HEARING LOSS AMONG SAILORS: A STUDY AT THE WESTERN NAVAL COMMAND, SEKONDI

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JULY, 2019
DECLARATION

I, MICHAEL DONKOR TETTEH do hereby declare that this thesis which is being submitted in fulfillment of the requirement for the Master degree in Audiology is the result of my own research performed under supervision, and that except where otherwise other sources are acknowledged and duly referenced, this work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

I hereby give permission for the Department of Audiology to seek dissemination/publication of the dissertation in any appropriate format. Authorship in such circumstances to be jointly held between me as the first author and the project supervisors as subsequent authors.

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Signed……………………………… Date………………………………

DR. NEAL BOAFO (Head of Department)
DEDICATION

This work is dedicated to the Almighty God and to my parents Mr. Samuel Y. Donkor and Madam Comfort A. Kornor. A special dedication also goes to my wife Emelia Comfort Dabri-Donkor and beautiful daughters Tehillah Mawuhi Adzo Donkor and Michelle Korkor Awisi Donkor for their encouragement and support.
ACKNOWLEDGEMENTS

I would like to express my profound gratitude to God almighty for giving me the strength to accomplish this work. I wish to acknowledge the efforts of my supervisors Dr. Neal Boafo, Dr. Samuel Anim-Sampong, and the acting head of Department, Dr. Neal Boafo for making suggestions and corrections to my work.

Another thanks to the Department of Audiology, Speech and Language Therapy School of Biomedical and Allied Health Sciences, College of Health Sciences, University of Ghana for providing me with all the tools and equipment needed for the research work. I would also like to acknowledge my colleagues especially George, David and Frank for their support. To Brig. Gen. E.C. Saka and Col. N.A. Obodai, I cannot conclude without acknowledging your unflinching encouragement and support. I say thank you.

Finally, to the Ghana Armed Forces High Command, Chief of Naval Staff, Flag Officer Commanding Western Naval Command, Director General Medical Services, Director General Defence Intelligence and Commanding Officers of all the Naval Ships for their assistance to make this work a success.
ABSTRACT

Background: Hearing Sensitivity is the commonest form of hearing. Occupational hearing loss has received little or no attention in most industries and has left many employees with hearing loss of varying degrees after retirement. The navy has not been spared in this area as some of its personnel exposed to varying levels of noise. This study was carried out to determine the prevalence of hearing loss and to investigate the risk factors associated with hearing loss among naval personnel of the Ghana Armed Forces at the Secondi Naval Base.

Methods: The descriptive cross-sectional study design was employed in this study. A random sample of 153 naval personnel from the Sekondi naval base took part in this study. Both air and bone conduction of the ear were measured using an audiometer and additional data collect using a structured questionnaire. Data analysis in the form of descriptive statistics and inferential statistical tests, specifically Independent t-test and the Chi-square statistic were done using the Statistical Package for Social Sciences (V. 22.0).

Results: The prevalence of hearing loss among the naval personnel was 28.1%. Working in the engine room, ageing, diabetes and hypertension were the main risk factors associated with hearing loss. Other less significant risk factors were non-use and poor use of ear protectors, and exposure to loud music.

Conclusion: The prevalence of hearing loss among naval personnel remains a source of concern. The Ghana navy command and the health directorate of the Ghana Armed Forces should carry out regular ear and hearing screening of their naval personnel for early identification, treatment and prevention of hearing loss among the personnel. Earmuffs and earplugs should also be provided for the naval personnel with proper instruction on its use.
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<tr>
<td>AOR</td>
<td>Adjusted Odds Ratio</td>
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<tr>
<td>ASHA</td>
<td>American Speech-Language-Hearing Association</td>
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<tr>
<td>CI</td>
<td>Confidence Interval</td>
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<tr>
<td>dB</td>
<td>Decibel</td>
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<td>EPRC</td>
<td>Ethics and Protocol Review Committee</td>
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<td>GAF</td>
<td>Ghanaian Armed Forces</td>
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<td>GN</td>
<td>Ghana Navy</td>
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<td>GNS</td>
<td>Ghana Navy Ship</td>
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<td>IRB</td>
<td>Institutional Review Board</td>
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<td>NIH</td>
<td>National Institutes of Health</td>
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<td>ONIHL</td>
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<td>RNN</td>
<td>Royal Norwegian Navy</td>
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<td>SBAHS</td>
<td>School of Biomedical and Allied Health Sciences</td>
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<td>SPSS</td>
<td>Statistical Package for Social Sciences</td>
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<td>STS</td>
<td>Significant Threshold Shift</td>
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<td>TTS</td>
<td>Temporary Threshold Shifts</td>
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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

Hearing loss is characterized by a reduction in the sensitivity of the auditory mechanism so that sounds need to be of higher intensity than normal before they are perceived by the listener. This may be mild, moderate, severe, or profound (Stach, 2010). A person who is not able to hear as well as someone with normal hearing – hearing thresholds of 25 dB or better in both ears – is said to have hearing loss (Stach, 2010).

The number of individuals with impaired hearing worldwide more than doubled from 120 million to 275 million from 1995 to 2004 (Horikawa et al., 2013). The World Health Organization (WHO) reported that 466 million people worldwide suffer from disabling hearing loss globally (World Health Organisation, 2019). Approximately 15% of American adults (37.5 million) aged 18 and over report some trouble hearing (Blackwell, Lucas, & Clarke, 2015). About 18% of adults in America aged 20-69 have speech-frequency hearing loss in both ears from among those who report 5 or more years of exposure to very loud noise at work, as compared to 5.5% of adults with speech-frequency hearing loss in both ears who report no occupational noise exposure (Hoffman, Dobie, Losoncze, Themann, & Flamme, 2017). Two percent of adults in America aged 45 to 54 have disabling hearing loss (Hoffman et al., 2017). In a Norwegian population-based study, disabling hearing loss was found among 10.3% of the participants (Arve Lie et al., 2016).

Hearing loss can affect one ear or both ears, and leads to difficulty in hearing conversational speech. People with hearing loss ranging from mild to severe are referred to as “hard of hearing”. People who are “hard of hearing” usually communicate
through spoken language and can benefit from hearing aids, cochlear implants, and other assistive devices as well as captioning. People with more significant hearing losses may benefit from cochlear implants. ‘Deaf’ people mostly have profound hearing loss, which implies very little or no hearing. They often use sign language for communication (Stach, 2010). Types of hearing loss include conductive hearing loss and sensorineural hearing loss. If a loss occurs as a result of changes in the outer or middle ear and the cochlea, it will have both a conductive and a sensory component and is considered a mixed hearing loss.

There are many contributing factors in hearing loss including a genetic predisposition, complications at birth, aging, certain infectious diseases such as meningitis, chronic ear infections, use of ototoxic drugs, or exposure to excessive noise and ageing (World Health Organisation, 2019). Age is the strongest predictor of hearing loss among adults (Hoffman et al., 2017). Presbycusis, which is sensorineural hearing loss related to aging, is the most common cause of hearing loss, and is characterized by gradual, bilateral, high-frequency hearing loss (Yueh, Shapiro, MacLean, & Shekelle, 2003). The risk of developing hearing impairment is enhanced in males and in those with less education, or a history of industrial or military service and occupational noise exposure (Kurmis & Apps, 2007; Muhr, Mansson, & Hellstrom, 2006). Exposure to noise is an important cause of hearing loss and hearing loss is frequently found in workplaces known for high noise levels, for example the mining and construction industries (A Lie et al., 2016). Noise Induced Hearing Loss (NIHL) is regarded as a serious problem and one of the most recorded occupational disorders in Europe and in the rest of the world and amounts to between 7 and 21% of the hearing loss (Nelson, Nelson, Concha-Barrientos, & Fingerhut, 2005). This is lowest in the industrialized countries, where the incidence is going down, and highest in the developing countries (Lie et al., 2016). In
Africa, studies in Nigeria (Ali, Garandawa, Nwawolo, & Somefun, 2012), Tanzania (Musiba, 2015), and Ghana (Amedofu, Ribera, & Nyarko, 2013), have all shown the dangers associated with Occupational Noise-Induced Hearing Loss (ONIHL).

In the military, noise exposure is among the most prevalent occupational health hazards, with hearing loss commonly reported (A Lie et al., 2016). Military personnel are dependent on proper hearing acuity in order to ensure effective verbal communication. Hence, the consequences of impaired hearing are critical as it may degrade performance and have negative effects on operational readiness during military activities (Irgens-Hansen et al., 2016).

Despite a high level of public awareness regarding the importance of hearing preservation and increasingly stringent international occupational health, safety and welfare requirements mandating provision of safer work environments, ONIHL continues to be a significant occupational hazard (Kurmis & Apps, 2007). It is permanent and may cause significant disability, for which there currently exists no cure, but is largely overtly-preventable (Trost & Shaw, 2007). Work on board Navy vessels is associated with exposures to continuous noise from the vessel machinery and to impulse noise from shooting and explosions (Irgens-Hansen et al., 2016) and the Ghana Navy is no exception.

Personnel on board the Ghana Navy ships are exposed to excessive noise that could cause noise-induced hearing loss. If risks associated with hearing loss among naval personnel can be identified, then focused prevention programs can be implemented to help address the situation. Hence, this study is aimed at investigating the prevalence of hearing loss among naval personnel at the Western Naval Command, Sekondi-Western Region of Ghana.
1.2 PROBLEM STATEMENT

Hearing loss is a common public health problem (Irgens-Hansen et al., 2016). This raises a lot of concerns with regards to the important role of hearing among security personnel. The records on hearing loss among personnel of the Ghana Armed Forces appear to be even higher among the naval personnel (37 Military Hospital, Annual Report, 2016; 2017). According to Trost and Shaw (2007), permanent hearing loss is one of the most common disabilities among sailors.

Constant exposure to the loud engine sound on board a naval ship may increase one’s risk of hearing loss. Noise levels measured in different locations on board navy vessels have been found to exceed the recommended maximum noise levels in most vessel classes ((Irgens-Hansen et al., 2015). Irgens-Hansen et al.(2016) found that 31.4% of personnel on board Norwegian naval vessels had hearing loss. This gives an indication as to the risks of developing hearing loss among naval personnel. However, no known studies have been conducted to assess the prevalence of hearing loss among Ghanaian naval personnel. This underscores the need to assess the prevalence of hearing loss among personnel of the Ghana Navy.

1.3 PURPOSE OF THE STUDY

The purpose of the study was to determine the prevalence of hearing loss and to investigate the risk factors associated with hearing loss among naval personnel of the Ghana Armed Forces at the Secondi Naval Base.
1.4 RESEARCH OBJECTIVES

1. To determine the prevalence of hearing loss among naval personnel in the Ghana Armed Forces?

2. To identify the risk factors associated with hearing loss among naval personnel in the Ghana Armed Forces?

1.5 RESEARCH QUESTIONS

1. What is the prevalence of hearing loss among naval personnel in the Ghana Armed Forces?

2. What are the risk factors associated with hearing loss among naval personnel in the Ghana Armed Forces?

1.6 SIGNIFICANCE OF THE STUDY

Findings of the study will serve as evidence-based information to the general public and especially, the Ghana Navy High Command on the prevalence and risk factors associated with hearing loss among naval personnel in the Ghana. This will help sensitize them on the need to make concerted efforts to address the problem.

Findings on the risk factors associated with hearing loss among naval personnel in Ghana will help the Ghana Navy administration and the Ghana Armed Forces Medical Services to make informed decisions on policy, planning and interventions to eliminate, if not possible, reduce to the barest minimum, causes and risks associated with hearing loss among the naval personnel.
1.7 OPERATIONAL DEFINITION OF TERMS

**Prevalence:** Percentage of naval personnel having hearing loss within a particular period of time

**Hearing loss:** One with hearing thresholds of 25 dB or worse in both ears.

**Naval personnel:** Officers and ratings of the Ghana navy at Secondi Naval Base.
CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter presents the review of literature for the study. Literature was accessed from articles and abstracts from online databases including ScienceDirect, PubMed, CINAHL and Google Scholar. The review of literature covered the concept of hearing loss, prevalence and risk factors of hearing loss. The other sections of the chapter included the causes of hearing loss, effects of hearing loss, occupational noise standards, personal hearing protection, and the summary of literature review.

2.2 CONCEPT OF HEARING LOSS

Hearing loss refers to conditions in which individuals are fully or partially unable to detect or perceive sound which can range from slight to complete deafness (Stedman, 2005). Hearing loss is characterized by a reduction in the sensitivity of the auditory mechanism so that sounds need to be of higher intensity than normal before they are perceived by the listener (Stach, 2010). Persons with hearing thresholds of 25 dB or worse in both ears are said to have hearing loss. It can affect one or both ears, and leads to difficulty in hearing conversational speech or loud sounds. The amount of hearing loss is defined as a mild, moderate, severe or profound loss and is identified by the decibel (dB) loss (World Health Organisation, 2019).

A mild loss is 25 - 40 dB, moderate 41 - 55 dB, moderately severe 56 - 70 dB, severe 71 - 90 dB, and profound 91+ dB (World Health Organisation, 2019). An individual with a mild hearing loss has difficulty hearing soft sounds and a far-away speaker; a moderate loss can lead to misunderstanding of conversational speech if the speaker is more than 5 feet away or the speaker is close but in a noisy environment such as a
public area or classroom. For someone with a moderately severe loss the speaker must be loud to be understood (World Health Organisation, 2019).

Hearing thresholds are recorded across frequencies using air conduction pure tone signals that are presented using transducers (E.g. insert earphones, supra-aural, circum-aural, or free field speakers). In addition to air conduction signals, bone conduction pure tone thresholds, presented with a bone oscillator, represent hearing thresholds when directly stimulating the cochlea. Air conduction stimuli represent hearing thresholds of sound conducted through the entire auditory system (external, middle, inner ear and auditory nervous system) whilst bone conduction audiometry represents thresholds of sound conducted through the inner ear and auditory nervous system (Stach, 2010).

A basic pure tone hearing test (air conduction) checks individuals’ ability to hear tones of different pitches in each ear. In most cases, soft foam earphones are inserted into ear canals, and will deliver a series of tones into the ears. The tones will vary in pitch and loudness. This audiologic testing is performed to assess hearing thresholds across the range of frequencies that are important for human communication. Auditory thresholds are typically measured for air- and bone-conducted pure-tone stimuli in order to differentiate conductive from sensorineural hearing loss and to characterize the pattern of hearing loss at various frequencies (Cunningham & Tucci, 2017).

In doing so, each ear is tested individually. The patient will indicate when a tone is heard by pushing a button or raising his/her hand. However, the bone conduction audiometry is conducted by placing a bone oscillator behind the ear instead of using headphones. The bone oscillator transmits sound through bone vibration to the cochlea or inner ear, bypassing the middle and outer ear. This is helpful in determining the presence of hearing difficulty due to a problem with the middle ear, such as an ear
infection, or with the inner ear, which may be due to aging, noise exposure, or a variety of other causes (Stach, 2010).

Hearing loss can either be conductive or sensorineural (Martines, Martines, Mucia, Sciacca, & Salvago, 2013). Conductive hearing loss is hearing loss that affects the structures that conduct sound to the inner ear (Aithal, Aithal, Kei, & Driscoll, 2012). Ear wax, infection and fluid can block transmission of sound. Damage to the eardrum and middle ear bone can also cause conductive hearing loss. Conductive hearing loss usually involves a reduction in sound level, or the ability to hear faint sounds (R. Sataloff & Sataloff, 1993). Conductive hearing loss is a type of hearing loss that can often be medically or surgically corrected or treated if detected early.

Sensorineural hearing loss affects the sensory cells in the inner ear (cochlea) due to nerve damage which affects the loudness and clarity of hearing (Martines et al., 2013; R. Sataloff & Sataloff, 1993). Sensorineural hearing loss not only involves a reduction in sound level, or ability to hear faint sounds, but also affects speech understanding if it occurs congenitally. Sensorineural hearing loss can be caused by birth injury, drugs that are toxic to the auditory system, ototoxic, and genetic syndromes (Marfoh, 2011). Sensorineural hearing loss may also occur as a result of persistent noise exposure, head injury, and aging. In mixed hearing loss, conductive hearing loss occurs in combination with a sensorineural hearing loss. In other words, there may be damage in the outer or middle ear and in the inner ear or auditory nerve. When this occurs, the hearing loss is referred to as a mixed hearing loss (R. Sataloff & Sataloff, 1993).
2.3 PREVALENCE OF HEARING LOSS

Estimates of the prevalence of hearing loss vary widely based on both the method of estimation (e.g., survey or diagnostic codes) and the sample from which they are made. Evidence shows that there has been a significant rise in disabling hearing loss; rising from 0.9% in the year 1985 to 2.1% in 1995; and reaching an estimated global prevalence of 10% in the year 2008 (Oishi & Schacht, 2011).

Hearing loss has been recognized as the most common sensory loss affecting a significant number of the world's population (Olusanya, Neumann, & Saunders, 2014). However, there is difficulty in recognizing the onset of hearing impairment among adults and usually comes to light after several years after its onset; thus, resulting in dire consequences on their health (Mcmahon et al., 2013) and employment (Mcmahon et al., 2013; World Health Organisation, 2019).

The prevalence of hearing loss, vary widely based on both the method of estimation (e.g., survey or diagnostic codes) and the sample from which they are made. Worldwide, estimates show that approximately about 432 million of adult population have some form of hearing loss (WHO, 2019). About 5% of the global population suffer from permanent disabling hearing loss (World Health Organisation, 2019). Majority of these people with hearing loss reside in low- and middle-income countries including Ghana (World Health Organisation, 2019).

A number of studies in the United States have revealed that a significant number of the general population suffer from a form of hearing disorder (Kochkin, 2001; Lin, Niparko, & Ferrucci, 2011), ranging from mild to severe hearing loss (Goman & Lin, 2016; Lin et al., 2011). In a study to determine the prevalence of hearing loss in the United States, using a cross-sectional analysis of data obtained between 2001 through
2010 from 9648 respondents, it was established that approximately 38.3 million people aged 12 years and above had a form of hearing loss. In terms of its degree, 25.4 million had mild hearing loss, 10.7 million experienced moderate hearing loss, 1.8 million suffered from severe hearing loss, and 0.4 million had profound hearing loss (Goman & Lin, 2016).

Comparing the prevalence of disabling hearing impairment between developed and developing countries including Ghana, reports indicate that the prevalence rate in developing countries is as twice as what pertains in developed countries; depicting an unequal distribution across the globe (World Health Organisation, 2019). For instance, estimates show that about two-thirds of the world's population suffering from hearing impairment are within developing countries (World Health Organisation, 2019). Studies in some countries including Sub-Saharan African countries highlight a prevalence rate of hearing impairment hovering around of 4.7% to 7.8% in Southern Vietnam and Northern Vietnam respectively; 7.6% in Nigeria (Beria et al., 2007; Mathers, Lopez, & Murray, 2006; World Health Organisation, 2019) and also accounting for approximately 20% of reported disabilities in South Africa (Africa, 2012).

With regards to the relationship between gender and age associated hearing impairment a plethora of studies have pointed out that at higher frequencies, women are able to hear better than men. However, a reversal of this phenomenon occurs as they age (Beria et al., 2007; Murphy & Gates, 1997; Sharashenidze, Schacht, & Kevanishvili, 2007). This simply implies that women have a poorer hearing capacity at lower frequencies as they age compared to men.
In terms of age, some studies have reported that one-third of persons above 65 years have hearing problems with high incidence seen in South Asia, Asia Pacific and Sub-Saharan Africa (Olusanya et al., 2014; World Health Organisation, 2019). Similarly, findings from some other works relying on data from Sub-Saharan Africa has shown that people within the age range 15 years and above suffer from various degree of disabling hearing loss ranging from slight impairment to profound impairment (World Health Organisation, 2019). Specifically, statistics in terms of hearing impairment severity shows that; 14.1% suffer from slight impairment (26-40dB); moderate impairment 5% (41-60dB), and severe impairment 1% (61-80dB) (World Health Organisation, 2019).

Other studies have been conducted to determine the prevalence of hearing loss among different groups considering their occupation. For example, Kitcher, Ocansey, & Tumpi, (2012) conducted a cross-sectional study in Ghana comparing 140 workers from the stone crushing industry to a control group of 150 health workers. In the study, aside gathering data by means of a questionnaire, pure tone audiometric assessment was carried out for both groups. Results from the study showed a higher incidence of tinnitus among the stone workers (26.9%) compared to the control group (21.5%). Also, they concluded that the prevalence rate for hearing loss is about 19.3% for the left ear as against 14.3% for the left ear.

Correspondingly, a study conducted among military personnel's in Belgium uncovered that the military officers had various degree of hearing loss. From a sample size of 2055 subjects within the age range 18-55 years, data was gathered on hearing-related medical history, noise exposure in military and leisure time activity using a questionnaire. In combination with assessment carried out using an audiometer to determine hearing
threshold, the results of the study showed that: 32.2% (661) had a slight hearing loss; 13.6% (280) had a moderate hearing loss; and 10.0% (206) had severe hearing loss (> 60 dB) of 4 and 6 kHz for both ears (Collée et al., 2011). Furthermore, Collée and colleagues found out that the prevalence of hearing impairment in terms of its classification as mild, moderate, severe, and profound increased significantly with age and within certain infantry unit.

2.4 RISK FACTORS ASSOCIATED WITH HEARING LOSS

Quite a number of factors have been linked to the development of hearing loss ((Forge & Schacht, 2000; Gates, Schmid, Kujawa, Nam, & D’Agostino, 2000). A conductive hearing loss is due to an abnormal reduction or attenuation of sound as it travels from the outer ear to the cochlea. Increasing age, hypertension, current or former smoking, obesity, obstructive sleep apnoea, hypercholesterolemia, loud leisure-time activities, firearm use, and occupational noise exposure are all associated with an increased frequency of auditory dysfunction complaints (Casale et al., 2012; Figueiredo, de Azevedo, & Penido, 2015).

Excessive noise is considered as one of the most common occupational hazards. Based on the World Health Organization (World Health Organisation, 2019) definition, about 16% of hearing loss (HL) worldwide is attributable to occupational noise exposure. The armed forces are among the occupational categories that are the most exposed to noise at work (Paoli & Merllié, 2000). The exposure to noise, both long or short term, repeated exposure to noise and a single exposure to an extremely intense sound, may cause irreplaceable damage to the auditory system and results in hearing loss, termed noise-induced hearing loss (Azizi, 2010).
The hearing loss is usually slow in onset but progresses relentlessly for as long as the exposure continues (Forge & Schacht, 2000; Gates et al., 2000). Kujawa & Liberman, (2006) observed that repeated exposure to noise can cause the death of sensory hair cells and permanent hearing loss, referred to as a “permanent threshold shift.” Death of hair cells can be followed by a slower loss of spiral ganglion neurons over a period of months or years.

In June 2008, a study by the U.S. National Institute of Health (NIH) published in the Annals of Internal Medicine, found a strong and consistent link between impaired hearing and diabetes. After analysing the results of hearing tests given to a nationally representative sample of working-age adults in America, the investigators found participants with diabetes or pre-diabetes were more likely to have at least mild hearing loss in their ability to hear low-to-mid and high-frequency tones compared to people without diabetes (Bainbridge, Hoffman, & Cowie, 2008).

Furthermore, Horikawa et al. (2013) confirmed that diabetes affects hearing in several ways. In explaining the underlying factor, Horikawa et al. (2013) argued that anytime an individual blood sugar rises; there is a breakdown of nerves in the ears the same kind of nerve damage that causes tingling and other symptoms in the fingertips and toes. A recent study found that hearing loss is twice as common in people with diabetes as it is in those who don't have the disease. Also, of the 84 million adults in the U.S. who have pre-diabetes, the rate of hearing loss is 30 percent higher than in those with normal blood glucose (American Diabetes Association, 2017). It’s known that high blood sugar can damage blood vessels throughout the body, including your ears. If you’ve had diabetes for a long time and it isn’t well-controlled, there could be damage to the vast network of small blood vessels in your ears.
To determine the likely association between hypertension and hearing loss, Agarwal, Mishra, Jagade, Kasbekar, and Nagle (2013) conducted a study using 150 cases and 124 controls, both genders, aged 45–64 years. In the study, hypertension was verified through blood pressure readings and was classified as grade 1, grade 2 and grade 3 hypertension or no hypertension according to the blood pressure readings. Hearing was assessed by measuring pure tone threshold at various frequencies ranging between 250 and 8,000 Hz. There is a significant association between hypertension and increase in the hearing threshold. Hearing loss in the population under study suggests that hypertension is an accelerating factor of degeneration of the hearing apparatus due to aging (Agarwal et al., 2013).

2.5 CAUSES OF HEARING LOSS

The causes of hearing loss in adults are legion (World Health Organisation, 2019) and obviously workers are not immune from non-occupational causes. Some illnesses and their treatments can affect the way in which the ear responds to potentially damaging noise trauma. Few of these causes are reviewed below.

To begin with, drugs adversely affect the auditory system; the main ones in clinical use are aminoglycoside antibiotics and cisplatin, both of which are toxic to sensory hair cells. Hearing loss develops in approximately 20% of patients receiving aminoglycosides, (Duggal & Sarkar, 2007; Forge & Schacht, 2000) and the prevalence is as high as 56% among patients with cystic fibrosis (Al-Malky, Dawson, Sirimanna, & Bagkeris, 2015), population exposed to repeated courses of aminoglycoside therapy. Among adults who have received cisplatin, clinically significant hearing loss develops in approximately 60% of patients with testicular cancer and 65% of patients with head and neck cancer (Frisina et al., 2016). According to Cunningham and Tucci (2017),
susceptibility to cisplatin-induced hearing loss depends on the cumulative dose of the drug, the age of the patient (children are more susceptible than adults), and status with respect to concurrent cranial irradiation. Lambert, Gunn and Gidley (2016), indicate that patients who have severe hearing loss caused by ototoxic drugs are likely to be identified and referred for follow-up auditory testing, but many more patients with mild-to-moderate drug-induced hearing loss are not identified and hence do not receive treatment for their hearing loss (Lambert et al., 2016).

Acoustic trauma by gunfire noise, in the case of rifles, typically causes unilateral or asymmetrical hearing loss in which hearing loss of the left ear is more profound than the right ear in right-handers by the head-shadow effect (Moon, 2007). (Sataloff, Hawkshaw, & Sataloff, 2010) posited that guns are loud enough to the extent that one can suffer hearing damage from even a single shot - although it is quite unlikely. In addition, it is quite likely that one would lose hearing, at least temporarily, within a minute or two of prolonged exposure to gun fire. Firearm noise can cause hearing loss for one simple reason; the noise that emanates from a firearm is in excess of the 80 decibels safety range. Noises above 80 decibels are considered unsafe because they can cause permanent hearing damage within hours. Firearm noise ranges at about 140 decibels, and that figure can go up if the firearm is held close to the ear when firing. At almost double the safety range, firearm noise can cause permanent hearing loss within seconds. The loud noise from a firearm enters the ear canal and damages the small delicate hairs found inside the cochlea.

Another cause of hearing loss is perforated ears. A perforated eardrum is a hole or tear that has developed in the eardrum (Willacy, 2018). The extent of hearing loss can vary greatly. For example, tiny perforations may only cause minimal loss of hearing. Larger perforations may affect hearing more severely. Also, if the tiny bones (ossicles) are
damaged in addition to the eardrum then the hearing loss would be much greater than, say, a small perforation which is not close to the ossicles. A number of things can cause the eardrum to rupture; one of the most common causes is an ear infection. When the middle ear is infected, pressure builds up and pushes against the eardrum. When there is a build-up of pressure, it can cause the eardrum to perforate (Roizen, 1999). When that happens, you may suddenly notice that the pain and pressure you've felt from the infection suddenly stops and pus drains from the ear. Another common cause of a ruptured eardrum is poking the eardrum with a foreign object, such as a cotton-tipped swab or a bobby pin that's being used to clean wax out of the ear canal (Abi-Hachem, Zine, & Van De Water, 2010).

Hearing loss can also be caused by an ear infection. Eliminating the build-up of fluid relieves the pain and pressure that often accompanies an ear infection and can prevent the eardrum from rupturing. If fluid builds up without resolution, the pressure can cause your eardrum to rupture. A history of recurrent ear infections can also lead to tympanosclerosis, which is the thickening or scarring of the tympanic membrane (McCormick et al., 2016). A perforated eardrum and tympanosclerosis adversely affect the mobility of the eardrum and reduce hearing acuity.

The conductive as well as sensorineural hearing loss have been demonstrated both in cases of closed head injury with fracture of the base of the skull and in cases without fracture (Brusis, 2011). The degree of hearing loss may vary depending on the severity of the head injury. The severity of Head injury is measured clinically using the Glasgow coma scale scoring system (G.C.S). The Glasgow Coma Scale was first published by Teasdale & Jennett, (1974). This scoring system provides the best measure of severity of head injury. The score is the sum of the scale’s three measures of eye opening, best motor and verbal responses. This ranges from a score of 3 for a patient with no motor,
verbal response or eye opening to painful stimuli, to 15 for a patient who is oriented, follows commands, and has spontaneous eye opening.

Devastating head injuries have been closely linked to sensorineural hearing loss (Irgens-Hansen et al., 2016; Willacy, 2018). Podoshin & Fradis, (1975) observed that trauma to the ear may result in fracture of the external auditory canal, tympanic membrane perforation, fracture to the ossicular chains, fracture of the temporal bone itself, damage to the cochlea or the facial nerve. Lesser bone trauma causes damage to the ossicular chains. Injuries sustained around the internal and external ear can affect the hearing threshold. Internal ear injuries (injuries to the ear canal or eardrum) can be caused by sticking things in the ear (a cotton swab, finger, or pencil) or from abrupt changes in pressure, as from flying or deep-sea diving. The eardrum also may be ruptured by a blow to the ear, particularly when the ear is wet. External ear injuries (injuries to the soft fleshy tissue of the ear) may be caused by any force or trauma applied to the ear. These include blows or accidents that cause scratches, bruises, blood clotting, cuts, or swelling of the fleshy tissue.

Inflammation from an injury in the chain of bones can result in ossification or arthritis type response which compromises the passage of sound into the cochlea (Abi-Hachem et al., 2010). Head injuries can also result in temporal bone fractures, and direct damage to the central auditory cortex areas located on both sides of the brain. Serious head trauma can also cause ruptures of the thin membranes of the cochlea or vestibular system, resulting in loss of balance and hearing. More often than not, patients with head injury find pure tones objectionable at levels far below normal ears, i.e., less than 90 dB.
2.6 HEARING LOSS AMONG SAILORS

Trost and Shaw (2007), conducted a cross sectional survey among 267,658 enlisted sailors who had occupational exposure above an 8-hour time and enlisted sailors who had reached the termination of their service. Only audiograms corresponding to active duty Navy enlisted personnel during the period of 1979 to 2004 were used. They found that enlisted sailors who spent one-half of a 30-year Navy career assigned to a surface warship had a 13-percentage point higher probability of leaving the service with a reduction in the ability to hear, compared with someone who spent his or her whole career in a shore billet. If the same sailor spent two-thirds of his or her 30-year Navy career assigned to a surface warship, then the probability of hearing loss at the end of his or her career would increase by another 5 percentage points.

Furthermore, Trost and Shaw (2007) argued that if one-half of an individual's time during a 30-year Navy career is spent on a warship, then the probability of a Significant Threshold Shift (STS), which implies a reduction in the ability to hear normally at the end of his or her career is 0.48. If the individual spent two-thirds of his or her time on a surface warship, then the probability increases to 0.53. As a comparison, if an individual spends his or her entire career at a shore duty station, then the probability of a STS is only 0.35. They concluded that time spent on surface warships is far more damaging to hearing than time spent at shore duty stations. The findings from this study also suggest, navy personnel assigned to shore duties or warships stand a risk of developing hearing loss. The term “threshold shift” refers to a change in hearing thresholds between sequential audiologic tests; it may reflect improvement or worsening of hearing (Cunningham & Tucci, 2017).

Another cross-sectional study by Kaewboonchoo, Srinoo, Lormphongs, Morioka and Mungarndee (2014) aimed at examining the prevalence of hearing loss and its risk
factors among Thai naval officers. The subjects consisted of 149 males who were asked to complete a questionnaire. Audiometric threshold testing was performed at the audiometric frequencies of 0.5, 1, 2, 4, and 8 kHz. The noise levels and the organic solvent concentrations in the working environment were measured on a common type of gun boat. The findings revealed that 39.6% of naval officers had hearing loss. The noise level (LAeq) was 100.6 dB in the engine room. The organic solvent concentrations were less than the occupational exposure limit for organic solvents.

Wells et al. (2015) also conducted a study on the hearing loss associated with US military combat deployment using data from the Millennium Cohort Study. Self-reported data and objective military service data were used to assess exposures and outcomes. Among all 48,540 participants, 7.5% self-reported new-onset hearing loss. Self-reported hearing loss showed moderate to substantial agreement ($k = 0.57-0.69$) with objective audiometric measures. New-onset hearing loss was associated with combat deployment (adjusted odds ratio [AOR] = 1.63, 95% confidence interval [CI] = 1.49-1.77). Among deployers, new-onset hearing loss was also associated with proximity to improvised explosive devices (AOR = 2.10, 95% CI = 1.62-2.73) and with experiencing a combat-related head injury (AOR = 6.88, 95% CI = 3.77-12.54).

Irgens-Hansen et al. (2016) in a longitudinal study also assessed noise exposure and health in the Royal Norwegian Navy (RNN). Similarly, audiometry was performed by trained personnel at three naval bases, and a questionnaire was prepared to identify the determinants of Significant Threshold Shift (STS) development between examinations. The incidence of STS among the Navy personnel during the study period (April 2012 to December 2014) was 23.0%. For the left ear, significantly higher mean hearing thresholds (i.e., impaired hearing) were found at frequencies 250-6000 Hz, and significantly lower at 8000 Hz at follow-up compared to baseline. For the right ear,
mean hearing thresholds were significantly higher at follow-up than at the baseline at the frequencies 1,000 Hz, 2,000 Hz, 3,000 Hz, and 4,000 Hz. The participants were 226, comprising 217 males and 9 females with a mean age of 33 years, ranging from 20-53 years.

In addition, Irgens-Hansen et al. (2016) found that participants who reported exposure to >5 episodes of Temporary Threshold Shifts (TTS) in the Navy during the last 12 months had a significantly higher risk of STS compared to Navy personnel without this exposure. Furthermore, participants who were currently exposed to >15 hours/week of loud noise during work on board (making it difficult to have a conversation) had a significantly higher risk of STS compared to Navy personnel without this exposure. A significantly higher risk of STS was also found among participants who had been shooting 1-200 gun shots (in the Navy, hunting, or sports) during the last 12 months compared to participants who had not been shooting at all. The estimates also increased for shooting >200 gun shots although these were not significant. In multivariate regression analyses, the two noise exposure determinants were both associated with a higher STS risk although estimates were slightly reduced.

2.7 OCCUPATIONAL NOISE STANDARDS

Exposure to excessive occupational noise is a problem worldwide. In the United States of America (USA) for instance, about 30 million workers are exposed to hazardous noise (National Institute for Occupational Safety and Health (NIOSH), 1998). Also, in Germany about 5 million workers are exposed to high levels of noise that can be hazardous (WHO, 2001). Occupations at highest risk for NIHL include those in manufacturing, transportation, mining, construction, agriculture and the military (Concha-Barrientos, Campbell-Lendrum, & Steenland, 2004). Table 2.1 shows examples of various occupational noise level intensities.
Table 2.1: Reported occupational noise levels

<table>
<thead>
<tr>
<th>Type of noise</th>
<th>Reported intensity levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miscellaneous industrial</td>
<td>88 – 104 dB SPL; 80 – 103 dBA</td>
</tr>
<tr>
<td>Weaving machines</td>
<td>102 dB SPL</td>
</tr>
<tr>
<td>Boiler shop</td>
<td>91 dB SPL</td>
</tr>
<tr>
<td>Riveting</td>
<td>113 dB SPL</td>
</tr>
<tr>
<td>Shipyard caulking</td>
<td>111.5 dB SPL</td>
</tr>
<tr>
<td>Drop forging background</td>
<td>109 dB SPL</td>
</tr>
<tr>
<td>Drop hammer</td>
<td>126.5 peak SPL</td>
</tr>
<tr>
<td>Mining industry trucks</td>
<td>102 – 120 dB SPL</td>
</tr>
<tr>
<td>Mining equipment</td>
<td>96 – 114 dB SPL</td>
</tr>
<tr>
<td>Military weapons</td>
<td>168 – 188 peak SPL</td>
</tr>
</tbody>
</table>

Modified from Gelfand (2016)

Regulations to curb noise have been established in most industrialized countries throughout the world. These regulations have many commonalities, addressing hearing loss and annoyance or communication (Cowan, 2016). As hearing loss is the only negative physiological effect related to sound that is universally accepted, most industrialized countries have established regulatory limits related to hearing protection and those limits are similar based on the many years of research that have been used to establish those limits (Cowan, 2016).

The Occupational Safety and Health Administration (OSHA) (1983) recommended a scale on which the time that a worker may be safely exposed to intense sounds is decreased as the intensity of the noise is increased. Under this rule, the maximum exposure level before hearing conservation measures must be implemented is 85 dBA for an 8-hour work day (Martin & Clark, 2012). For every 5 dB increase in noise above
90 dBA, the allowable exposure time is cut in half. Also, NIOSH publicized guidelines that are becoming the benchmark for standard care for many audiologists (NIOSH, 1998). The NIOSH guidelines are more restrictive than those set by OSHA in several areas including noise monitoring, noise exposure limits, hearing monitoring practices, and the training of audiometric technicians (Martin & Clark, 2012). For instance, NIOSH recommends a more protective 3 dB time-intensity trade off rather than OSHA’s 5 dB exchange rate. Table 2.2 compares the OSHA 29 CFR1910.95 occupational noise exposure standard with that of NIOSH.

Table 2.2: Permissible noise exposure based on the OSHA 29CFR1910.95 standard and NIOSH (1998) recommendations

<table>
<thead>
<tr>
<th>Maximum exposure level in dB A</th>
<th>Maximum exposure duration per day (Hour limit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>85</td>
<td>8</td>
</tr>
<tr>
<td>88</td>
<td>4</td>
</tr>
<tr>
<td>90</td>
<td>8</td>
</tr>
<tr>
<td>92</td>
<td>6</td>
</tr>
<tr>
<td>94</td>
<td></td>
</tr>
<tr>
<td>95</td>
<td>4</td>
</tr>
<tr>
<td>97</td>
<td>3</td>
</tr>
<tr>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>102</td>
<td>1 ½</td>
</tr>
<tr>
<td>105</td>
<td>1</td>
</tr>
<tr>
<td>110</td>
<td>½</td>
</tr>
<tr>
<td>115</td>
<td>¼ or less</td>
</tr>
</tbody>
</table>

Modified from Martin & Clark (2012)
2.8 PERSONAL HEARING PROTECTION

In spite of the advancement in technology to control noise, there are many situations where reduction of occupational noise is neither economically nor technically feasible (Gerges, Vedsmand, & Lester, 2001). Also in some situations, it may take many years before machines and processes generating hazardous noise can be modified or replaced. In such cases, or during the period in which noise controls actions are being started, hearing protection devices (HPDs) should be considered as an interim solution. Employees exposed to noise at or above 85 dBA for an 8-hour time weighted average (TWA) must be provided hearing protection if engineering or administrative controls fail to reduce the noise exposure below 85 dBA (Laborer-AGC Education and training Fund, 2000).

The purpose of hearing protectors is to attenuate the amount of sound conducted to the middle ear and inner ear (Laborer-AGC Education and training Fund, 2000). The number of decibels or amount of sound reduced by the protector is called attenuation. Hearing protection devices have attenuation or noise reduction rating (NRR) indicated in dB for each model. The right hearing protection, correctly worn, can attenuate noise level by 20 – 30 dB.

Usually, HPDs when worn in the field does not provide the amount of attenuation indicated by the NRR. This may be attributed to workers not wearing it properly, using wrong size, or HPD being old. Therefore, the NRR of the HPD is derated to arrive at the actual protection it provides for the worker. There are two approaches for computing the expected differences between labelled NRR and achieved attenuation (Katz et al., 2015). The first is recommended by OSHA and involves derating the labelled NRR of a HPD by 50%:
OSHA attenuated exposure (dBA) = TWA (dBA) – [(NRR - 7) × 50%]

For example, if the ear plugs you are using have an NRR of 29 dB and you are exposed to 95 dBA noise on the job, then you are exposed to 84 dBA.

\[= 95 \text{ dBA} - [(29-7) \times 50\%] = 95 \text{ dBA} - 11 = 84 \text{ dBA}\]

It must be noted that the 7 dB value in the equation is a spectral correction factor required to account for differences in the way noise is measured during the NRR test in the laboratory (using dBC) versus measurements made in the workplace (using dBA) (Katz et al., 2015).

The second approach is recommended by NIOSH and assumes patterns in achieved attenuation by the type of HPD used:

NIOSH attenuated exposure (dBA) = TWA (dBA) - (NRR\text{\textsubscript{d}} - 7)

where NRR\text{\textsubscript{d}} is the derated NRR for the type of earplug being considered. NIOSH’s recommended deratings involve subtracting 25% of the NRR for earmuffs, 50% for foam earplugs, and 70% from all other earplugs (Gerges, Vedsmand, & Lester, 2001). So, as an example, if a worker uses a foam earplug with an NRR of 30 dB, the NIOSH NRR\text{\textsubscript{d}} would be 30 - (30 × 70%) = 9 dBA. Employees who are exposed to sound greater than 100 or 105 dBA TWA should be provided with dual hearing protection, that is, a pair of earmuffs over earplugs (NIOSH, 1998).

There are different types of HPDs available on the market and several factors have to be considered before selection. These factors include noise attenuation provided, comfort, cost, durability, chemical stability, safety, wearer acceptability, hygiene, and work
situation (Gerges, Vedsmand, & Lester, 2001). The main categories are: (1) Circumaural protection (those that cover the outer ear and act as an acoustic barrier sealing it against the head), example is earmuffs (2) Intraural protection (those that can be inserted into the outer ear canal, blocking sound to the middle ear), examples are custom earplugs and foam earplugs and (3) Supraural protection, also referred to as semi-inserts or semi-aural (those that seal the ear canal at its opening), example is the ear caps (Gerges, Vedsmand, & Lester, 2001).

Figure 2.1: Earmuffs

Source: www.iosh.co.uk/Books-and-resources/Our-OH-toolkit/noise.aspx
Figure 2.2: Examples of earplugs

Source: www.iosh.co.uk/Books-and-resources/Our-OH-toolkit/noise.aspx

Figure 2.3: Ear caps or semi-insert earplugs

Source: www.iosh.co.uk/Books-and-resources/Our-OH-toolkit/noise.aspx
2.9 SUMMARY OF LITERATURE REVIEW

The literature suggests the existence of hearing loss among naval personnel. However, these studies were mainly carried out on naval personnel in countries other than Ghana. Therefore, these findings may not necessarily reflect the Ghanaian situation. These countries may also have more sophisticated machinery and war ships. Experiences on these vessels and their effect on hearing may be different compared to that of the Ghana Navy. Findings from this study will fill this gap.
CHAPTER THREE
METHODOLOGY

3.1 INTRODUCTION

This chapter presents the methodology of the study which includes the study design, study sites, study populations, procedure for data collection, data management plan, data analysis and ethical consideration and dissemination of results.

3.2 STUDY DESIGN

This study employed a descriptive cross-sectional study design with a quantitative approach to guide the study.

3.3 STUDY SITE

This study was carried out at the Western Naval Command, Sekondi on board the available Ghana Navy ships. The Western Naval Command comprises the Western Naval Command headquarters, Ghana Navy Fleet, the Naval Dockyard Complex, Ghana Navy Stores Depot, Naval Base at Sekondi and the Naval Trade Training School. The study focused on prime areas on board the ships such as the engine room, the bridge, the galley, and the lower and upper decks. This setting was selected due to the emergence of oil drilling activities in the region, thereby making operations of the Ghana Navy more active in that area.
3.4 STUDY POPULATION

The target population for the study was personnel of the Ghana Navy at the Western Naval Command, Sekondi.

3.5 INCLUSION AND EXCLUSION CRITERIA

3.5.1 Inclusion Criteria

The criteria for inclusion were naval personnel on board the naval ships (Ship’s Company) at the Western Naval Command, Sekondi.

3.5.2 Exclusion Criteria

Naval personnel who were ashore in addition to naval personnel on board the naval ships who refused to take part in the study were excluded from the study.

3.6 SAMPLE SIZE

The sample size for the study was calculated using the Yamane (1967) formula for calculating sample size of a finite population.

\[ n = \frac{N}{1 + N(e)^2} \]  

where \( n \) is the sample size, \( N \) is the accessible population, and \( e \) is the margin of error.

Using the total number of 600 company staff (\( N=600 \)), and a ±7% (\( e \)) error margin, the sample size was calculated as follows:

\[ n = \frac{600}{1 + 600(0.07)^2} = 152 \cdot 3 \]

Therefore, a total of 153 naval personnel were selected as the sample size to represent the population for the study.
3.7 SAMPLING TECHNIQUE

The simple random sampling technique was used to select participants as the sample for the study. The lottery method was employed to randomly select 17 naval personnel from each ship. Naval personnel from each ship were assigned numbers that were written in folded pieces of paper and randomly picked. This was done until the required number was met.

3.8 DATA COLLECTION TOOLS

A structured questionnaire, a check list and an audiometer were employed as the tools for data collection.

3.8.1 Structured Questionnaire

A 2-section structured questionnaire was used to collect data. Section A gathered data on the demographic characteristics of the respondents including their age, sex, rank, educational status, unit, department and numbers of years in the service. The risk factors associated with hearing loss among naval personnel was assessed in Section B.

3.8.2 Audiometer

A calibrated Interacoustics AD226 Diagnostic Audiometer (Figure 3.1) with a TDH39 supra-aural headphone was used to conduct the hearing assessment across the frequencies 250 Hz, 500 Hz, 1000Hz, 2000 Hz, 3000 Hz, 4000 Hz, 6000 Hz, and 8000 Hz.
3.8.3 Check list

A check list to take records of ratings from the audiometer recordings of the naval personnel was developed. This contained audiogram recordings of both right and left air conduction readings from 250Hz to 8000Hz in addition to both right and left bone conduction readings from 500Hz to 4000Hz.

3.9 PROCEDURE FOR DATA COLLECTION

An introductory letter from the Department of Audiology, Speech and Language Therapy, School of Biological and Allied Health Sciences (SBAHS), College of Health Sciences, University of Ghana, Legon was sent to the Chief of the Naval Staff, Navy Headquarters, Burma Camp, and a copy sent to the Flag Officer Commanding the Western Naval Command to introduce the researcher to them and to seek approval to collect data for the study. The Command Operations Officer at the Western Naval Command, Sekondi, was also contacted through the Flag Officer Commanding the
Western Naval Command to inform the Commanding Officers of the various ship companies about the study. The Commanding Officers of the ships company then introduced the researcher and assistant to their staff and the researcher informed the staff about the study. Arrangements were made ashore to screen the staff. Only those who agreed to take part in the study were screened.

3.9.1 Pure Tone Audiometric Test

Pure tone audiometric test assesses the hearing threshold of an individual (Audiology, 2017). Calibration was performed on Interacoustics AD226 Diagnostic Audiometer based on the ANSI S3. 6-2004 standards. The hearing test was conducted in a quiet room located in the Naval Base, Sekondi with a measured ambient noise of 31 dBA which is less than the recommended permissible level of less than 35 dBA (British Society of Audiology, 2017).

The participants were given clear instructions to press the button and release the button immediately the test signal is perceived. The participants sat in an angle of 45 degrees so they were seen clearly by the examiner during the test.

3.9.2 Conduction of Hearing Assessment

The headphones, bone vibrator, and the response button were properly connected to the audiometer. The audiometer was then connected to the power supply and switched on and allowed to warm for about 5 minutes. Biological calibration was performed using the research assistant who has a normal hearing as the subject. The audiometer was functioning properly. The headphone was placed on the head of the participants with the blue phone on the left ear and red phone on the right ear. When the test signal is presented through the headphones it is termed air conduction (AC) hearing thresholds (Audiology, 2017). The better ear according to each participant was tested first.
The frequency dial was set on the 1000 Hz and intensity dial on 40 dB to perform the initial familiarization. The intensity dial was then set at 30 dB and the test commenced. The intensity was reduced by 10 dB steps until there is no response, and then the intensity is increased in 5 dB step until there is a response from the participant again. This procedure was repeated until the participant indicates 50% of the time that he/she perceived the test signal. The hearing threshold for 1000 Hz was then indicated on the form and then proceeded to 2000 Hz, 3000 Hz, 4000 Hz, 6000 Hz, 500 Hz, and 250 Hz. To ensure test reliability, a test-retest was performed at the 1000 Hz in the first tested ear only. Either there was no difference between the first recorded hearing threshold and the repeated threshold or the difference was 5 dB HL. This indicates that the accuracy of the test is satisfactory. The procedure was repeated until the hearing threshold was recorded for all tested frequencies in the other ear. Air conduction masking was applied when necessary to prevent cross-hearing and establish the true hearing threshold.

Bone conduction (BC) test was performed when there was a deviation in the AC test. The bone vibrator was placed on the mastoid process of the worse hearing ear and tested at the frequencies 1000 Hz, 2000 Hz, 4000 Hz, and 500 Hz respectively. This helps to identify which type of hearing loss. Records of audiometric tests were then taken with the check list.

3.9.3 Administration of questionnaire

After the screening, they were given the questionnaires to fill. This was done by the researcher with the help of a research assistant. They were allowed enough time to complete the questionnaires which were collected the same day. Hearing screening and administration of questionnaires were done during the day and on weekdays. The entire data collection exercise lasted for one week.
3.10 DATA MANAGEMENT PLAN

Data was keyed into the Statistical Package for Social Sciences (SPSS V. 22.0) software and password lock placed on the document to restrict access to the general public. Only the researcher and the supervisor had access to the data. Filled questionnaires were also kept under lock and key in a safe place under the custody of the researcher.

3.11 DATA ANALYSIS

Data analysis was analysed using the Statistical Package for Social Sciences (SPSS V. 22.0). Demographic data was analysed descriptively using frequencies, means and standard deviations.

Prevalence of hearing loss was also analysed descriptively showing the frequencies and levels of hearing loss (normal hearing, mild, moderate, moderately severe, severe, profound hearing loss) among the respondents. Pure tone audiometric recordings of <25dB represented normal hearing, 25-39dB represented mild hearing loss, 40-55dB represented moderate hearing loss, 56-70dB represented moderately severe, 71-90dB represented severe impairment and >90dB represented profound impairment in hearing. Frequencies and levels of hearing from these audiometric recordings were used to estimate the prevalence of hearing loss among participants.

Air and bone conduction audiometric recordings of 25dB and above represented air and bone conduction hearing loss. Air or bone conduction hearing loss estimates on either right or left ear represented asymmetrical hearing loss. A combination of right and left ear hearing loss from either air or bone conduction tests represented bilateral hearing loss.
Frequencies and levels of sensorineural (poor air and bone conduction) and conductive (poor air and better or normal bone conduction) hearing losses were also assessed to determine their prevalence among the participants. Independent *t* Tests were used to determine the association between hearing loss and diabetes, hypertension and age at the 0.05 level of significance. The Chi-Square statistic was used to establish the factors associated with hearing loss among the respondents at the 0.05 level of significance.

### 3.12 ETHICAL CONSIDERATION

Ethical approval for the study was sought from the Ethics and Protocol Review Committee (EPRC) of the School of Biomedical and Allied Health Sciences (SBAHS), University of Ghana. Another approval was sought from the Institutional Review Board (IRB) of the Ghana Armed Forces Medical Services, 37 Military Hospital. Security clearance for data collection was also sought from General Headquarters Defence Intelligence GHQ (DI). Permission to collect the data was also sought from Chief of the Naval Staff, Flag Officer Commanding the Western Naval Command and the Commanding Officers of the ship’s companies to be used for the study.

All the respondents were duly informed about the study. The purpose, benefits and potential risks for taking part in this study was duly explained to all the respondents. They were provided a written informed consent to sign to indicate their willingness to participate in the study.

### 3.13 DISSEMINATION OF RESULTS

A full copy of the project work will be submitted as a dissertation for the award of Master of Science degree in Audiology to the University of Ghana, College of Health
Sciences, Department of Audiology, Speech and Language Therapy, School of Biomedical and Allied Health Sciences. Other copies will also be submitted to the Chief of the Naval Staff, Medical Department of the Ghana Armed Forces Medical Services and General Headquarters Training GHQ (Trg) and Personnel Administration (PA). It will also be disseminated through seminar presentations and workshops. Articles derived from the study will also be published in peer reviewed journals for access to the larger population.
CHAPTER FOUR

RESULTS

4.1 INTRODUCTION

This Chapter presents the results of the study and is divided into sections. The first section reports the demographic characteristics of participants. The rest of the sections present the results according to the objectives of the study.

4.2 DEMOGRAPHICS

Table 4.1 below presents the demographic characteristics of the participants. This includes their gender, rank, educational status and unit/ship. Out of the 153 participants, 126 (82.4%) were males and 27 (17.6%) were females. The age range of the participants was 23-51 years, with a mean age of 35.45 years (SD=5.975).

The participants consisted of 28 (18.3%) officers (from Sub Lt to Cdre) and 125 (81.7%) ratings whose ranks ranged from OS to CPO1. There were 17 (11.11%) naval personnel stationed on each of the 9 unit ships within the Western Naval Command. Forty (26.2%) of the personnel had undergraduate and postgraduate qualifications while diploma holders were 51 (33.3%). Most, 62 (40.5%) of them had SSSC/ SHSC level of education.

Most (47.7%) of them worked in the engine room, while 43 (28.1%) had duty on the bridge, and 21 (13.7%) were assigned to the galley. The average years of service among the participants was 11.3 years (SD= 6.081), ranging from 1 to 25 years.
Table 4.3: Demographic data of participants

<table>
<thead>
<tr>
<th>Variable</th>
<th>Frequency (n)</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>126</td>
<td>82.4</td>
</tr>
<tr>
<td>Female</td>
<td>27</td>
<td>17.6</td>
</tr>
<tr>
<td>Total</td>
<td>153</td>
<td>100</td>
</tr>
<tr>
<td><strong>Rank</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SLT/LT</td>
<td>20</td>
<td>13.1</td>
</tr>
<tr>
<td>LTCDR/CDR</td>
<td>7</td>
<td>4.6</td>
</tr>
<tr>
<td>CAPT/CDRE</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td>OS/ABII</td>
<td>13</td>
<td>8.5</td>
</tr>
<tr>
<td>ABI/LS</td>
<td>38</td>
<td>24.8</td>
</tr>
<tr>
<td>POI/POII</td>
<td>57</td>
<td>37.3</td>
</tr>
<tr>
<td>CPOI/CPO2</td>
<td>17</td>
<td>11.1</td>
</tr>
<tr>
<td>Total</td>
<td>153</td>
<td>100</td>
</tr>
<tr>
<td><strong>Educational status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diploma</td>
<td>51</td>
<td>33.3</td>
</tr>
<tr>
<td>Degree</td>
<td>37</td>
<td>24.2</td>
</tr>
<tr>
<td>Masters</td>
<td>3</td>
<td>2.0</td>
</tr>
<tr>
<td>SSSC/SHSC</td>
<td>62</td>
<td>40.5</td>
</tr>
<tr>
<td>Total</td>
<td>153</td>
<td>100</td>
</tr>
<tr>
<td><strong>Unit/ Ship</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yaa Asantewaa</td>
<td>17</td>
<td>11.1</td>
</tr>
<tr>
<td>Anzone</td>
<td>17</td>
<td>11.1</td>
</tr>
<tr>
<td>Bonsu</td>
<td>17</td>
<td>11.1</td>
</tr>
<tr>
<td>Stephen Otu</td>
<td>17</td>
<td>11.1</td>
</tr>
<tr>
<td>David Hansen</td>
<td>17</td>
<td>11.1</td>
</tr>
<tr>
<td>Chemle</td>
<td>17</td>
<td>11.1</td>
</tr>
<tr>
<td>Ehwor</td>
<td>17</td>
<td>11.1</td>
</tr>
<tr>
<td>Garinga</td>
<td>17</td>
<td>11.1</td>
</tr>
<tr>
<td>Blika</td>
<td>17</td>
<td>11.1</td>
</tr>
<tr>
<td>Total</td>
<td>153</td>
<td>100</td>
</tr>
<tr>
<td><strong>Department</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engine room</td>
<td>73</td>
<td>47.7</td>
</tr>
<tr>
<td>Bridge</td>
<td>43</td>
<td>28.1</td>
</tr>
<tr>
<td>Galley</td>
<td>21</td>
<td>13.7</td>
</tr>
<tr>
<td>Mess</td>
<td>7</td>
<td>4.6</td>
</tr>
<tr>
<td>Other</td>
<td>9</td>
<td>5.9</td>
</tr>
<tr>
<td>Total</td>
<td>153</td>
<td>100</td>
</tr>
</tbody>
</table>
4.3 PREVALENCE OF HEARING LOSS AMONG NAVAL PERSONNEL

4.3.1 Results on Right Ear Air Conduction Hearing Loss

As shown in Table 4.2, majority, 120 (78.4%) of the participants had normal right ear air conduction and 23 (15%) had mild right ear air conduction hearing loss. The few remaining had moderate, 5 (3.3%), moderately severe, 3 (2%) and severe, 2 (1.3%) right ear air conduction hearing loss.

Table 4.4: Degree of Right Ear Air Conduction Hearing Loss

<table>
<thead>
<tr>
<th>Degree</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>120</td>
<td>78.4</td>
</tr>
<tr>
<td>Mild</td>
<td>23</td>
<td>15.0</td>
</tr>
<tr>
<td>Moderate</td>
<td>5</td>
<td>3.3</td>
</tr>
<tr>
<td>Moderately Severe</td>
<td>3</td>
<td>2.0</td>
</tr>
<tr>
<td>Severe</td>
<td>2</td>
<td>1.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>153</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Less than a quarter, 33 (22%) of the participants had right ear air conduction hearing loss. This is illustrated in Figure 4.1.

Figure 4.1: Right Ear Air Conduction Hearing Loss
4.3.2 Results on Left Ear Air Conduction Hearing Loss

It can be seen in Table 4.3 that majority, 122 (79.7%) of the participants had normal hearing in the left ear by air conduction and 22 (14.4%) had mild left ear air conduction hearing loss. The few remaining however, had moderate, 5 (3.3%), moderately severe, 3 (2%) and severe, 1 (0.7%) left ear air conduction hearing loss.

Table 4.5: Degree of Left Ear Air Conduction Hearing Loss

<table>
<thead>
<tr>
<th>Degree</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>122</td>
<td>79.7</td>
</tr>
<tr>
<td>Mild</td>
<td>22</td>
<td>14.4</td>
</tr>
<tr>
<td>Moderate</td>
<td>5</td>
<td>3.3</td>
</tr>
<tr>
<td>Moderately Severe</td>
<td>3</td>
<td>2.0</td>
</tr>
<tr>
<td>Severe</td>
<td>1</td>
<td>.7</td>
</tr>
<tr>
<td>Total</td>
<td>153</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Less than a quarter, 31 (20.3%) of the participants had left ear air conduction hearing loss. This is illustrated in Figure 4.2.
4.3.3 Results on Bilateral (Right and Left) Air Conduction Hearing Loss

As shown in Table 4.4, 19 (12.4%) of the participants had bilateral air conduction hearing loss. However, majority, 134 (87.6%) of them did not have air conduction hearing loss in both right and left ears.

Table 4.6: Bilateral Air Conduction Hearing Loss in Right and Left Ears

<table>
<thead>
<tr>
<th>Hearing Loss</th>
<th>Frequency (n)</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilateral Hearing Loss</td>
<td>19</td>
<td>12.4</td>
</tr>
<tr>
<td>No Bilateral Hearing Loss</td>
<td>134</td>
<td>87.6</td>
</tr>
<tr>
<td>Total</td>
<td>153</td>
<td>100.0</td>
</tr>
</tbody>
</table>

4.3.4 Results on Right Ear Bone Conduction Hearing Loss

Table 4.5 shows that majority, 135 (88.2%) of the participants had normal right bone conduction but 15 (9.8%) of them had mild right bone conduction hearing loss. The few remaining had moderate, 2 (1.3%) and moderately severe, 1 (0.7%) right bone conduction hearing loss.

Table 4.7: Degree of Right EAR Bone Conduction Hearing Loss

<table>
<thead>
<tr>
<th>Degree</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>135</td>
<td>88.2</td>
</tr>
<tr>
<td>Mild</td>
<td>15</td>
<td>9.8</td>
</tr>
<tr>
<td>Moderate</td>
<td>2</td>
<td>1.3</td>
</tr>
<tr>
<td>Moderately Severe</td>
<td>1</td>
<td>.7</td>
</tr>
<tr>
<td>Total</td>
<td>153</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Out of the 153 participants, just a few, 18 (11.8%) had right bone conduction hearing loss. This is shown in Figure 4.3.

![Figure 4.3: Right Ear Bone Conduction Hearing Loss](image)

### 4.3.5 Results on Left Ear Bone Conduction Hearing Loss

As shown in Table 4.6 majority, 142(92.8%) of the participants had normal left bone conduction. However, 7 (4.7%), 3 (2%) and one (0.7%) of the participants had mild, moderate and moderately severe left bone conduction hearing loss respectively.

<table>
<thead>
<tr>
<th>Degree</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>142</td>
<td>92.8</td>
</tr>
<tr>
<td>Mild</td>
<td>7</td>
<td>4.6</td>
</tr>
<tr>
<td>Moderate</td>
<td>3</td>
<td>2.0</td>
</tr>
<tr>
<td>Moderately Severe</td>
<td>1</td>
<td>.7</td>
</tr>
<tr>
<td>Total</td>
<td>153</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 4.8: Degree of Left Ear Bone Conduction Hearing Loss
Figure 4.4 shows that only 11 (7.2%) of the participants had left bone conduction hearing loss.

![Figure 4.4: Left Ear Bone Conduction Hearing Loss](image)

### 4.3.6 Results on Bilateral Conductive Hearing Loss

A few, 9 (5.9%) of the participants bilateral conductive hearing loss. However, the majority, 144 (94.1%) of them did not have bone conduction hearing loss in both right and left ears. This is shown in Table 4.7.

<table>
<thead>
<tr>
<th>Hearing Loss</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilateral Hearing Loss</td>
<td>9</td>
<td>5.9</td>
</tr>
<tr>
<td>No Bilateral Hearing Loss</td>
<td>144</td>
<td>94.1</td>
</tr>
<tr>
<td>Total</td>
<td>153</td>
<td>100.0</td>
</tr>
</tbody>
</table>
4.3.6 Results on Overall Hearing Loss

With regard to overall hearing loss, 43 (28.1%) of the participants had some level of hearing loss in both right and left ears. This is shown in Figure 4.5.

![Figure 4.5: Overall Hearing Loss](image)

4.3.7 Results on Type of Hearing Loss

Participants with poor air and bone conduction were classified as having sensorineural hearing loss whilst, those with poor air conduction but better or normal bone conduction were classified as having conductive hearing loss. This is presented in Table 4.8.

As shown in Table 4.8, out of the 43 participants with hearing loss, 24 (55.8%) of the had conductive hearing loss and 19 (44.2%) of them had sensorineural hearing loss.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensorineural hearing loss</td>
<td>19</td>
<td>44.2</td>
</tr>
<tr>
<td>Conductive hearing loss</td>
<td>24</td>
<td>55.8</td>
</tr>
<tr>
<td>Total</td>
<td>43</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 4.10: Type of Hearing Loss
4.4 RISK FACTORS ASSOCIATED WITH HEARING LOSS

The results on risk factors associated with hearing loss among the participants are presented in this section. This includes diagnosis of chronic ailments, the non-use of ear protectors, and exposure to loud music. The results of the diagnosis of chronic ailments among the participants are presented in Table 4.9. Five (3.3%) of them were diagnosed as suffering from hypertension. Just a few, 3 (2%) also were diagnosed of suffering from diabetes.

Table 4.11: Diagnosis of diabetes & hypertension

<table>
<thead>
<tr>
<th>Variable</th>
<th>Yes</th>
<th>%</th>
<th>No</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnosed of suffering from diabetes</td>
<td>3</td>
<td>2.0</td>
<td>150</td>
<td>98</td>
</tr>
<tr>
<td>Diagnosed of suffering from hypertension</td>
<td>5</td>
<td>3.3</td>
<td>148</td>
<td>96.7</td>
</tr>
</tbody>
</table>

The result in Table 4.10 indicates a significant difference in hearing loss among those with hypertension and those without hypertension \( t(151) = 1.181, p = .023 \). This means naval personnel who are diagnosed are suffering from hypertension have significant hearing loss compared to those who do not have hypertension.

Table 4.12: Independent \( t \)-test of diagnosis of hypertension and overall hearing loss

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Df</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertensive</td>
<td>5</td>
<td>20.3125</td>
<td>20.05607</td>
<td>151</td>
<td>1.181</td>
<td>0.023</td>
</tr>
<tr>
<td>Not hypertensive</td>
<td>148</td>
<td>14.9024</td>
<td>9.65621</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The independent \( t \)-test statistic is significant at the 0.05 level.*
The result in Table 4.11 indicates a significant difference in hearing loss among those with diabetes and those without diabetes \( t_{(151)} = 2.162, p = 0.003 \). This implies that naval personnel who are diagnosed are suffering from diabetes have significant hearing loss compared to those who do not have diabetes.

**Table 4.13: Independent t-test of diagnosis of diabetes and overall hearing loss**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>Df</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertensive</td>
<td>3</td>
<td>27.3958</td>
<td>24.66639</td>
<td>151</td>
<td>2.162</td>
<td>0.003</td>
</tr>
<tr>
<td>Not hypertensive</td>
<td>150</td>
<td>14.8329</td>
<td>9.61546</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

_The Independent T-test statistic is significant at the 0.05 level._

As shown in Figure 4.6, 63 (41.2%) of the participants never use ear protectors in the engine room and 58 (37.9%) of them sometimes use ear protectors in the engine room. However, 25 (16.3%) of the participants rarely use ear protectors in the engine room and a few, 7 (4.6%) of them always use ear protectors in the engine room.

![Figure 4.6: Frequency of use of ear protectors in the engine room](image-url)
4.4.1 Chi-Square Statistic of Significance of use of Ear Protectors on Hearing Loss

Descriptively, among those with hearing loss, 12 (27.9%) never used ear protection, 11 (25.6%) rarely used ear protection, 19 (42.2%) sometimes and only 1 (2.3%) always used ear protectors in the engine room. This shows a reduced risk of hearing loss among those who regularly used ear protectors.

The chi-square statistic was used to determine the relationship between use of ear protectors and hearing loss among naval personnel. At the 0.05 level of significance, the use of ear protectors in the engine room had no significant impact on hearing loss ($\chi^2=6.967$, $p=0.73$). This implies that although the risk of hearing loss is reduced with the use of ear protectors, its effect is not significant. This is shown in Table 4.12.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Overall hearing loss</th>
<th>$\chi^2$ test</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No hearing loss</td>
<td>Hearing loss</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$n$ (%)</td>
<td>$n$ (%)</td>
<td></td>
</tr>
<tr>
<td>Use of ear protectors in the engine room</td>
<td>-</td>
<td>-</td>
<td>6.967</td>
</tr>
<tr>
<td>Never</td>
<td>51(46.4)</td>
<td>12(27.9)</td>
<td></td>
</tr>
<tr>
<td>Rarely</td>
<td>14(12.7)</td>
<td>11(25.6)</td>
<td></td>
</tr>
<tr>
<td>Sometimes</td>
<td>39(35.5)</td>
<td>19(42.2)</td>
<td></td>
</tr>
<tr>
<td>Always</td>
<td>6(5.5)</td>
<td>1(2.3)</td>
<td></td>
</tr>
</tbody>
</table>

The Chi-square statistic is significant at the 0.05 level.

Figure 4.7 shows that majority, 126 (82.4%) of the participants sometimes listen to loud music and 8 (5.2%) always listen to loud music. However, 17 (11.1%) of them rarely and 2 (1.3%) never listen to loud music.
Figure 4.7: Frequency of listening to loud music

4.4.2 Chi-Square Statistic of Significance between Exposure to Loud Music and Hearing Loss

Descriptively, among those with hearing loss, 1 (2.3%) never listened to loud music, 1 (2.3%) rarely listened to loud music and 38 (88.4%) sometimes listened to loud music. However, 3 (7%) always listened to loud music.

The chi-square statistic was used to determine the relationship between listening to loud music and hearing loss among naval personnel. At the 0.05 level of significance, listening to loud music had no significant impact on hearing loss ($\chi^2 = 5.242, p = 1.55$). This implies that although it appears listening to loud music increased risk of hearing loss, this is not significant.
Table 4.15: Association between Exposure to Loud Music and Hearing Loss

<table>
<thead>
<tr>
<th>Variables</th>
<th>Overall hearing loss</th>
<th>(\chi^2) test</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No hearing loss</td>
<td>Hearing loss</td>
<td></td>
</tr>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
<td></td>
</tr>
<tr>
<td>How often one listens to loud music</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>1(0.9)</td>
<td>1(2.3)</td>
<td>5.242</td>
</tr>
<tr>
<td>Rarely</td>
<td>16(14.5)</td>
<td>1(2.3)</td>
<td></td>
</tr>
<tr>
<td>Sometimes</td>
<td>88(80)</td>
<td>38(88.4)</td>
<td></td>
</tr>
<tr>
<td>Always</td>
<td>5(4.5)</td>
<td>3(7)</td>
<td></td>
</tr>
</tbody>
</table>

The Chi-square statistic is significant at the 0.05 level.

The impact of age on hearing loss was tested using the independent \(t\)-test. This is because the independent variable (overall hearing loss) is a categorical variable with two levels (No hearing loss & hearing loss) and the dependent variable (age) is assumed to be measured on an interval scale. The results are presented in Table 4.14.

Table 4.16: Independent \(t\)-test of age and overall hearing loss

<table>
<thead>
<tr>
<th>Treatment</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>Df</th>
<th>(T)</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>No hearing loss</td>
<td>110</td>
<td>34.79</td>
<td>5.575</td>
<td>151</td>
<td>2.214</td>
<td>0.028</td>
</tr>
<tr>
<td>Hearing loss</td>
<td>43</td>
<td>37.14</td>
<td>6.668</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The independent \(t\)-test statistic is significant at the 0.05 level.

The result in Table 4.9 indicates a significant difference in age among those with hearing loss and those without hearing loss \([t_{(151)} = 2.214, p=.028]\). This means older naval personnel are significantly vulnerable to hearing loss than younger ones.

4.4.3 Chi-Square Statistic of Significance of Hearing Loss between Personnel at the Engine Room other Units on the Ship

Among participants with hearing loss, majority, 27 (62.8%) of them were stationed in the engine room and 16 (37.2%) were stationed in other units.
The chi-square statistic was used to determine the relationship between hearing loss among personnel in the engine room and other units.

At the 0.05 level of significance, there was a significant difference in hearing loss between personnel stationed in the engine room and other units on the ship ($\chi^2 = 5.451$, $p = 0.015$). This implies personnel in the engine room have higher risk of developing hearing loss compared to those stationed in other units on the ship.

Table 4.17: Association between hearing loss and units or operation on the ship

<table>
<thead>
<tr>
<th>Variables</th>
<th>Overall hearing loss</th>
<th>$\chi^2$ test</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No hearing loss $n$ (%)</td>
<td>Hearing loss $n$ (%)</td>
<td></td>
</tr>
<tr>
<td>Unit</td>
<td>-</td>
<td>-</td>
<td>5.451</td>
</tr>
<tr>
<td>Engine room</td>
<td>46(41.8)</td>
<td>27(62.8)</td>
<td></td>
</tr>
<tr>
<td>Other Units</td>
<td>64(58.2)</td>
<td>16(37.2)</td>
<td></td>
</tr>
</tbody>
</table>

*The Chi-square statistic is significant at the 0.05 level.*

4.4.4 Chi-square Estimates of Risk Factors Associated with Hearing Loss

The chi-square statistic was used to determine further risk factors of hearing loss among naval personnel. At the 0.05 level of significance, ear infection ($\chi^2 = 0.180$, $p = 0.026$) had significant impact on hearing loss. On the other hand, loud sound of gun fire ($\chi^2 = 0.136$, $p = 0.092$), ear drum perforation ($\chi^2 = 0.114$, $p = 0.157$), head injury ($\chi^2 = 0.106$, $p = 0.421$) and surgery ($\chi^2 = 0.130$, $p = 0.107$) had no significant impact on hearing loss. Details are shown in Table 4.16.
Table 4.18: Risk factors associated with hearing loss among naval personnel

<table>
<thead>
<tr>
<th>Variables</th>
<th>Overall hearing loss</th>
<th>χ² test</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No hearing loss</td>
<td>Hearing loss</td>
<td></td>
</tr>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
<td></td>
</tr>
<tr>
<td>Loud sound of gun fire</td>
<td>-</td>
<td>-</td>
<td>0.136</td>
</tr>
<tr>
<td>Yes</td>
<td>102(92.5)</td>
<td>36(83.7)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>8(7.3)</td>
<td>7(16.3)</td>
<td></td>
</tr>
<tr>
<td>Perforation of ear drum</td>
<td>-</td>
<td>-</td>
<td>0.114</td>
</tr>
<tr>
<td>Yes</td>
<td>4 (3.6)</td>
<td>4(9.3)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>106(96.4)</td>
<td>39(90.7)</td>
<td></td>
</tr>
<tr>
<td>Ear infection</td>
<td>-</td>
<td>-</td>
<td>0.180</td>
</tr>
<tr>
<td>Yes</td>
<td>24(21.8)</td>
<td>17(39.5)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>86(78.2)</td>
<td>26(60.5)</td>
<td></td>
</tr>
<tr>
<td>Head Injury</td>
<td>-</td>
<td>-</td>
<td>0.106</td>
</tr>
<tr>
<td>Never</td>
<td>96(87.3)</td>
<td>37(86)</td>
<td></td>
</tr>
<tr>
<td>Rarely</td>
<td>9(8.2)</td>
<td>2(4.7)</td>
<td></td>
</tr>
<tr>
<td>Sometimes</td>
<td>5(4.5)</td>
<td>4(9.3)</td>
<td></td>
</tr>
<tr>
<td>Surgery</td>
<td>-</td>
<td>-</td>
<td>0.130</td>
</tr>
<tr>
<td>Yes</td>
<td>2(1.8)</td>
<td>3(7)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>108(98.2)</td>
<td>40(93)</td>
<td></td>
</tr>
</tbody>
</table>

The Chi-square statistic is significant at the 0.05 level.

The chi-square statistic was used to determine the relationship between risks of hearing loss and the rank and level of education of the naval personnel. At the 0.05 level of significance, rank ($\chi^2=5.011$, $p=0.542$) and educational level ($\chi^2=0.493$, $p=0.920$) had no significant impact on hearing loss. Details are shown in Table 4.17.
### Table 4.19: Relationship between risk of hearing loss and between rank and educational level of naval personnel

<table>
<thead>
<tr>
<th>Variables</th>
<th>Overall hearing loss</th>
<th>( \chi^2 \text{ test} )</th>
<th>( p )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No hearing loss</td>
<td>Hearing loss</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( n ) (%)</td>
<td>( n ) (%)</td>
<td></td>
</tr>
<tr>
<td>Rank</td>
<td>-</td>
<td>-</td>
<td>5.011</td>
</tr>
<tr>
<td>SLT/LT</td>
<td>16 (14.5)</td>
<td>4 (9.3)</td>
<td></td>
</tr>
<tr>
<td>LTCDR/CDR</td>
<td>4 (3.6)</td>
<td>3 (7)</td>
<td></td>
</tr>
<tr>
<td>CAPT/CDRE</td>
<td>0 (0)</td>
<td>1 (2.3)</td>
<td></td>
</tr>
<tr>
<td>OS/ABII</td>
<td>10 (9.1)</td>
<td>3 (7)</td>
<td></td>
</tr>
<tr>
<td>ABI/LS</td>
<td>29 (26.4)</td>
<td>9 (20.9)</td>
<td></td>
</tr>
<tr>
<td>POI/POII</td>
<td>40 (36.4)</td>
<td>17 (39.5)</td>
<td></td>
</tr>
<tr>
<td>CPOI/CPO2</td>
<td>11 (10)</td>
<td>6 (14)</td>
<td></td>
</tr>
<tr>
<td>Educational Level</td>
<td>-</td>
<td>-</td>
<td>0.493</td>
</tr>
<tr>
<td>Diploma</td>
<td>35 (31.8)</td>
<td>16 (37.2)</td>
<td></td>
</tr>
<tr>
<td>Degree</td>
<td>27 (24.5)</td>
<td>10 (23.3)</td>
<td></td>
</tr>
<tr>
<td>Masters</td>
<td>2 (1.8)</td>
<td>1 (2.3)</td>
<td></td>
</tr>
<tr>
<td>SSSC/SHSC</td>
<td>46 (41.8)</td>
<td>16 (37.2)</td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER FIVE
DISCUSSION

5.1 INTRODUCTION

A discussion of the findings of the study has been duly presented in this chapter. This involves a comparison of the findings to that of already existing literature and deducing meanings from the findings. The first section comprises a discussion of the demographic properties of the participants. Subsequently, the discussion of the findings will follow in a manner after the order of objectives of the study.

5.2 DEMOGRAPHIC CHARACTERISTICS OF THE PARTICIPANTS

This descriptive cross-sectional study was carried out to determine the prevalence of hearing loss in addition to the causes and risk factors associated with hearing loss among naval personnel in the Ghana Armed Forces. A total of 153 naval personnel from the Western Naval Command, Sekondi took part in the study. They comprised 57 Petty Officer Class One/Two (POI/POII) (37.3%), 38 Able Seaman Class One/ Leading Seaman (ABI/LS) (24.8%) and 20 Sub Lieutenant/ Lieutenant (SLT/LT) (13.1%). This suggests that most of the naval personnel in this current study were of the lower ranks. The rest however were 17 Chief Petty Officer Class One/Two (11.1%) (CPOI/CPO2), 13 Ordinary Seaman/ Able Seaman Class Two (OS/ABII) (8.5%), 7 Lieutenant Commander/ Commanders (LTCDR/CDR) (4.6%) and one Captain/ Commodore (CAPT/CDRE) (0.7%). Thus, an indication of the presence of a few senior ranked naval personnel in command of the many lower ranked personnel in the navy.

Majority (82.4%) of the sailors in this current study were males. Similarly, Irgens-Hansen et al. (2016) had 217 males in their longitudinal study of the Royal Norwegian Navy. Kaewboonchoo et al. (2014) however, had all 149 Thai naval personnel being
male in their cross-sectional study. This shows that the military continues to be a male
dominated profession. This may be due to the stamina and resilience required of a
soldier making men a more preferred choice, despite the fact that women still remain a
small but significant part of the military. It may also be linked to the fact that more men
avail themselves for the military compared to women.

Wells et al. (2015) on the other hand, in their study on the hearing loss associated with
US military combat deployment had a total of 48,540 US naval personnel in their study.
This number of participants was very high compared to the 153 Ghanaian naval
personnel who took part in this current study. This difference however, may be due to
the large numbers of the US naval personnel compared to that of the Ghana Navy.

Furthermore, the average age of the naval personnel in this current study was 35.45
years, ranging from 23 to 51 years of age. Thus, an indication of the youthful nature of
military personnel. Similarly, Irgens-Hansen et al. (2016) in their longitudinal study of
the Royal Norwegian Navy had naval personnel with a mean age of 33 years, ranging
from 20-53 years. In addition, Collée et al. (2011) had participants age ranging from 18
to 50 years when they assessed the Belgian Military. This underscores the importance
of young and active persons in the military.

Although all of the naval personnel obviously had some level of education, majority
(78.3%) of the naval personnel had SSSC/ SHSC and diploma level education with
about a quarter (24.2%) having degree level education. This suggests that not many of
the naval personnel have higher education. This may be as a result of the unique
military ranking they gain during their tenure of service. As a result of this most of the
naval personnel may not be motivated to climb higher the academic ladder – an
indication of contentment with their current military status and the prospects that they
see ahead. However, these may exclusively not replace the need for them to attain higher academic degrees.

Almost half (47.7%) of the naval personnel who took part in the study were stationed in the engine room. This is a source of concern imagining the level of noise exposure from the engines of the vessel. This percentage is however, high compared to that from a cross-sectional study from Kaewboonchoo et al. (2014) aimed at examining the prevalence of hearing loss and its risk factors among Thai naval officers. This exposure is likely to have a negative effect on their sense of hearing.

The average years of service among the naval personnel in this current study was 11.3 years (SD= 6.081). This ranged from 1 to 25 years which suggests that most of the naval personnel have had enough experience in their naval carrier. This however, increases their risk of continues exposure to noise among naval personnel and its consequent occupational health hazard to the ear (WHO, 2019; Azizi, 2010). In their cross-sectional survey, Trost and Shaw (2007) found that naval personnel who spend longer time in service have a higher probability of developing hearing disability by the time they leave the service, especially those who were assigned to operate from surface war ships. This emphasizes the threat that being naval personnel poses to one’s health, especially to one’s hearing ability.

5.3 PREVALENCE OF HEARING LOSS AMONG NAVAL PERSONNEL

One main objective of this study was to assess the prevalence of hearing loss among naval personnel at the Sekondi Naval base in Ghana. Cunningham and Tucci (2017) posited that in order to differentiate between sensorineural and conductive hearing loss, auditory thresholds of air and bone conducted stimuli need to be measured. In this
current study, air and bone conduction of both left and right ears of the naval personnel was assessed using the headphone and the bone conductor respectively. The audiometer was then used to determine the hearing levels of both conduction.

Twenty-two percent of the personnel were found to have right ear air conduction hearing loss. Thus specifically, mild (15%), moderate (3.3%), moderately severe (2%) and severe (1.3%) right ear air conduction hearing loss. Comparatively, 20.3% of the participants had left ear air conduction hearing loss. Thus mild (14.4%), moderate (3.3%), moderately severe (2%) and severe (0.7%) left ear air conduction hearing loss to be precise. This shows a similar trend in the levels of air conduction hearing loss in both left and right ears of the naval personnel. Despite the fact that majority of the naval personnel do not have any hearing loss, the percentage of those found to be suffering from either bone or air conduction hearing loss is quite higher if generalized to the entire population of naval personnel in Ghana.

Among those found to have hearing loss in this current study, most of them were found to be suffering from mild hearing loss. According to the WHO (2019), people with mild hearing loss find it difficult to hear soft sounds from a distance. Although this might be considered as something that has little disabling effect on an ordinary individual, its effect on naval personnel need not be taken lightly looking at the nature of their work as security personnel. Furthermore, despite that fact that this may be considered as mild, it still calls for concern due to the risk of progression.

When air conduction of both left and right ears were assessed it was found that 12.4% of the naval personnel had bilateral air conduction hearing loss. These result however, is lower compared to that of Collée et al. (2011) who found that 32.2% mild hearing
loss, 13.6% moderate hearing loss and 10.0% severe hearing for both ears among the Belgian military.

With regard to results from bone conduction tests carried out among the naval personnel in this study, 11.8% had right bone conduction hearing loss and 7.2% had left bone conduction hearing loss. Particularly among those with right bone conduction hearing loss, 9.8% were mild, 1.3% was moderate and 0.7% was moderately severe. However, among those with left bone conduction hearing loss, 4.7% had mild, 2% had moderate and 0.7% had moderately severe left bone conduction hearing loss.

This shows that the prevalence of bone conduction hearing loss is less than air conduction hearing loss among the naval personnel, an indication of poor hearing ability among most of those classified as having hearing loss. The WHO (2019) posited that persons with moderately severe and severe hearing loss require that sounds are made loud enough in order to make them perceive it. Therefore, findings on the levels of hearing loss among the naval personnel need to be addressed particularly due to the importance of hearing in the discharge of duties among military personnel.

According to Stach, (2010), hearing loss represents a reduction in the sensitivity of an individual’s auditory mechanism. As a result of this, sounds need to be of higher than normal intensity before it can be perceived (World Health Organisation, 2019). In this current study, forty-three, representing 28.1% of the naval personnel suffer from some degree of hearing loss; ranging from mild to severe. Out of which 24 had conductive hearing loss and 19 had sensorineural hearing loss representing 55.8% and 44.2% respectively. These indicate the proportion of be sensorineural or conductive hearing loss among the naval personnel. However, this percentage is high compared to 20% prevalence of hearing loss recorded by Lin et al. (2011) among US citizens. This
difference may be attributed to the fact that participants in the later study were civilians and were less exposed to the hazards of hearing compared to naval personnel in the current study. On the other hand, Kaewboonchoo et al. (2014) in their cross-sectional study among Thai naval personnel found that 39.6% of their naval personnel suffered some form of hearing disability. Although this percentage level is high compared to that of the current study, it still calls for great concern.

5.4 RISK FACTORS ASSOCIATED WITH HEARING LOSS AMONG NAVAL PERSONNEL

A second major objective of this study was to assess risk factors associated with hearing loss among naval personnel at the Sekondi naval base. Non-communicable diseases such as diabetes and hypertension, in addition to factors such as increasing age, exposure to loud noise, use of firearms, to mention but a few have been identified to be associated with increasing levels of hearing loss among victims (Casale et al., 2012; Figueiredo et al., 2015). In this study, diagnosis of diabetes and hypertension, in addition to noise exposure and increasing age were compared with hearing loss among the naval personnel to determine how these variables predict hearing loss among the sailors.

Out of the 153 naval personnel that took part in the study, 3.3% had hypertension and 2% had diabetes. Findings from the study showed a significant relationship between diabetes and hearing loss ($p=.003$). Naval personnel who were diagnosed as suffering from diabetes had significant hearing loss compared to those who do not have diabetes. This confirms literature which associated with diabetes with hearing loss. Literature shows that increasing blood glucose levels damages nerve cells (Horikawa et al., 2013)
Hearing disability results when nerves involved in the transmission of hearing impulses get affected. In addition, Bainbridge et al. (2008) found at least mild hearing loss among the working age adults in America who had pre-diabetes or diabetes.

Furthermore, the findings from this study also showed a significant difference in hearing loss among those with hypertension and those without hypertension \( (p=0.023) \). Thus, an indication that naval personnel who are diagnosed as suffering from hypertension have significant hearing loss compared to those who do not have hypertension. This is consistent with the findings of Agarwal et al. (2013) who found hypertension as a major contributing factor in the degeneration of an individual’s hearing apparatus as he or she ages. This underscores the need for naval personnel and all military personnel in general to make concerted efforts towards positive lifestyle changes that will improve upon their health and prevent them from developing these non-communicable diseases and their consequent effect on their hearing ability.

With regard to the use of ear protectors among the naval personnel, most (41.2%) of them never used ear protectors in the engine room. Among the 58.8% that ever-used ear protection, 16.3% rarely used it. However, 37.9% of them sometimes use ear protectors in the engine room. Just a few (4.6%) of them always used ear protectors in the engine room. This is an indication of the poor and irregular use of ear protection devices among the naval personnel. In a systematic review, Tikka et al. (2017) underscored the importance of the use of ear protectors in protecting one from occupational noise exposure. This suggests that most of the naval personnel either do not appreciate the importance of using the ear protectors or undermine its importance in protecting their ears from hazardous noise exposure. However, this may also be as a result of shortage of lack of ear protectors available for the sailors to use.
Although the risk of hearing loss was found to be low with the use of ear protectors, its effect is not significant \( (p = 0.73) \). According to Tikka et al. (2017), ear protectors if used under proper instruction reduce loud noise exposure to about 20dB. This suggests that, if the naval personnel use the ear protectors regularly, and properly it might contribute to a significant reduction on the risk of hearing loss.

Furthermore, in this current study, there was higher risk of developing hearing loss among personnel in the engine room \( (p = 0.015) \). Usually, sounds from the high-powered engines in the engine room produce loud noise which may be linked to the increased risk of hearing loss among the staff stationed at the engine room. This can be linked to Kujawa and Liberman (2006) who explained that exposure to loud noise is known to cause death in the sensory hearing cells leading to permanent hearing loss known as permanent threshold shift. Furthermore, Clark and Bohne (1999) posited that repeated unprotected exposure to loud sound may result in an insidious type of sensorineural hearing loss. This is termed Noise Induced Hearing Loss (NIHL) (Azizi, 2010). In addition to that, listening to loud music was also found to be common among the naval personnel in the current study (87.6%). This also places them at risk of developing hearing loss (World Health Organisation, 2019). However, the risk of developing hearing loss due to exposure to loud noise among the naval personnel in this current study was not significant. However, this does not underestimate the risk that exposure to loud noise poses to the development of hearing loss.

Comparing the impact of ageing on hearing loss, a significant difference was found in age among naval personnel with hearing loss and those without hearing loss \( (p = 0.028) \). Thus, an indication that older naval personnel are at a more risk of hearing loss than the younger ones. This can be linked to the findings of Collée et al. (2011) who found a
significant increase in the prevalence of mild, moderate and severe hearing loss with age and within certain infantry units in the Belgian army. This is an indication that hearing loss may not be particularly limited to only the navy within the military. This warrants the need for further studies into the prevalence of hearing loss among the other services of the military.
CHAPTER SIX

CONCLUSION, RECOMMENDATIONS AND LIMITATIONS

6.1 INTRODUCTION

This chapter focuses on conclusions of the study, implications of the finding for research, policy, practice and education. Also included in this chapter are the limitations of the study and recommendations based on the findings of the study.

6.2 CONCLUSION

This study assessed the prevalence of hearing loss including the causes and risk factors associated with hearing loss among naval personnel of the Ghana Armed Forces at the Secondi Naval Base. Overall prevalence of hearing loss among the naval personnel at the Sekondi naval base was 28.1% and which was high compared to records on the prevalence of hearing loss among the general population. Among those with hearing loss, 55.8% had conductive hearing loss and 44.2% had sensorineural hearing loss.

Prevalence of bilateral air and bone conduction hearing loss among the naval personnel was 12.4% and 5.9% respectively.

The significant risk factors associated with hearing loss among the naval personnel were working in the engine room ($p= 0.015$), ageing ($p=.028$), diabetes ($p=.003$) and hypertension ($p=.023$) which emphasises the need for lifestyle changes among the naval personnel to reduce risk of hearing loss. Other risk factors included the non-use and poor use of ear protectors and exposure to loud music however, these were not significant.
6.3 IMPLICATIONS OF THE STUDY

The findings from the current study present implications for the practice, management, education, policy and research for the Ghana navy. These implications centre on the occupational safety of naval personnel in the Ghana armed forces.

6.3.1 IMPLICATIONS FOR RESEARCH

Study findings on the risk factors associated with hearing loss has significant implications for research within the Ghana armed forces. Due to the fact that other services of the Ghana armed forces are also at risk of occupational noise exposure there is the need for future research to pay attention to the prevalence, risks associated and causes of hearing loss among these other services of the Ghana armed forces. Appreciating the extent and depth of the situation will inform the needed actions to be taken to address the situation.

6.3.2 IMPLICATIONS FOR POLICY MAKING

This study has significant implications for policy making in the area of occupational safety of the Ghana naval. The poor use of ear protectors among the naval personnel and exposure to loud noise shows that most of them are not aware of the dangers associated with the non-use of ear protectors and the negative effects of exposure to loud noise. The Ghana armed forces medical directorate in collaboration with the naval command, Ghana health service and all stakeholders should institute and enforce a strong occupational safety policy that will ensure that all naval vessels have enough ear protectors, well installed noise proof cabins and the establishment of other measures of protecting naval personnel and personnel from the other services of the military from hazardous noise exposure.
6.3.3 IMPLICATIONS FOR PRACTICE AND MANAGEMENT

With regard to practice and management, it behoves on all naval commanders to ensure that the necessary occupational safety measures including regular use of ear protectors are enforced, especially among staff stationed at the engine room. This underscores the need for necessary disciplinary actions to be established and enforced to serve as deterrent to any naval personnel or staff on board the ship who refuses to comply with these occupational safety regulations.

6.3.4 IMPLICATIONS FOR EDUCATION

General findings from the study, suggest poor understanding of the dangers of occupational hazards, especially occupational noise exposure, to the health of the naval personnel. This implies that occupational health should be considered as a major part of the education and training of personnel of the Ghana armed forces, especially, the navy. This will help equip them with the knowledge on the risk associated with occupational hazards to their health, especially noise exposure and its consequent dangers to their hearing ability.

6.4 LIMITATIONS OF THE STUDY

Despite the fact that concerted efforts were made to ensure an appropriate methodology, this study is not without limitations. The study was only conducted at the Sekondi naval base. As a result of this, findings from the study may not necessarily reflect the holistic situation of hearing loss among naval personnel in the entire Ghana navy.

Secondly, the use of a structured questionnaire in quantitative studies limits the participants’ chances of expressing themselves fully. However, many options were
made available for them to choose that which appropriately represents their preferred response.

Finally, noise levels in the engine rooms of the ships were not measured due to lack of equipment.

6.5 RECOMMENDATIONS

The following recommendations were made based on the findings of the study:

1. The prevalence of hearing loss among the naval personnel in this current study is 28.1% – something that should not be taken lightly. There is the need for concerted efforts through collaboration with the Ghana navy command and the health directorate of the Ghana armed forces to carry out regular ear and hearing screening of their naval personnel for early identification and treatment and prevention of hearing loss among the personnel.

2. The Ghana navy High command should, as a matter of urgency, procure and employ the combined use of earmuffs and earplugs by its personnel because of its higher noise attenuation level. The naval personnel should also be given proper instruction on the handling and use of these ear protectors on the job, as well as periodic monitoring, to achieve maximum ear protection. This would be particularly helpful to the naval personnel in the engine room.

3. General use of ear protectors among the naval personnel was found not to be encouraging. Senior officers and naval commanders should always use ear protectors in the engine room and any other noisy place on board the ship and also ensure that all naval personnel also use ear protectors on board the ship. By
so doing, they will serve as role models and motivate junior ranks to take up the habit of always using ear protectors on board the ship.

4. The medical directorate of the Ghana armed forces should carry out annual seminars on the dangers of occupational noise exposure. This will help create an interaction platform for naval and all military personnel in all the garrisons about the importance of auditory health for all personnel during their professional career and personal life after retirement.

5. The significant effect of diabetes and hypertension as risk factors in the development of hearing loss underscores the need for Lifestyle changes among naval personnel as a matter of urgency. The medical directorate of the Ghana Armed forces should organize quarterly health seminars on good nutrition, stress prevention and management, drinking habits, to mention but a few, for the Ghana navy and other services in the Ghana Armed forces. This will help prevent them from developing diabetes and hypertension and their consequent risk of hearing loss.

6. Due to the fact the exposure to occupationally hazardous noise is not only limited to the naval personnel in the Armed Forces, future quantitative studies using larger samples should be carried out to compare hearing loss among other services in the Ghana Armed Forces. This will help appreciate identify other services in the Ghana Armed Forces at risk of hearing loss so that collective efforts can be made to address the situation.
REFERENCES


American Diabetes Association (2017). Standards of Medical Care in Diabetes-2017 Abridged for Primary Care Providers. Clinical diabetes: a publication of the


https://doi.org/10.1002/14651858.CD006396.pub4


https://doi.org/10.7205/MILMED.172.4.426


APPENDIX I: QUESTIONNAIRE

Dear Sir/ Madam,

I am conducting a study on the prevalence of hearing loss among naval personnel. I will be grateful if you could spend a little of your time to complete this questionnaire. There are no right or wrong answers. Any information provided is private and confidential. This study is only for academic purposes. Your participation in this study is entirely voluntary. Please feel free to answer the questions below.

INSTRUCTION: Please tick [√] your choice of answer in the boxes below or write in the spaces provided.

Section A: Demographic Data

1. Age
   - 20-30 years [ ]
   - 31-40 years [ ]
   - 41-50 years [ ]
   - 51-60 years [ ]

2. Sex:
   - Male [ ]
   - Female [ ]

3. Rank:
   - SLT/LT [ ]
   - LTCDR/CDR [ ]
   - CAPT/CDRE [ ]
   - OS/ABII [ ]
   - ABI/LS [ ]
   - POI/POII [ ]
   - CPO1/CPOII [ ]

4. Educational status:
   - Diploma [ ]
   - Degree [ ]
   - Masters [ ]
   - PhD [ ]
   - Other (specify) _____________________________________________

5. Unit: _______________________________________________________

6. Department
   - Engine room [ ]
   - Bridge [ ]
   - Galley [ ]
   - Mess [ ]
   - Other (specify) _____________________________________________

7. Number of years in service: _____________ years
Section B: Types of hearing loss

The table below presents hearing test results of each participant. These are classified under Mild hearing loss (25-39dB), Moderate hearing loss (40-55dB), Moderately severe (56-70dB), Severe impairment (71-90dB) and Profound impairment (>90dB).

<table>
<thead>
<tr>
<th></th>
<th>250Hz</th>
<th>500Hz</th>
<th>1000Hz</th>
<th>2000Hz</th>
<th>3000Hz</th>
<th>4000Hz</th>
<th>6000Hz</th>
<th>8000Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right AC</td>
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<td></td>
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<td></td>
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</tr>
</tbody>
</table>

Section C: Risk factors associated with hearing loss

1. Have you ever been diagnosed as suffering from diabetes? Yes [ ] No [ ]
2. Have you ever been diagnosed as suffering from hypertension? Yes [ ] No [ ]
3. How often do you use ear protectors whenever you visit the engine room of the ship? Never [ ] Rarely [ ] Sometimes [ ] Always [ ]
4. How often do you listen to loud music? Never [ ] Rarely [ ] Sometimes [ ] Always [ ]
Section D: Causes of hearing loss

1. Which of the following drugs have you ever taken? (You may tick more than one option)
   - Streptomycin [ ]
   - Gentamycin [ ]
   - Canamycin [ ]
   - Quinine [ ]

2. Have you ever been exposed to loud sound of heavy gun fire? Yes [ ] No [ ]

3. Have you ever had any object perforating your ear drum? Yes [ ] No [ ]

4. Have you ever had any ear infection? Yes [ ] No [ ]

5. How often have you had head injury? Never [ ] Rarely [ ] Sometimes [ ] Most often [ ]

6. Have you ever had any ear surgery? Yes [ ] No [ ]

I DO APPRECIATE YOUR ASSISTANCE, THANK YOU.
APPENDIX II: PARTICIPANTS INFORMATION FORM

School of Biomedical and Allied Health Sciences

College of Health Sciences

University of Ghana

Department of Audiology, Speech and Language Therapy

**Title:** Prevalence of Hearing Loss among Sailors; A Study at the Western Naval Command, Sekondi.

**Principal Investigator:** Michael Donkor Tetteh

Department of Audiology, Speech and Language Therapy

Professional MSc Audiology

Mob: 0242877616; email: mickeydon83@yahoo.com

**General Information about research**

I, Michael Donkor Tetteh, a graduate student of the Department of Audiology, Speech and Language Therapy, am conducting a research on prevalence of hearing loss among sailors; a study at the Western Naval Command, Sekondi. The purpose of the study is to determine the prevalence of hearing loss and to investigate the causes and risk factors associated with hearing loss among naval personnel of the Ghana Armed Forces at the Western Naval Command, Sekondi.
Possible risks and discomforts
This research does not pose any foreseeable risks or discomfort to the participant. There are no risks for participating in this study since the testing equipment and procedure does not give any side effects.

Possible benefits
Participating in the study will provide you with the opportunity of knowing your hearing status and the presence or not of any hidden hearing problem without any cost.

Alternatives to Participation
In the event of any noticed problem, the participant will be referred for further testing and the necessary action as needed will be taken.

Confidentiality
All information provided will remain confidential and will only be reported as group data with no identifying information. All data, including test results will be kept in a secure location and only those directly involved with the research will have access to them.

Voluntary Participation and Right to Leave the Research
Participation in this study is voluntary. The participants have the right to withdraw at any time or refuse to participate entirely without any jeopardy to them.
Contacts for Additional Information

For any information, clarification or questions about the study, please contact the principal investigator, Michael Donkor Tetteh on 0242 877 616.

Your rights as a Participant

This research has been reviewed and approved by the 37 Military Hospital Institutional Review (37MHIRB). If you have any questions about your rights as a research participant you can contact the IRB Office between the hours of 7:30am – 3:00pm through the landline +233-302-775958 or email addresses: irb37milhosp@hotmail.com
APPENDIX III: VOLUNTEER AGREEMENT/CONSENT FORM

The document describes the benefits, risks and procedures for the research: prevalence of hearing loss among sailors; a study at the Western Naval Command, Sekondi.

I ....................................................................................................................................................have been given an opportunity to have any questions about the research asked and answered to my satisfaction. I will like to take part in the study so far as my details will be kept confidential. I agree to participate as a volunteer.

........................................................................................................................................

Signature of participant            Date

........................................................................................................................................

Signature of researcher             Date
APPENDIX IV: ETHICAL APPROVAL LETTER – SCHOOL OF BIOMEDICAL AND ALLIED HEALTH SCIENCES

UNIVERSITY OF GHANA
SCHOOL OF BIOMEDICAL AND ALLIED HEALTH SCIENCES

Ref. No.:..............................


Mr. Michael Donkor Tetteh,
Dept. of Audiology, Speech and Language Therapy,
SBAHS,
Korle Bu.

Dear Mr. Michael Donkor,

ETHICS CLEARANCE


Following a meeting of the Ethics and Protocol Review Committee of the School of Biomedical and Allied Health Sciences held on Tuesday 30th January, 2018, I write on behalf of the Committee to approve your research proposal as follows:

TITLE OF RESEARCH PROPOSAL: HEARING LOSS AMONG SAILORS: A STUDY AT THE WESTERN NAVAL COMMAND, SEKONDI

This approval requires that you submit three-monthly review reports of the protocol to the Committee and a final full review to the Committee on completion of the research. The Committee may observe the procedures and records of the research during and after implementation.

Please note that any significant modification of the research must be submitted to the Committee for review and approval before its implementation.

You are required to report all serious adverse events related to this research to the Committee within seven (7) days verbally and fourteen (14) days in writing.

As part of the review process, it is the Committee’s duty to review the ethical aspects of any manuscript that may be produced from this research. You will therefore, be required to furnish the Committee with any manuscript for publication.

This reviewed report is valid till 31st August, 2018

Please always quote the ethical identification number in all future correspondence in relation to this protocol.

Thank you.

Yours sincerely,

Dr. S. D. Amanquah
(Chairman, Ethics and Protocol Review Committee)

Cc: Dean
School Administrator
Head, Dept. of Audiology, Speech and Language Therapy

COLLEGE OF HEALTH SCIENCES

* P.O. Box KB 142, Korle Bu, Accra, Ghana.
* Telephone: +233 (0) 303 972268 / 0303970950  •  Email: sbahs@ug.edu.gh  •  Website: www.sbahs.ug.edu.gh
APPENDIX V: ETHICAL APPROVAL LETTER - 37 MILITARY HOSPITAL

Institutional Review Board
37 Military Hospital
Neghelli Barracks
ACCRA
Tel: 0302 769667
Email: irbmilhosp@gmail.com

13 March 2018

ETHICAL CLEARANCE

37MH-IRB IPN 207/2018

On 13th February 2018, the 37 Military Hospital (37MH) Institutional Review Board (IRB) at a Board Meeting reviewed and approved your protocol.

TITLE OF PROTOCOL: Prevalence of Hearing Loss among Sailors: A study at the Western Naval Command, Sekondi

PRINCIPAL INVESTIGATORS: Michael Donkor Tetteh

Please note that a final review report must be submitted to the Board at the completion of the study.

Please report all serious adverse events related to this study to 37MH-IRB within seven (7) days verbally and fourteen (14) days in writing.

This certificate is valid until 12th February 2019.

DR EDWARD ASUMANU
(37MH-IRB, Vice Chairperson)

Cc: Brig Gen MA Yeboah-Agyapong
Commander, 37 Military Hospital
APPENDIX VI: APPROVAL LETTER – GENERAL

HEADQUARTERS (DEFENCE INTELLIGENCE)
APPENDIX VII: APPROVAL LETTER – GENERAL

HEADQUARTERS, DEPARTMENT OF MEDICAL SERVICES

RESTRICTED

Department of Medical Services
General Headquarters
Ghana Armed Forces
BURMA CAMP
Accra

Accra: 777397
email: gafmeddept@gmail.com
ghqmed@yahoo.com

April 2018

GHQ/9062/G/MED
See Distribution

PERMISSION TO CONDUCT RESEARCH
LT (GN) MT DONKOR (GH/3857)

References:
A. GHQ/5141/A/DA/574 dated 19 Apr 18 (Not to All).
B. GHQ/9062/G/MED dated 5 Apr 18.

1. The above-mentioned subject vide quoted references in respect of mentioned Officer is referred. Reference ‘B’ requested permission for mentioned Offr to conduct research on the topic “Prevalence of Hearing Loss among Sailors” at the Western Naval Command.

2. I am to indicate that GHQ (D1) has interviewed the Offr and found that the research is not likely to have any adverse effect on the security of GAF. I am therefore to respectfully request approval for the Offr to conduct the research at the Western Naval Command, Sekondi.

3. Respectfully submitted for action, please.

RK GATOR
Colonel
for Director-General

Distribution:
External: Internal:
Action: Information:
Naval HQ GHQ (PA)
Information: GHQ (D1)
WNC
37 Mil Hosp

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