A STUDY ON PREVALENCE OF HEARING IMPAIRMENT AND EAR DISEASES AMONG NAVY PERSONNEL OF THE ROYAL MALAYSIAN NAVY, LUMUT PERAK

By

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LIST OF ABBREVIATIONS

CHL	Conductive Hearing Loss
dB	Decibel
Hz	Hertz
kHz	kiloHertz
TTS	Transient thereshold shift
PTS	Permanent thereshold shift
OAE	Otoacoustic Emission
DPOAE	Distortion product otoacoustic emission
PTA	Pure Tone Audiometry
WHO	World Health Organization

ABSTRACT OF DISSERTATION

TITLE: A STUDY ON PREVALENCE OF HEARING IMPAIRMENT AND EAR DISEASES AMONG NAVY PERSONNELS OF ROYAL MALAYSIAN NAVAL, LUMUT, PERAK

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Introduction: Hearing impairment among military personnels is already well known worldwide including navy personnels. The disability will leads to psychosocial and financial dilemma but it is preventable.

Objective: This study was conducted to determine the prevalence of hearing impairment and ear diseases among navy personnels of Royal Malaysian Naval**,** Lumut, Perak.

Methodology: This is cross sectional study that had been conducted among navy personnels of Royal Malaysian Naval Lumut, Perak, from September till November 2010. Basically, two major groups involved in which they were diver and non-diver Units. Each participant was subjected to otoscopic examination and hearing tests which were Distortion Product Otoacoustic Emission (DPOAE) screening tool, Pure Tone Audiometric (PTA) and Tympanometry.

Result: A total number of 233 army personnel involved in this study. The prevalence of hearing impairment among army personnel was 18.9%. There was no significant difference in percentage of hearing impairment between Diver and Non-diver unit. However, there is a significant correlation of hearing impairment with age and duration of service. Majority of them were suffering of sensorineural hearing loss specifically noise-induced hearing loss. The higher prevalence of ear disease is otitis media (0.85%) follow by impacted wax and tympanosclerosis (0.4%).

Conclusion: There was high prevalence rate of hearing loss among navy personnel. While loud noise is recognized as a hazard, initiatives are required to increase use of effective preventative measures. Hearing conservation programmes are beneficial programmes that should be considered in Ministry of Defense.

ABSTRAK

Pengenalan: Masalah hilang pendengaran dikalangan anggota tentera diketahui umum termasuklah tentera laut. Masalah ini memberi kesan kepada psikososial dan kewangan tetapi ianya boleh dielakkan.

Objektif: Kajian ini dilakukan untuk mengenalpasti jumlah peratus kekurangan tahap pendengaran dan penyakit-penyakit telinga di kalangan anggota Tentera Laut Diraja Malaysia, Lumut, Perak.

Metodologi: Kajian ini merupakan kajian hirisan lintang di kalangan anggota Tentera Laut Diraja Malaysia, Lumut, Perak dari September sehingga November 2010. Secara umumnya, anggota tentera laut dibahagikan kepada dua unit utama iaitu unit penyelam dan bukan penyelam yang terdiri dari bahagian kapal perang permukaan dan teknikal. Setiap anggota menjalani pemeriksaan telinga dan ujian pendengaran iaitu 'Tympanometry', 'Distortion Otoacoustic Emission' (DPOEA) dan 'Pure Tone Audiometry' (PTA).

Keputusan: Sejumlah 233 anggota terlibat dalam kajian ini. Hasil kajian menunjukkan peratusan kurang pendengaran dikalangan anggota tentera laut ialah 18.9%. Namun kajian menunjukkan tidak terdapat perbezaan yang signifikan antara unit penyelam dan bukan penyelam. Akan tetapi terdapat hubungan yang signifikan antara tahap kekurangan pendengaran dengan factor umur dan tempoh berkhidmat. Manakala bagi penyakit telinga, peratus tertinggi bagi penyakit telinga adalah jangkitan telinga tengah iaitu 0.85%.

Kesimpulan: Kajian ini menunjukkan peratusan kurang pendengaran yang agak tinggi dikalangan anggota tentera laut. Oleh kerana kita mengetahui bunyi yang kuat adalah satu pencemaran dan boleh mengakibatkan kekurangan tahap pendengaran, maka usaha untuk meningkatkan cara pemeliharaan pendengaran yang berkesan adalah amat penting. "Program Pemeliharaan Pendengaran" adalah program yang sangat berfaedah untuk diambil kira dan dilaksanakan oleh Kementerian Pertahanan.

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

1.1 INTRODUCTION AND LITERATURE REVIEW

Hearing impairment among military personnels is already well known worldwide. People serving in military at some point will be exposed to high-intensity noise of various types. A wide range of weapons inflict damage on their operators as well as targeted enemy. The consensus group agreed that a sound environment of below 75dB was not harmful (Alberti P.W., 1992). Above this level, the transient threshold shift (TTS) occurs. However, the severity is depending upon frequency of sound and individual susceptibility. TTS will recover after periods of time. The greater the exposure, the longer recovery time till at one point, it will become permanent damage and this is described as permanent threshold shift (PTS).

Like an army personnels, permanent hearing loss is one of the most common disabilities among navy personnel as well. Although noise-induced injury is preventable by limiting exposure, it is generally irreversible once it occurs. The problem of reduced hearing function in active navy personnel has been documented in several studies. For example, using data from 1995 to 1999 Bonhker, *et al.* (2002), showed a significant threshold shift (STS) as high 25% in some Navy Personnel Ratings. Similar findings of hearing loss among military personnel are discussed in Gwin and Lacroix (1985) for submariners, Wolgemuth, K.S. *et al.* (1995) for Navy personnel, Ridgley and Wilkins (1991) for both Army and Navy personnel. In 2004 the Veterans Administration (VA) spent $108 Million dollars in disability payments to 15.8 thousand former Navy personnel for hearing loss. This represents an increase of $65

Million in spending by the VA on Navy hearing disability payments since 1999 (Geoffrey and Robert, 2007).

Given the enormity of the increase in spending by the VA on hearing loss disability payments to former Navy personnel, it is important to find the sources of this hearing loss and then investigate ways to reverse this trend. Although there are poorly understood individual susceptibilities to ear injury, and there may be individual predisposing factors such as hypertension, reliable measures for hearing screening on groups has become standard management in occupational health and safety. National standards of exposure are established by Occupational Safety and Health Administration (OSHA) of the US Department of Labor at 90 dB for 8 hours a day. The US Navy abides by the standards given in OPNAVINST 5100.19D, "Occupational Safety and Health Program Manual for Forces Afloat," which specifies that the 8-hour time-weighted average (TWA) is 84 dB(A). This instruction defines noise hazardous areas as areas where the routine noise is greater than 84 dB(A) or where peak noise levels are greater than 140 dB. In these areas, hearing protection or administrative controls are required. This study did not evaluate the degree of compliance with these exposure limits.

The primary focus of this study is to find out if the length of service impacts hearing loss. Over a career in the Malaysian navy, service members characteristically are posted to a variety of stations, both afloat and ashore. Many of these posts have high noise levels, such as certain ships; and particular ratings have high exposure, such as jobs near machines. If assignments of higher risk both in location and tasking can be identified, then focused prevention programs can be brought to bear, such as closer monitoring of all personnel, preventive measures in key high risk locations and ratings, and perhaps better rotational schedules.

All these preventative methods may reduce damage to the hearing of navy personnel. This will preserve quality of life for personnel, and save millions of dollars for government.

In general, many sources of potential damaging noise existed in military setting. These including the weapons system (e.g. handgun, rifles, artillery), wheeled and tracked vehicles, aircraft, ship and communication devices. Table 1.1 shows the military weapons and the sound level of each weapon.

Table 1.1: Military weapons and the sound level of each weapon

Weapons	Model	Sound Level (dB)
9 mm pistol	M9	157
5.56mm rifle	M16A2	157
5.56mmsquad automatic weapon	M249	160
7.62m machine gun	M60	155
0.50 caliber machine gun	M2	153
Machine gun	MK19,Mod3	145

Source: Rothschild *et al*., 1998.

Service members who encounter these noise sources throughout training, standard military operation or even combat which is more unpredictable in onset and duration are at risk of getting hearing impairment. Two possible risks are high frequency noise-induced hearing loss and tinnitus, typically referred as ‘ringing of the ears’. This morbidity is well known to be suffered and common among army personnel throughout the world but remains to be ‘hidden’ in most countries.

This study is to document the prevalence of hearing impairment and ear diseases among the navy personnels in Hospital Angkatan Tentera Laut (HAT), Lumut, Perak. According to Geoffrey and Robert (2007) statistical analysis of hearing impairment in navy found out that 13% of navy personnel have worsening hearing level meanwhile, Zulkaflay *et al.* (1996) Hospital Angkatan tentera, Lumut, revealed insidious development of high frequency sensorineural hearing loss may associated with diving.

1.2 DEFINITION OF HEARING LOSS AND HEARING IMPAIRMENT

Hearing threshold worse than 25dB at any frequency in either ear is defined as hearing loss. Hearing loss can either be in the low frequency range (0.5 to 2 kHz), high frequency range (4 to 8 kHz) or both ranges. The magnitude of hearing loss is determined by taking the mean threshold of 0.5, 1 and 2 kHz for low frequency hearing loss; the mean threshold of 4, 6 and 8 kHz if the hearing loss involved the high frequency and the mean of all frequencies if occurring in both ranges. Thus, the definition of hearing loss is presence of the mean hearing threshold level worse than 25dB in either ear (Toh *et al*., 2002).

The disabling hearing impairment of adult as defined by WHO is the permanent unaided hearing threshold level for the better ear of 41dB or greater, the "hearing threshold level" is to be taken as the average of hearing threshold level for the four frequencies 0.5, 1.2 and 4 kHz. Hearing impairment is classified into 3 major groups. The majority of hearing impairment is sensorineural type. It is related to disease of deformity of cochlea or cochlea nerve/retrocochlear. In this type of hearing impairment , there is no air-bone gap. Whereas if the air bone gap is 15dB or greater with normal tone conduction threshold, the individual has a significant conductive pathology contributing to the impairment. It is usually caused by either disease of external or middle ear. Some individuals having both components of conductive and sensorineural which is classified as mixed hearing loss.

Table 1.2: WHO classification, the degree of hearing loss

Degree of Hearing Loss	Decibel(dB)
Normal	0-25
Mild	26- 40
Moderate	41- 60
Severe	60 – 80
Profound	More than 80

1.3 DEFINITION OF NOISE-INDUCED HEARING LOSS

Noise can be described in terms of intensity (perceived as loudness) and frequency (perceived as pitch). Both the intensity and the duration of noise exposure determine the potential for damaging the hair cells of the inner ear. Sound intensity is measured as sound pressure level (SPL) in a logarithmic decibel (dB) scale. The term noise-induced hearing loss refers to reduction in auditory acuity results from exposure to sound. This situation may be temporary and described as temporary threshold shift (TTS) and duration may be from hours to days (Feurstein, 2002). The hearing loss may be permanent and this is described as permanent threshold shift (PTS). PTS may occur following repeated TTS, or following a single episode of noise exposure.

Acoustic trauma is used to describe the situation where a single exposure to an intense sound leads to an immediate hearing loss (National Institutes of Health Consensus Statement, 1990).

The sound stimuli generally exceed 140dB and much acoustic trauma is caused by 2 types of transient noises. They are the impulse noise, which is usually the result of an explosion, and the impact noise, which results from a collision (usually metal on metal). For example, a single gunshot, which is approximately 140 to 170 dB(A), has the same sound energy as 40 hours of 90dB(A) noise (Clark, 1999). This explains how an acoustic trauma may lead to permanent measurable hearing loss even from the first exposure to rifle practice.

The hearing loss abruptly reaches a maximum between 3 kHz and 6 kHz, followed by recovery at 8 kHz. This particular pattern of hearing loss, is typically referred to as the "noise-notch" audiogram. This is a characteristic audiometric configuration associated with noise induced hearing loss.

Coles *et al.* (2000) have published criteria for identification of an audiometric notch for use in medico-legal diagnosis of noise induced hearing loss. This was defined as a high-frequency notch where the hearing threshold at 3, 4, and/or 6 kHz is at least 10dB greater than at 1 or 2 kHz and at least 10dB greater than at 6 or 8 kHz. The hearing loss is variable between individuals. However, the principal characteristics of noise induced hearing loss as specified by the American College of Occupational Medicine Noise and Hearing Conservation Committee include the following:

1. It is always sensorineural.
2. It is usually bilateral and symmetric but in certain condition, it lead to unilateral hearing loss.
3. It rarely produce a profound loss.
4. It will not progress once noise exposure is stopped.
5. The 4 kHz frequency is the most severely effected and the higher frequencies (3-6 kHz) are more affected than the lower frequencies (500 Hz- 2 kHz).
6. Maximum losses typically occur after 10-15 years of chronic exposure.
7. Continuous noise is more damaging than intermittent noise (Dobie, 1998).

1.4 PATHOPHYSIOLOGY

Pathological change associated with noise-induced hearing loss is still having some controversy (Fridberger *et al.,* 2002). The two general theories have been advanced to account for the mechanism of injury.

The first theory is the metabolic mechanisms in which the sound with high intensity cause sensory cell damage by decreases cochlea blood circulation (Miller *et al.*, 1996). Acoustic overstimulation could potentially lead to excessive release of neurotransmitters such as glutamate associated with transduction function of the cochlea. Other metabolic cochlear mechanisms include outer hair cell plasma membrane fluidity and oxidative stress (Chen and Zhao, 2007). These leads to metabolic exhaustion.

The second theory is the structural mechanisms. Changes to micromechanical structures within cochlea have been reported as possible mechanisms of noise-induced hearing loss. Depolymerization of actin filaments in stereocilia maybe a substrate of TTS. Thus leads to decrease stiffness of the stereocilia of outer hair cells. It is sometimes referred as auditory fatigue. The stereocilia become disarrayed and floppy. Presumably, in such a state they respond poorly. The primary site of injury appears to be the rootlets that connect the stereocilia to the top of the hair cell. With loss of the stereocilia, the hair cells die. Death of the sensory cell can lead to progressive Wallerian degeneration and loss of primary auditory nerve fibers (Sohmer, 1997). There are also changes to nonsensory elements such as swelling of supporting cells, stria vascularis afferent nerve endings (Lim, 1986).

Acoustic trauma appears to have its pathophysiologic basis in mechanical tearing of membranes and physical disruption of cell walls with mixing of perilymph and endolymph.

At high energies, it can result in disruption of the tympanic membrane and ossicular injury (Sohmer, 1997).

1.5 CONSEQUENCES OF HEARING IMPAIRMENT

Inappropriate healthcare, ‘denial’ of importance of hearing conservation, reduced awareness and inadequate knowledge leading to increase risk of having hearing impairment. Hearing disability would later on had impact on person from doing normal and usual role in daily life including occupational and psychosocial need (Anonymous, 1997).

When hearing loss is limited to the high frequencies, individuals are unlikely to have difficulty in quiet conversational situations. The first difficulty that the patients usually notice is the trouble understanding speech when a high level of ambient background noise is present. As noise-induced hearing loss progresses, individuals may have the difficulty understanding high-pitched voices (e.g. women's, children's) even in quiet conversational situations.

Good hearing in both ears facilitates to localize the pinpoint of sniper fire and other relevant sounds. This impairment leads to difficulties in obtaining and performing effectively in their military service.

1.6 THE IMPORTANCE OF HEARING CONSERVATION PROGRAMMES

Hearing loss caused by exposure to recreational and occupational noise results in devastating disability that is virtually 100 percent preventable. Shearing forces that are caused by any sound have an impact on the stereocilia of the hair cells of the basilar membrane of the cochlea. When excessive, these forces can cause cell death. Avoiding the noise exposure stops further progression of the damage. Noise-induced hearing loss can be prevented by avoiding excessive noise and using hearing protection such as earplugs and earmuffs (Rabinowitz, 2003). In United States of America from the Department of Veterans Affairs (VA), the disabilities of auditory system including tinnitus and heavy loss, were the third most common type, accounting for almost 10% of total number of disabilities among military personnel. At the end of 2004, US military pay an annualized cost of some $660 million in hearing loss pensions (William & George, 2007).

They have also developed the effective hearing conservation programmes. These programmes sound maintaining situational awareness and affective communication. Service members receive the "reference, periodic, and termination" audiograms at the beginning, annually, and at the end of their enrollment in the programmes.

CHAPTER 2

OBJECTIVES OF STUDY

2.0 OBJECTIVES

2.1 GENERAL OBJECTIVE

To study the prevalence of hearing impairment and ear diseases among navy personnels of Royal Malaysian Navy, Lumut, Perak.

2.2 SPECIFIC OBJECTIVES

1. To determine the prevalence of hearing impairment and ear diseases among navy personnels.

2. To know the association of hearing impairment with age and duration of services.

3. To know the association of hearing impairment between divers and non divers.

2.3 RESEARCH HYPOTHESIS

Hypothesis for all objectives

2.3.1 There is an high percentage of hearing impairment and ear diseases among navy personnel.

2.3.2 There is an association of hearing impairment with age and duration of services.

2.3.3 There is an association of hearing impairment between divers and Non divers.

CHAPTER 3

METHODOLOGY

3.0 METHODOLOGY

3.1 STUDY DESIGN

This was a cross sectional study among the navy personnels which was conducted in the Hospital Angkatan Tentera (HAT) Malaysia, Lumut, Perak. On the basis of published military literature and our discussions with Navy Commanding General, we have divided the navy into two general groups:

1. Non diver: navy personnel who is stationed in surface warship/ technical units.
2. Diver.

Generally both groups have been exposed to same basic trainig and navy schooling an later stationed in either groups.

3.2 SELECTION CRITERIA

3.2.1 INCLUSION CRITERIA

1. All personnel of Royal Malaysian Navy, Lumut, Perak.

3.2.2 EXCLUSION CRITERIA

1. Personnel with history of ear disease and other pathological prior to join navy.

2. Navy personnel with exposed to shooting training less than 48 hrs (temporary theresold shift).

3.3 SAMPLE SIZE

1. Samples: individual who is serving as the navy personnels from The Royal Malaysian Navy, Lumut, Perak.
2. Sample size: calculated by using a single proportion formula:

$$n= \frac{(Z\alpha/2)^2}{(\Delta)^2} P(1-P)$$

Where:

n=sample size

Δ=precision

Z value=1.96 for 95% confidence interval

Based on above formula,

For prevalenve of hearing impairment:

P=13% (Geoffrey B.S., Robert P.T., 2007)

n=(3.84/0.025)1.3(0.87)= 173.7

=174 sample

= + 20% drop off = 174 + 35

=209

3.4 EQUIPMENTS

3.4.1 QUESTIONNAIRE

The questionnaire was used in this study as in Appendix 3. The questions included gender, age, duration of service in military and medical problem.

3.4.2 OTOSCOPE

The otoscope that was used in the study was Welch Allyn, (USA) (Figure 3.1). It is an important tool that gave the examiner an idea of the individual’s ear problem. It is used to visualize the external auditory canal and tympanic membrane as well as to assess the middle ear condition.

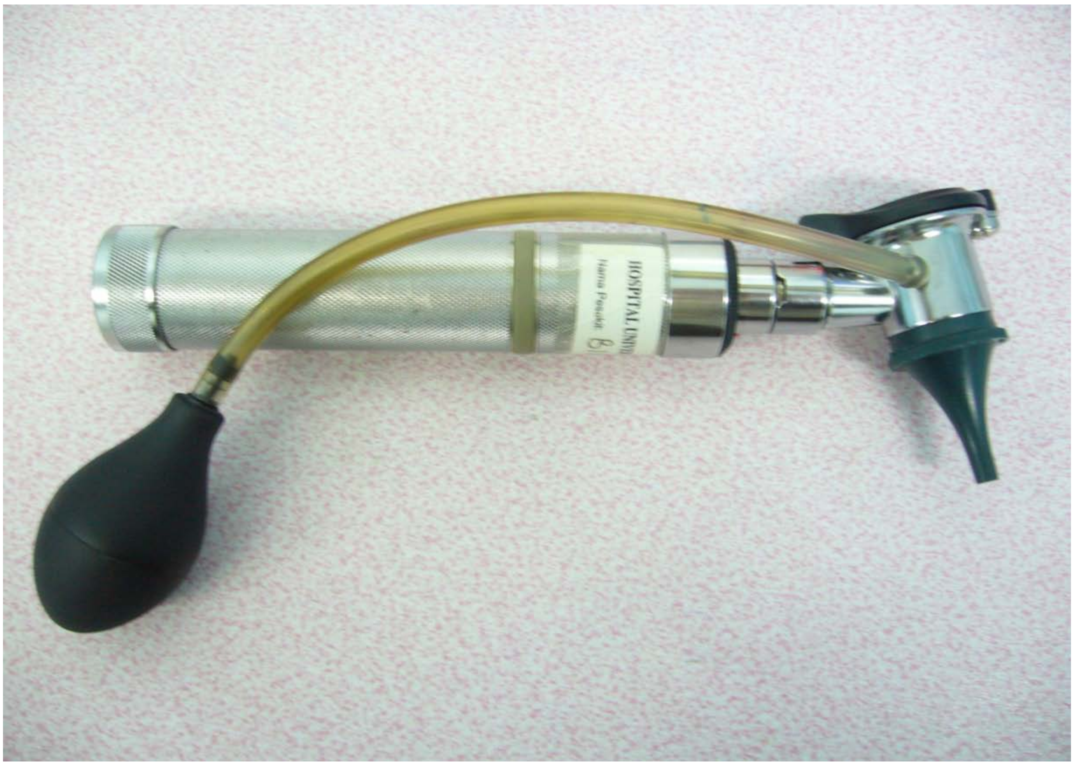

Figure 3.1: Welch Allyn Otoscope

3.4.3 TYMPANOMETER

Tympanometry is an objective test of middle-ear function. Tympanometry is performed by using Diagnostic Tympanometer GSI 38 (Welch Allyn). The test is non-invasive and does not require any response from the patient. The typical test time for both ears was less than two minutes. It is used to test the condition of the middle ear, mobility of the tympanic membrane and the conducting ossicles by creating variations of air pressure in the ear canal. The results of this test should always be viewed in conjunction with pure tone audiometry. Tympanometry is a valuable component of the audiometric evaluation. In evaluating hearing loss, tympanometry permits a distinction between sensorineural and conductive hearing loss, when evaluation is not apparent via tuning fork test. Furthermore, in a primary care setting, tympanometry can be helpful in making the diagnosis of otitis media by demonstrating the effect of a middle ear effusion.

3.4.4 OTOACOUSTIC EMISSION (OAE) MACHINE

Otoacoustic emission (OAE) are acoustic signals emitted from the cochlea to the middle ear and into external ear canal where they are recorded. The normal cochlea does not just receive sound; it also produces low-intensity sounds called OAEs. These sounds are produced specifically by the cochlea and, most probably, by the cochlear outer hair cells as they expand and contract. Historically, OAEs could not be measured until the late 1970s, when technology created the extremely sensitive low-noise microphones needed to record these responses. Pure tone audiometry measures the hearing pathway throughout the outer ear, middle ear, cochlea, cranial nerve (CN) VIII, and central auditory system. However, OAEs measure only the peripheral auditory system, which includes the outer ear, middle ear, and cochlea. OAE testing often is used as a screening tool to determine the presence or absence of cochlear function (McPherson *et al*., 2006).

The 4 types of otoacoustic emissions are as follows: spontaneous otoacoustic emissions (SOAEs), transient evoked otoacoustic emissions (TEOAEs), distortion product otoacoustic emissions (DPOAEs) and stimulus frequency otoacoustic emissions (SFOAEs). The most useful clinically otoacoustic emissions are transient evoked otoacoustic emissions (TEOAEs) and Distortion product otoacoustic emissions (DPOAEs). In this study, we measured DPOAE by using the Bio-logic AUDX II machine by biologic system corporation, USA. (Figure 3.2)

Figure 3.2: Otoacoustic emission device

3.4.5 PURE TONE AUDIOMETER

The instrument used in the measurement of auditory threshold is known as the audiometer. An audiometer has been described by the International Electrochemical Commission in 1976 as an instrument used for the measurement of acuity of hearing, and threshold of audibility. There are two types of audiometry widely used. They are: 1. Those that require a subjective response on the part of the patient and 2. Those that require no subjective response from the patient. The example of the first type is pure tone audiometry (PTA) which is used to measure the auditory threshold of an individual. Audiometric examination was performed by using Diagnostic audiometer model GSI 61.

3.4.6 SOUND TREATED BOOTH

This booth was designed by Medi Aids Sdn. Bhd. for audiometric examination for medical research. The booth was placed in a quiet room to improve the ambient noise.

3.5 STUDY PROCEDURE

This survey had been started after getting an approval from the Markas Angkatan Tentera Laut Di Raja Malaysia and Hospital Angkatan Tentera, Lumut, Perak. We met the Navy Commanding General and discussed regarding the details of study including our objectives and procedures.

All army personnel that fit the criteria were included in this study. The consent was taken and the questionnaire was answered. Ear examination was then performed. The otoscopic examination of external auditory canal and tympanic membrane was done. The Audiologist then conducted hearing assessments. The hearing test that was first performed on the subjects using Distortion Product Otoacoustic Emission (DPOAE) screening followed by tympanometry test. Finally, the pure tone audiometry (PTA) was performed in a sound treated booth. Pure tone stimulus was delivered at frequencies 500, 1000, 2000, 3000, 4000, 6000 and 8000 Hz. Both air and bone conduction thresholds were tested. Participants with problem and/or diseased ear were advised and referred to ORL specialist clinic, Hospital Angkatan Tentera, Lumut, Perak, for further evaluation and management.

Figure 3.3: Team member was performing the PTA on the subject

Figure 3.4 The researcher was performing the tympanometry on the subject

CHAPTER 4

RESULTS

4.0 RESULT

4.1 TOTAL NUMBER OF PARTICIPANTS

The total number of navy personnel recruited in this study was 233 subjects. All of them from Royal Malaysian Navy, Lumut, Perak. A total of 123 of them were from the diver group and another 110 from the non diver group (surface warship and technical units).

4.3 RACE DISTRIBUTION

Majority of the navy were Malay (87.1%), Indian (0.9%) and others (Kadazan, Bajau, Bidayuh) is 12%.

Table 4.1 The race distribution

Race	Frequency	Percentage (%)
Malay	203	87.1
Indian	2	0.9
Others	28	12
Total	233	100

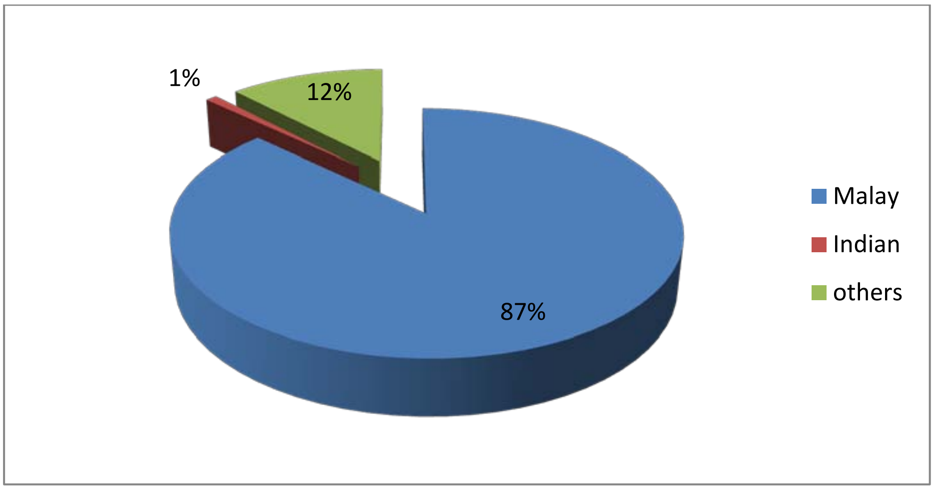

Figure 4.1 Racial distributions of subjects

4.3 GENDER DISTRIBUTION

Based on the study, 98.7% were male and 1.3% female. All females from the non diver group.

Table 4.2 Gender distribution among subject

Gender	Frequency	Percentage (%)
Male	230	98.7
Female	3	1.3
Total	233	100

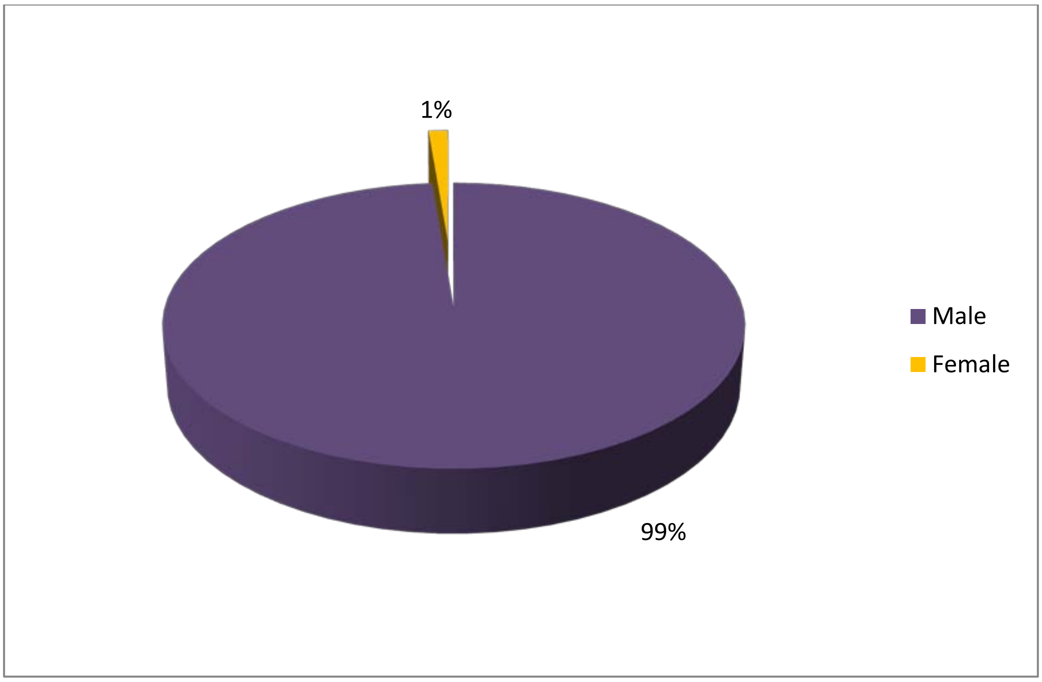

Figure 4.2: Gender distribution among subjects

4.4 AGE DISTRIBUTION

The age ranged from 21 to 47 year old with the mean age of 28.20. Majority were from the 25 to 30 years age group.

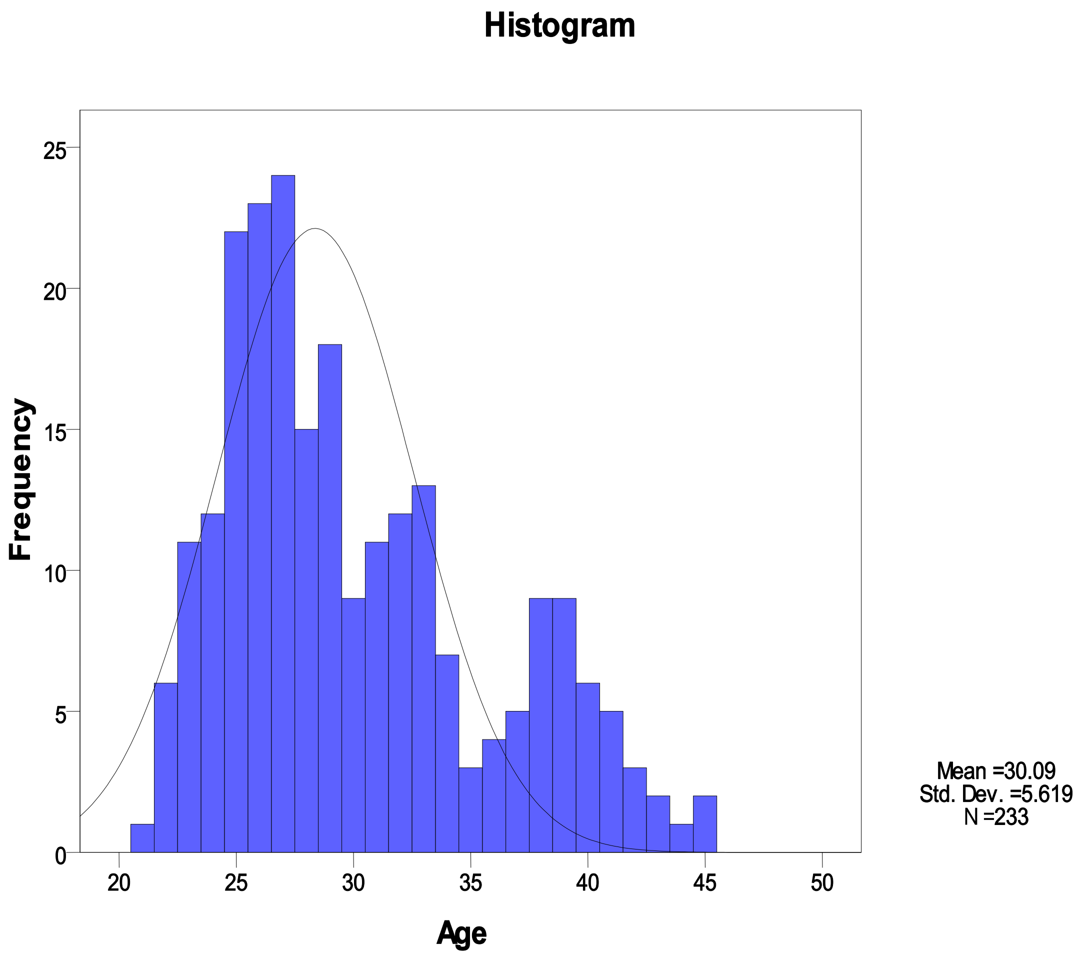

Figure 4.3: Age distribution

Table 4.3: Mean age according to the groups

Group	Mean	N	Std. Deviation
Diver	28.20	123	4.330
Non diver	32.22	110	6.131