing loss that occurs gradually due to aging factors(National Institute on Deafness and Other Communication

Disorders,2022). This shows that age does not correlate with hearing loss because wide range of age group could experience hearing loss.

The median duration of employment in the Collée et al., in 2011 study was at 17 years compared to this study which was at 11.5 years. The findings implied that there is a low number of longer serving military participating in this study. This could be due to the higher serving military could be at a higher rank and not willing to participate in study. The serving duration could be pose high correlation with the hearing loss. A study comprised of 1923 participants aged 50+ years with 10 years of noise exposure shows hearing loss incidence at 35.5% compared to those not been exposed to noise exposure for 10 years which is at 29.1%(Gopinath et al., 2021).

This study also reveals that median age for attaining formal education was 11 years old in which most of the participants in this study finished their studies until SPM . This could be due to the requirements to enter Military Service in Malaysia is completing SPM and they can enrol as cadet. The requirement to complete tertiary studies are for the commanding officer meanwhile the regular military doesn't need higher education level to serve as military.

At about 63 respondents claimed that they are exposed to noise in their residential area. Majority of them (73%) of them claimed to have been to exposed to traffic noise in their residential area, This is normal due to number of registered vehicles at Malaysia by Dec 2021 is at 17,728,482 units which shows that the number of car on the road and highway is a lot. The higher number of vehicles do requires a increase in number of roads and highway to accommodate the vehicles and shorten distance and time taken on road for vehicles. The constant exposure traffic noise exposure above 70dB could causes hearing loss(Wang et al., 2021). Based on a study in 32 point in Kuala Lumpur shows that the noise emitted by vehicles and the traffic equipment recorded up to

133dBA in which 24 out 30 participants were diagnosed with Noise Induced Hearing Loss(NIHL) (N;Mariah, 2017). This could be one of the risk factor that resulted in hearing loss of the respondents in this study which is not further studied in this study.

As for the recreational noise exposure, 100% of respondents participated in recreational during leisure time in which most of them (82.5%) of them participated in one activities. The median time for the recreational activities was at 2 hours The activities that the respondents participated were either participating in extreme activities which is mountain hiking or diving, using gardening tool which is either grass cutter or chainsaw, visiting night clubs or karaoke, shooting range practice, car or motorcycle racing and attending concerts. All of this activities could result in hearing impairment. The extreme activities could result in Eustachian Tube become closed or blocked and causes slight hearing loss. Apart from that, a lawn mower could produce sound level up to 90dBA and chainsaw produced at about 110dBA and the average noise level at a concert is around 100dBA in which a rock concert could be up to 120dBA. The high noise level that all this recreational activities constitutes could be among the risk factor for hearing loss among the respondents.

In terms of medical history background of the worker, all(100%) claimed that they never undergoes any ear treatment with ototoxic medicine, ear surgery or head surgery. The perceived hearing handicap experience of the worker was 66.3% of them have trouble understanding woman voices . This was subjected to high frequency hearing loss which does correlate with the findings in this study in which most of them reported high frequency hearing loss. About 29 respondents claimed that they have hearing problems in which 26 of them claimed that they have tinnitus. Loud noise exposure could causes tinnitus in which it might subside over time but possibly continues throughout persons life.

Based on their working background on normal hours, at about 90% of them claimed that they are working in a high noise exposure background but only 42% of them use hearing protection devices while working in the high noise exposure area. Hearing Protection Devices(HPD) could highly help in reducing high level of noise exposure and reduce the incidence of hearing loss. The conventional and level-dependant-earplug could attenuate the sound level from 21 to 40dB and 5 to 22dB respectively(Kwak & Han, 2021). This shows that respondents could choose to wear HPD depending on their exposure and suitability to reduce the incidence of occupational hearing loss. Apart from that, wearing HPD doesn't interrupt with sound localization and speech perception negatively.

5.1.2 Noise exposure level of the respondents.

The noise exposure measurement of the area throughout 4 readings for 2 hours reading each yields average TWA at 89.3(+-1.7) dBA with measure continuous sound level(Laeq) ranging between 57.4dBA to 119.5dBA. The peak sound level (Lapeak) that were recorded were at 136.9(+-2.0)dBA. The area measurement survey were carried out at the Bukit Jugra Firing Range where the military participated in shooting training. The recorded measurement of TWA shows that it exceeded the Permissible Exposure Limit(PEL) of 85dBA. Repeated overexposure to noise at or above 85 dBA can cause permanent hearing loss, tinnitus, and difficulty understanding speech in noise(Themann & Masterson, 2019) The shooting range training commenced for three days with day and night session. This shows that the military personnel are exposed to loud noise exposure throughout the shooting training. As for the peak sound level that were measured when the personnel start firing the gun during the training session.

The personal noise dosimetry measurement shows that mean TWA for 80 participants were at 90.2(+-1.5dBA) with continuous sound level(Laeq) ranging between 60.3dBA to 122.8dBA. The estimated Mean TWA for 8 Hours were calculated as 108.7(+-1,1) dBA. The measurement for personal noise exposure was carried out throughout 8 minute period in which the participants were in the firing range and doing shooting training. One participants doesn't participate in only one shooting session but they participate in more than 2 shooting session per person which is carried out with different time slot throughout 3 days of firing range training in Bukit Jugra. The estimated TWA for 8 hours shows that it exceeded the Permissible Exposure Limit(PEL) of 85dBA. This overexposure of noise exposure could lead to serious hearing impairment in the longer run.

The overall mean peak sound level(Lcpeak) were recorded at 144.0(+-0.2) dBA which is higher than PEL for impulsive noise exposure of 140dBA. All the participants were exposed to impulsive noise higher than 140dBA in the firing range. The impulsive noise exposure were due to sound produced from the firing of the gun throughout the shooting training in which all the participants in this study participated. Impulse noise from blast explosions and weapon firings are shock waves that can cause traumatic injuries to the auditory system(Chan et al., 2016). The longer duration that the personnel are exposed to impulsive noise, it increase the severity of hearing impairment that the personnel could experience. Immediately after shooting practice significant differences in PTA at 500, 1000, and 4000 Hz were observed for the right ear and no significant difference at any frequency for the left ear(Rezayee et al., 2011).

5.1.3 Mean hearing threshold between the right and left ear of the respondents at all frequencies.

The Pure Tone Audiometry Threshold test shows that the average threshold level was higher at low frequencies (500Hz,1000Hz and 2000Hz) and lower in the high frequency (3000Hz,4000Hz and 6000Hz). The average threshold level was highest at 500Hz in left and right ear and lowest in 3000Hz at left ear and 6000Hz for right ear. Noise exposure during military service often leads to greater hearing loss at 6 and 8 kHz than at 4 kHz due to impulsive noise generated from gun and explosion(Brian, 2022). This shows that audiometric assessment of the participants is linear in the study because most of the respondent that has average hearing threshold >25 is at high frequencies compared with low frequencies.

The configuration of the audiometry were represented by the depth of the frequencies of notch and shape of the curve. It is classified as V shaped if there is only one frequency in the depth of the notch and wide U shaped if there is more than one frequency in the depth of the notch. This is the pattern of the audiometric test for the workers or person that had been exposed to loud noise for certain period of time.

5.1.4 Comparison between hearing threshold between left and right ear at all test frequencies.

There is no significance difference in hearing threshold between left and right ear at all test frequencies that were recorded in this study. Although the military personnel bend one part of their head towards their gun during the shooting training, the noise exposure is distributed equally in both ear. Exposure to steady noise generally leads to hearing loss that is similar for the two ears while exposure to impulsive noise during

military service often leads to greater hearing loss in one ear than the other, because of the asymmetric nature of the noise exposure that the military exposed. (Brian, 2022). This was due to generally the military personnel are exposed to one ear much closer to the noise exposure rather than having ear closer.

5.1.5 Prevalence of hearing loss at all test frequencies.

The prevalence for hearing loss was at 18.8% in which 15 person of them have change in threshold level >25dBA. Most of them 9(11.3%) have hearing loss at 4000Hz for left ear and only 1(1.3) have hearing threshold level above 25dBA at 2000Hz. 10(66.3%) over 15(100%) of them have bilateral hearing loss. Some of the respondents have audiometry configuration with only one frequency in the depth of the notch and some of the respondents have more than one frequency in the depth of the notch. Compared with another studies that were conducted among the military personnel shows that the prevalence of slight to severe Hearing Loss in high frequencies which is at 4000Hz and 6000Hz were at 62.7%(Orru et al., 2020). Apart from that, in another study conducted among military personnel in Eastern Saudi Arabia shows that 71.6% of participants have hearing impairment. The differences in prevalence of hearing loss in this study compared with the two other studies could be due to low number of high employment duration respondents participating in this study (Alaraifi et al., 2021).

While assessing through the frequencies of both left and right ear separately, it shows that the hearing loss occurs at high frequencies compared to low frequencies in which out of 15 person only one person shows hearing loss at low frequency which is at 2000Hz. Based on the WHO Grading System Of Hearing Impairment, 66.6% of them have no impairment while 5 person of them have slight impairment of hearing loss.

Compared with another study among military personnel, most of it was having slight impairment (59.5%), as the prevalence of severe impairment (>65 dB) was 9.3%(Orru et al., 2020).

5.1.6 Correlation between the mean hearing threshold level of both ear and noise exposure level of the respondents.

Table 4.11 shows the correlation between hearing threshold level and noise exposure level. Spearman Rho correlation test were carried out. There was a moderate, positive correlation(R=0.441, p=0.001) at 4000Hz frequency for left ear. Compared with another study conducted among worker in Thailand it shows that noise exposure level above 90dBA does significantly increased the prevalence of hearing loss in both ears. (Sriopas et al., 2017)This were also supported in another study among workers in Ethiopia in which higher noise levels exposure in the weaving and spinning sections, reflected in higher prevalence of NIHL among workers in those sections(Belachew & Berhane, 2017) In a study among workers in Jordan also shows that It can be concluded that 1 out 3 workers were exposed to 95 dB(A) and 75% of this group were suffering from hearing loss(Shakhatreh et al, 2000), This shows the study finding are equivalent with other studies findings and noise exposure level does result in change of hearing threshold level.

5.1.7 Correlation between the mean hearing threshold level of both ear and duration of employment of the respondents.

There was weak and positive correlation at 4000Hz($r=0.357$, $p<0.05$) for left ear and 3000Hz for right($r=0.320$, $p<0.05$) and left ear($r=0.270$, $p<0.05$). This findings shows that people that are exposed to loud noise exposure for longer duration were more likely to have hearing impairment. The findings support the hypothesis that noise exposure during military duty increases hearing loss development for frequencies where hearing loss is non-existent or moderate at the conclusion of military service, by an average of 1.7 dB/year, but has no effect on or slows down hearing loss progression for frequencies where hearing loss reaches roughly 50 dB. (Moore & Lowe, 2022). Acceleration appears to occur over a wide frequency range, including 1 kHz. The time interval between the end-of-service audiogram and the later audiogram ranged from 5 to 27 years;. at the end of military service the men had a wide range of hearing losses for frequencies from 3 to 8kHz. (Moore & Lowe, 2022) According to our findings, which were in line with the findings of these earlier studies, working for a period of time more than 10 years considerably raised the risk of developing impaired hearing(Sriopas et al., 2017). When working for at least 25 years, the mean hearing loss increased with length of employment, reaching 38.8 dBHL(Shakhatreh et al, 2000).

5.1.8 Factor(s) that influence the prevalence of hearing loss

The other factor(s) that could influence the prevalence of hearing loss after controlling the confounder for age is the usage of hearing protection, residency area and duration of recreational exposure. Hearing loss with usage of hearing protection devices during shooting training shows that there is significant association. This shows that there is enough evidence to show that using hearing protection devices while training session could lead to hearing loss eventually. Earplugs and other hearing protection devices (HPDs) can help people who are often exposed to loud noises limit their exposure to noise and their risk of hearing loss(Brown et al., 2015).

Hearing loss with residential areas shows that there is no significant difference in the prevalence of hearing loss with living in heavy traffic area and living nearby construction areas. Heavy traffic areas do produce higher sound exposure level which could in turn induce hearing loss. According to a 2019 study by Pourabdian et al, among 65,533 heavy-vehicle drivers, including truck and intercity bus drivers, from February 2006 to March 2016, 26.8% of them experienced hearing loss, with 14.6% of them having it in both ears. Although heavy traffic areas could induce hearing loss but there is not enough evidence in this study to support it.

Hearing loss with duration of recreational activities that there is no significant difference in the prevalence of hearing loss with the duration of recreational activities ≥ 120 minutes and < 120 minutes. Although higher duration of occupational exposure do leads to high prevalence of hearing loss but there is not enough evidence in this study to support it. Strasser et al. in 1999 studied the white noise, industrial noise, heavy metal music, and classical music which is four energetically comparable exposures (94 dB for 1 hour) that were studied. Heavy metal music and industrial noise

were shown to cause equivalent amounts of TTS and need similar amounts of recovery time(Strasser et al,1999). This shows that recreational exposure could induce hearing loss the same amount as occupational which could affect the prevalence of hearing loss.

5.2 Conclusion

Based on the present research, the conclusion that can be drawn are noise exposure level in firing range do induce noise-induced hearing loss among army personnel based on the prevalence of hearing loss.

Apart from that, the sociodemographic and lifestyle factor could also be one of the supporting factors in occupational hearing loss. The prevalence of hearing loss among military personnel is also evident.

Moreover, there is no significant difference in hearing threshold between left and right ear. Other than that, noise exposure level and duration of employment do correlate with the mean hearing threshold level.

Finally, usage of hearing protection devices were shown to have significant association meanwhile residential area and duration of recreational activities is shown to have no significance difference in prevalence of hearing loss.

5.3 Recommendation

A large scaled sampling population need to be studied to assess the actual prevalence of hearing loss among army personnel by including every officer from commanding officer to regular military. Apart from that, by including commanding officer, it could also help in addressing the association of risk factor of usage of HPD, participation in NIHL leisure activities, residency area and duration of employment to the prevalence of hearing loss among military personnel.

It is recommended that Hearing Conservation Programs were planned and executed to address the military personnel hearing. An effective hearing conservation programs should contains the assessment of noise exposure, engineering and administrative control, audiometric evaluation and hearing monitoring, training and education, appropriate usage of personal protection equipment, record keeping and evaluation of program effectiveness. An adequate hearing conservation program should include explanation about normal audiometry, the causes of hearing loss and the types of it, the dangers of excessive noise exposure, NIHL warning signs, and prevention of hearing loss strategies.

The military should conduct training and provide information to the military personnel to understand the risk of noise exposure. It is important that the military personnel can understand the possible hearing loss risk factors and understand the explanation of their risk assessment It is also important for them to understand the significance of noise exposure measurement, evaluation of audiometry and the usage of HPD. The personnel should also undergoes individual health surveillance and notified about their possible hearing loss problems. The record should be kept and make available upon request for the military personnel.

The use of HPD also should be evaluated in term of efficiency of the HPD and comfortability of the personnel using the HPD. The most efficient HPD were earplug as they were able to attenuate sound at high level. The selection of HPD should be suitable on the type of noise exposure and duration of using HPD to avoid discomfort in military personnel using it. The HPD should also be selected based on their effectiveness. There are variety of HPD option in the market to be tested and selected for use of the military personnel.

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APPENDIX

BORANG PENYERTAAN PESERTA

1. Saya,.....No. KP.....

bersetuju untuk menyertai kajian yang bertajuk, "Pendedahan Bunyi Bising Lapang Sasar dan Masalah Hilang Pendengaran Di Kalangan Askar di Lapang Sasar"

2. Saya telah membaca dan memahami isi kandungan kajian berdasarkan apa yang telah dinyatakan di dalam "PENERANGAN KEPADA PESERTA" yang telah dilampirkan bersama surat kebenaran ini dan penerangan tambahan daripada penyelidik.

3. Saya faham bahawa kajian ini dijalankan untuk mengenalpasti hubungan diantara kesan pendedahan bunyi bising di persekitaran lapang sasar kepada masalah hilang pendengaran dikalangan askar.

4. Saya faham bahawa kajian in mungkin akan melibatkan aktiviti fizikal dan mental berdasarkan aktiviti pengumpulan data yang akan dijalankan.

5. Saya faham bahawa saya mempunyai hak untuk menarik diri dan juga mempunyai hak untuk menarik semula keizinan pada bila-bila masa sekiranya perlu apabila merasa tidak selesa pada mana-mana ujian atau aktiviti yang dijalankan oleh penyelidik semasa kajian dijalankan dan tiada sebarang tindakan boleh dikenakan ke atas saya atas tindakan tersebut.

6. Saya faham bahawa segala maklumat yang akan diberikan dan segala keputusan yang saya perolehi adalah sulit dan hanya akan digunakan untuk tujuan penyelidikan dan rujukan penyelidik.

7. Saya juga faham bahawa maklumat ini boleh digunakan untuk penerbitan tetapi setiap individu tidak akan dinyatakan identitinya.

…….

(Tandatangan peserta)

Nama/Jawatan:

No. K/P:

Tarikh:

PENERANGAN KEPADA PESERTA

TAJUK KAJIAN:

PENDEDAHAN BUNYI BISING TEMPAT KERJA DAN MASALAH HILANG PENDENGARAN DIKALANGAN ASKAR

Apakah kajian ini?

Bunyi bising, atau bunyi yang kita tidak dikehendaki, merupakan satu risiko kesihatan dan pendedahan kepada bunyi bising melebihi paras 85 dB(A) di tempat kerja boleh mengakibatkan perubahan aras ambang pendengaran seseorang individu. Perubahan aras ambang pendengaran tersebut mungkin bersifat sementara ataupun kekal. Dalam tempoh pendedahan tersebut, kemungkinan perubahan aras ambang pendengaran tersebut menyebabkan kehilangan pendengaran secara kekal atau dapat diperbetulkan.

Pendedahan berterusan kepada bunyi bising hasil daripada tembakan senjata yang mengeluarkan bunyi yang agak bising untuk mengakibatkan masalah kehilangan pendengaran.

Apakah tujuan kajian ini?

Kajian in dijalankan bertujuan untuk mengenal pasti hubungan antara kesan pendedahan bunyi bising di Kawasan lapangan menembak kepada perubahan aras ambang pendengaran dan masalah hilang pendengaran dikalangan askar.

Berapa ramai responden yang terpilih?

Responden akan dipilih daripada kalangan askar daripada setiap seksyen. Seramai 310 orang askar akan dipilih untuk kajian ini.

Apakah jenis ujian yang akan dijalankan?

Serua responden akan diberikan borang soal-selidik oleh pengkaji. Ujian audiometer akan dijalankan di dalam pondok audiometri. Alat audiometer model Amplivox 260 akan digunakan untuk menpukur aras ambang pendengaran dikalangan responden. bacaan pendedahan dos bunyi bising dikalangan responden akan diukur dengan melekalkan alat dosimeter model Cirrus pada bahu responden.

Adakah bayaran dikenakan?

Pangkaji akan menangeung segala pembiayaan ujian yang akan dijalankan dan tiada sebarang bayaran dikenakan terhadap setiap responden.

Adakah maklumat anda dijamin sulit?

Maklumat anda, keputusan anda dan indentiti anda adalah dijamin sulit dimana maklumat dan keputusan hanya digunakan untuk tujuan penyelidikan dan rujukan penyelidik.

Apakah hak anda?

Penyertaan anda dalam kajian ini adalah secara sukarela dan penyelidik tiada kuasa untuk memaksa anda untuk menyertai kajian ini. Anda dibenarkan untuk menarik diri atau menarik keizinan daripada menyertai kajian ini sekiranya mendapati tidak selesa dalam mana mana ujian.

Terima kasih atas Kerjasama dan bantuan anda.

RAHMAN HAZIQ BIN PACKEER MOHAMED

BORANG SOAL SELIDIK

PENDEDAHAN BUNYI BISING DAN MASALAH KEHILANGAN PENDENGARAN DI KALANGAN ASKAR DI LAPANG SASAR

Dengan ini, sukacita dimaklumkan bahawa pihak kami telah disenaraikan sebagai salah seorang responden dalam kajian penyelidikan yang mengkaji hubungan antara pendedahan bunyi bising dengan masalah hilang pendengaran di tempat kerja. Segala maklumat yang diterima akan dirahsiakan. Kerjasama dari pihak pihak tuan amatlah dihargai. Terima kasih atas bantuan yang diberikan.

No. Responden :

Tarikh:

No. Telefon:

ARAHAN

Borang soal selidik ini mengandungi lima (5) muka surat bercetak dan dibahagikan kepada empat (4) bahagian utama. Sila jawab 35 soalan tersebut dengan tepat dan jujur.

BAHAGIAN A: DATA RESPONDEN

1. No. Pengenalan Staf: _____
2. Tarikh Lahir: _____
3. Umur: _____
4. Bangsa:

☐	Melayu	☐	India
☐	Cina	☐	Lain-lain, sila nyatakan

5. Agama:

☐	Islam	☐	Kristian
☐	Buddha	☐	India
☐	Lain-lain, sila nyatakan _____	☐	

6. Taraf Perkahwinan:

☐	Berkahwin	☐	Duda
☐	Tidak Berkahwin		

7. Tempoh Pendidikan Formal: _____ Tahun
8. Jumlah Pendapatan (sebulan): _____

9. Adakah anda mempunyai hobi atau aktiviti seperti dinyatakan berikut? Jika ya, sila tandakan di kotak berkenaan.

☐	Daki gunung/Menyelam	☐	Menggunakan mesin potong rumput
☐	Mengunjungi pusat hiburan/karaoke/kelab malam	☐	Menggunakan alat pemotong kayu
☐	Bermain alat muzik	☐	Menembak/Latihan sasar
☐	Berlumba kereta/motorsikal	☐	Menghadiri konsert

Jika ya, nyatakan tempoh masa yang diluangkan untuk aktiviti tersebut dalam sehari.

10. Adakah kawasan kediaman anda berdekatan dengan tempat bising?

☐ Ya ☐ Tidak

Jika ya, nyatakan kawasan yang berkaitan:

☐ Tapak pembinaan ☐ Lalulintas/Lebuhraya

☐ Landasan keretapi atau monorel ☐ Lain-lain, nyatakan _____

Bahagian B

11. Apakah bidang perkerjaan anda?

_____

12. Adakah pekerjaan anda melibatkan pendedahan kepada bunyi bising'

☐ Ya ☐ Tidak.

Jika tidak, sila teruskan kepada soalan no. 15

13. Jikalau anda jawab ya, apakah aktiviti atau peralatan yang melibatkan pendedahan kepada bunyi bising.

☐ Peralatan pertukangan ☐ Automotif

☐ Senjata/ Letupan ☐ Mesin pemprosesan

☐ Jikalau lain, sila nyatakan _____

14. JIkalau anda jawab ya untuk soalan 13, berapakah tempoh masa anda terdedah kepada bunyi bising dalam sehari.

_____

15. Adakah anda menggunakan apa apa alat perlindungan diri semasa terdedah kepada bunyi bising terebut.

☐ Ya ☐ Tidak.

16. Adakah anda terlibat dalam Latihan menembak di lapang sasar?

☐ Ya ☐ Tidak.

17. Jikalau ya, berapakah kekerapan anda menyertai latihan menembak dalam tempoh 6 bulan.

_____

18. Apakah jenis senjata yang digunakan dalam latihan menembak tersebut? Sila tandakan yang berkenaan.

☐	Pistol 9mm	☐	Pistol 5.56 M4
☐	Letupan	☐	Kereta Kebal

19. Berapakah tempoh masa anda mengendalikan senjata atau letupan dalam sesi latihan tersebut? Sila nyatakan masa.

_____

20. Adakah anda menggunakan apa-apa alat pelindungan diri semasa menjalani latihan tersebut?

☐	Ya	☐	Tidak.

Bahagian C: MAKLUMAT KESIHATAN

21. Berdasarkan ujian audiometri yang telah dilakukan, adakah anda mengalami perubahan ambang pendengaran pada atau melebihi 25dB(A) pada mana mana frekuensi berikut:

Telinga Kiri		Telinga Kanan
☐	0.5 kHz	☐
☐	1 kHz	☐
☐	2 kHz	☐
☐	3 kHz	☐
☐	4 kHz	☐
☐	6 kHz	☐

22. Adakah anda pernah mengalami masalah berikut? Jikalau ya, sila tandakan pada petak yang berkenaan

☐	Telinga bernanah	☐	Telinga berdesing (Tinnitus)
☐	Teinga (berair, bengkak, gatal-gatal)	☐	Hidung berdarah
☐	Kemalangan melibatkan telinga	☐	Hilang pendengaran
☐	Cacat pendengaran		

23. Adakah anda pernah menjalani pembedahan atau rawatan telinga?

☐ Ya ☐ Tidak.

Jikalau tidak, sila beralih ke soalan no 26

24. Jika ya, sila nyatakan jenis rawatan dan tarikh dilakukan.

_____

25. Adakah selepas menerima rawatan, telinga anda bertambah baik?

☐ Ya ☐ Tidak.

26. Adakah ahli keluarga anda menghadapi masalah kesihatan yang sama?

☐ Ya ☐ Tidak.

Bahagian D: Pengalaman Kendiri

27. Berikut adalah perkara yang anda alami apabila terdedah kepada bunyi bising: Anda boleh menanda (/) lebih dari satu.

☐ Tertekan
☐ Komunikasi terganggu
☐ Peningkatan denyutan nadi
☐ Telinga berdengung
☐ Peningkatan kadar pernafasan
☐ Masalah kurang mendengar

28. Pernakah rakan/ahli keluarga anda mengadu yang anda kurang mendengar?

☐ Ya ☐ Tidak.

29. Pernahkah anda meminta rakan sekerja mengulangi apa yang dikatakan, walaupun dalam bilik yang sunyi?

☐ Ya ☐ Tidak.

30. Adakah anda sentiasa bercakap kuat semasa dan di luar waktu bekerja?

☐ Ya ☐ Tidak.

31. Adakah anda memahami suara lelaki lebih baik dari suara perempuan?

☐ Ya ☐ Tidak.

32. Adakah anda perlu mengubah posisi badan atau telinga anda ke arah orang yang sedang bercakap untuk memahami perkara yang disampaikan?

☐ Ya ☐ Tidak.

33. Adakah anda mengalami masalah untuk mengesan bunyi biasa seperti nada dering telefon atau loceng pintu?

☐ Ya ☐ Tidak.

34. Pernahkah rakan/ ahli keluarga anda mengadu yang bunyi televisyen anda dipasang terlalu kuat?

☐ Ya ☐ Tidak.

35. Adakah anda mengalami masalah memahami perbualan yang diadakan secara berkumpulan?

☐ Ya ☐ Tidak.

Sekian Terima Kasih diucapkan kerana sudi memberi kerjasama. Segala maklumat adalah suliit dan hanya untuk tujuan kajian ini sahaja.

Keputusan Ujian Audiometri

Lokasi	Kajang Army Camp	No Responden	
Nama Pekerja		Jantina	
		Tarikh Lahir	
No Pekerja		Tarikh Mula Bekerja	
No. K/P		Umur	
Jawatan		Tempoh Bekerja	
Tarikh Diuji		Audiometer	
Sumber bunyi bising di Tempat Kerja		Model No siri	
Pendedahan	dB(A)	Tarikh kalibrasi	
Pendedahan Maksima	dB(C)	Bebas daripada bunyi bising dalam tempoh 12 jam: _____ Ya _____ Tidak	

Hz	500	1000	2000	3000	4000	6000	0.5,1,2,3	4,5,6
R(dB)								
L(dB)								

FREKUENSI DALAM HERTZ, Hz

PARAS AMBANG PENDENGARAN dB(A)	500	1000	2000	3000	4000	6000	
							-10
							-5
							0
							5
							10
							15
							20
							25
							30
							35
							40
							45
							50
							55
							60
							65
							70
							75
							80

Ulasan	Petunjuk
	X= Untuk ambang pendengaran (telinga kiri) 0= Untuk ambang pendengaran (telinga kanan)