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**PREVALENCE OF HEARING IMPAIRMENT AT THE KORLE-BU
TEACHING HOSPITAL**



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DECLARATION

I, **ELSIE AKOSUA NYARKO** hereby declare that this dissertation which is being submitted in partial fulfillment of the requirements for the degree of MSc. in Audiology is the result of my own independent research project or investigation and that, except where otherwise other sources are acknowledged with explicit references and are included in the reference list, this work has not previously been accepted in substance for any degree and neither is it being concurrently submitted in candidature for any degree.

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DEDICATION

I dedicate this work to my mum, Christiana Serwaa Boateng and my husband Brian Otuo-Acheampong.



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TABLE OF CONTENTS

| TITLE | PAGE |
|---------------------------------|------|
| DECLARATION | i |
| DEDICATION | ii |
| ACKNOWLEDGEMENT | iii |
| TABLE OF CONTENTS | iv |
| LIST OF TABLES | viii |
| LIST OF FIGURES | ix |
| APPENDIX | x |
| ABSTRACT | xi |
| CHAPTER ONE INTRODUCTION | |
| 1.1 BACKGROUND OF THE STUDY | 1 |
| 1.2 PROBLEM STATEMENT | 3 |
| 1.3 SIGNIFICANCE OF THE STUDY | 5 |
| 1.4 AIM OF THE RESEARCH | 6 |
| 1.5 RESEARCH OBJECTIVES | 6 |
| 1.6 RESEARCH QUESTIONS | 7 |
| 1.7 PROFILE OF THE STUDY AREA | 7 |
| 1.8 ORGANIZATION OF WORK | 7 |



CHAPTER TWO LITERATURE REVIEW

| | | |
|-------------|---|-----------|
| 2.1 | INTRODUCTION | 9 |
| 2.2 | PREVALENCE STUDIES | 9 |
| 2.3 | TYPES OF HEARING LOSS | 10 |
| 2.3.1 | Conductive Hearing Loss | 10 |
| 2.3.2 | Sensorineural Hearing Loss | 11 |
| 2.3.3 | Mixed Hearing Loss | 13 |
| 2.4 | DEGREE OF HEARING LOSS | 13 |
| 2.5 | GENDER DISTRIBUTION OF HEARING LOSS | 14 |
| 2.6 | DISTRIBUTION OF HEARING LOSS AMONG VARIOUS AGES | 16 |
| 2.6.1 | Age Related Hearing Loss (Presbycusis) | 16 |
| 2.6.2 | Hearing Loss in Children | 17 |
| 2.7 | UNILATERAL AND BILATERAL HEARING LOSS | 18 |
| 2.8 | COMMON CAUSES OF HEARING LOSS | 19 |
| 2.8.1 | Occupational Noise Exposure | 19 |
| 2.8.2 | Otitis Media | 21 |
| 2.8.3 | Impacted Cerumen | 22 |
| 2.9 | CLINICAL PROCEDURES FOR DETERMINING HEARING LOSS | 22 |
| 2.9.1 | Patient History Intake | 22 |
| 2.9.2 | Pure Tone- Audiometry | 22 |
| 2.9.3 | Otoacoustic Emissions | 22 |
| 2.9.4 | Tympanometry | 24 |
| 2.10 | CONCLUSION | 25 |

| | | |
|----------------------|----------------------------------|----|
| CHAPTER THREE | METHODOLOGY | |
| 3.1 | INTRODUCTION | 26 |
| 3.2 | STUDY DESIGN | 26 |
| 3.3 | STUDY SITE | 26 |
| 3.4 | SAMPLING | 27 |
| 3.5 | SAMPLE SIZE | 27 |
| 3.6 | PROCEDURE FOR DATA COLLECTION | 28 |
| 3.7 | INCLUSION AND EXCLUSION CRITERIA | 28 |
| 3.4.1 | Inclusion Criteria | 28 |
| 3.4.2 | Exclusion Criteria | 28 |
| 3.8 | RESEARCH TOOLS | 28 |
| 3.5.1 | Audiograms | 28 |
| 3.5.2 | Tympanograms | 31 |
| 3.5.3 | Otoacoustic Emission Results | 32 |
| 3.9 | DATA MANAGEMENT PLAN | 32 |
| 3.10 | ANALYSIS | 33 |
| 3.11 | ETHICAL CONSIDERATIONS | 33 |
| 3.12 | DISSEMINATION OF RESULTS | 33 |
| CHAPTER FOUR | RESULTS | |
| 4.1 | INTRODUCTION | 34 |
| 4.2 | DEMOGRAPHIC VARIABLES | 34 |

| | | |
|---------------------------------------|--|----|
| 4.2.1 | Gender Demographics | 34 |
| 4.2.2 | Age Demographics | 34 |
| 4.3 | TYPES OF HEARING LOSS | 36 |
| 4.4 | AUDIOMETRIC CONFIGURATION OF HEARING LOSS | 37 |
| 4.5 | OTOACOUSTIC EMISSION AND TYMPANOMETRY ANALYSIS | 39 |
| | | |
| CHAPTER FIVE | | |
| DISCUSSION | | |
| 5.1 | INTRODUCTION | 41 |
| 5.2 | DEMOGRAPHIC PATTERN OF HEARING LOSS | 41 |
| 5.2.1 | Gender Distribution of Hearing Loss | 41 |
| 5.2.2 | Age Distribution of Hearing Loss | 42 |
| 5.3 | TYPES OF HEARING IMPAIRMENT AMONG THE STUDY POPULATION | 43 |
| 5.4 | UNILATERAL VERSUS BILATERAL HEARING LOSS | 43 |
| 5.5 | AUDIOMETRIC CONFIGURATION OF HEARING LOSS | 44 |
| 5.6 | OTOACOUSTIC EMISSIONS | 44 |
| 5.7 | TYMPANOMETRY | 44 |
| | | |
| CHAPTER SIX | | |
| CONCLUSION AND RECOMMENDATIONS | | |
| 6.1 | INTRODUCTION | 46 |
| 6.2 | CONCLUSION | 46 |
| 6.3 | RECOMMENDATIONS | 47 |

LIST OF TABLES

| | |
|-----------|--|
| Table 3.1 | Study variables |
| Table 4.1 | Gender difference and frequency of attendance of patients |
| Table 4.2 | Age difference and frequency of attendance of patients |
| Table 4.3 | Frequency distribution of hearing loss for gender and varying age categories |
| Table 4.4 | Prevalence of types of hearing loss evaluated for both ears |
| Table 4.5 | Audiometric configuration of evaluated hearing loss for right and left ears |
| Table 4.6 | Evaluated OAE passes/referrals and types of middle ear disorders |

LIST OF FIGURES

- Figure 2.1 Prevalence of hearing loss by age group and gender
- Figure 3.1 Audiometric configuration of hearing loss
- Figure 3.2 An audiogram of sensorineural hearing loss
- Figure 3.3 An audiogram of conductive hearing loss
- Figure 3.4 An audiogram of a mixed hearing loss
- Figure 4.1 Distribution of types of hearing loss in both ears
- Figure 4.2 Degree of evaluated hearing loss in left and right ears
- Figure 4.3 Tympanometry in left and right ears

APPENDIX

| | |
|--------------|---|
| APPENDIX I | KBTH Audiogram Form |
| APPENDIX II | Letter to the Hearing Assessment Centre of KBTH |
| APPENDIX III | Ethical Clearance Form |

ABSTRACT

BACKGROUND: Hearing loss makes a large contribution to the global burden of disease, which substantially adversely affect social and economic development in communities and countries. Due to this, WHO therefore promotes surveys and gathers data for measuring the burden of deafness and hearing impairment. At KBTH, data on the prevalence of hearing impairment is lacking. There is therefore the need for accurate prevalence studies to be carried out in Ghana to enable health organizations and the medical profession to economically analyze the burden of hearing impairment.

AIM: To determine the prevalence of hearing impairment at KBTH.

METHODS: A retrospective review of the records of 715 patients who visited the Hearing Assessment Centre of KBTH during the periods of January - December 2013 was conducted.

RESULTS: Four hundred and seventy four (66.3%) had a significant hearing loss. The highest prevalence of hearing loss was recorded for the age group 60 and above. The overall data gathered suggested that, sensorineural hearing loss was the most prevalent for both the left and right ears, with prevalence rates of 36.7% and 40.5% in the right and left ears respectively. In addition, mild hearing loss was the most prevalent.

KEYWORDS: Hearing loss, tympanometry, prevalence, sensorineural, conductive, mixed hearing loss, Korle-Bu Teaching Hospital

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

The burden of hearing impairment on both children and adults cannot be over emphasized. Hearing loss in children is a silent hidden handicap: it is hidden because children, especially infants and toddlers cannot tell us that they are not hearing well. It is a handicap because, if undetected and untreated, hearing loss in children can lead to delayed speech and language development, social and economic problems and academic failure (Northern and Downs, 1991).

The negative impact of hearing loss on older adults is significant (LaForge et al., 1992). Adult hearing loss is often associated with an increased risk of psychiatric and effective mood disorders. A person with hearing loss is likely to experience feelings of frustration, sadness and isolation as his/her interpersonal and social life narrows. This is because hearing impaired adults (and children) are often socially stigmatized. Hearing loss is associated with depression, social isolation, poor self-esteem, and functional disability particularly for those suffering from hearing impairment, who have not been evaluated or treated for hearing loss (Mulrow et al., 1990a). The problem of hearing loss is wide spread. In the United States of America, it is the fourth most common developmental disorder and deafness is the most common sensory disorder. The incidence of congenital hearing loss based on universal neonatal screening programs is estimated to be 1.1 per 1,000 with a range of 0.22–3.61 per 1,000 between individual states (Mehra, Eavey and Keamy, 2009).

In Australia, it is estimated that one in six persons is hearing impaired. Prevalence rates for hearing loss are associated with increasing age, rising from less than 1% for people aged younger than 15 years to 75% for people aged over 70 years. With an ageing population, hearing loss is projected to increase to 1 in every 4 Australians by 2050. Nearly 50% of the people with hearing loss are in the working age (15-64 years) and there are an estimated 158,876 unemployed people in 2005 due to hearing loss (Access Economics Report, 2006).

In addition to its effects on individuals, hearing impairment makes a large contribution to the global burden of disease, which substantially adversely affects social and economic development in communities and countries. In developing countries, children with hearing loss and deafness rarely receive any schooling. Adults with hearing loss also have a much higher unemployment rate. Among those who are employed, a higher percentage of people with hearing loss are in the lower levels of employment compared with the general workforce. According to the World Health Organization (WHO), improving access to education and vocational rehabilitation services, and raising awareness especially among employers would decrease unemployment rates among adults with hearing loss (WHO, 2012). For example, it has been estimated that the cost of communication disorders to the U.S. economy ranged between US\$176 billion and 212 billion in 1999, representing 2.5-3% of the gross national product (Ruben, 2000). In Australia, the real financial cost of hearing loss was \$11.75 billion or 1.4% of Gross Domestic Product (GDP) in 2005. This figure represents an average cost of \$3,314 per person per annum for each of the 3.55 million Australians who have hearing loss or \$578 for every Australian (Access Economics Report, 2006).

Various prevalence studies have been carried out in some developing countries. Saunders et al (2007) analyzed clinical screening data in rural schools as well as data on pediatric hearing loss patients data seen at a clinic from a study conducted on the prevalence and etiology of hearing loss in rural Nicaraguan children, and established a high prevalence of significant hearing loss (>30 dB) of 18% among the school children. The clinic based evaluation revealed a population with a predominantly severe-profound hearing loss. A related study on the prevalence and risk factors of hearing loss among Sierra Leonean children was conducted by Seely et al (1995). Among the 2015 children evaluated, a total of 184 (9.1%) presented with mild or greater hearing loss indicating a high prevalence. Another screening program study conducted in Gambia by McPherson and Holborow (1985) to determine the incidence and causes of severe to profound hearing loss showed that, a primarily preventive approach may prove to be the most rational way of reducing the incidence.

While interventions such as hearing aids and cochlear implants enhance a person's ability to communicate, WHO estimates that fewer than 1 in 40 people will need a hearing aid. Various studies have been conducted in Ghana but the exact prevalence of hearing impairment at the Korle-Bu Teaching Hospital (KBTH) is yet to be established.

1.2 PROBLEM STATEMENT

According to WHO reports, over 5% of the world's population (360 million) people have disabling hearing loss (328 million adults and 32 million children) (WHO, 2012). Disabling hearing loss refers to hearing loss greater than 40dB in the better hearing ear in adults and a hearing loss greater than 30dB in the better hearing ear in children. Over 275 million people are estimated to have moderate to profound hearing loss in both ears. The figure is about 4.2% of the

world's population. Also, 364 million people have mild hearing loss and 80% of deaf and hearing-impaired people live in low and middle-income countries (WHO, 2012).

It is estimated again that about 50% cases of hearing loss can be prevented through primary prevention. Some simple strategies for prevention include:

- immunization of children against childhood diseases, including measles, meningitis, rubella and mumps.
- immunization of adolescent girls and women of reproductive age against rubella before pregnancy;
- screening for and treating syphilis and other infections in pregnant women.
- improvement of antenatal and perinatal care, including promotion of safe childbirth.
- avoiding the use of ototoxic drugs, unless prescribed and monitored by a qualified physician.
- referring babies with high risk factors (such as those with a family history of deafness, those born with low birth weight, birth asphyxia, jaundice or meningitis) for early assessment of hearing, prompt diagnosis and appropriate management as required.
- reducing exposure (both occupational and recreational) to loud noises by creating awareness, using personal protective devices, and developing and implementing suitable legislation.

WHO therefore promotes surveys and gathers data for measuring the burden of deafness and hearing impairment. A number of surveys have been undertaken in various countries excluding Ghana. The results of these surveys were discussed during a meeting of the key investigators held in the WHO headquarters in Geneva, Switzerland in 2003. According to the WHO surveys,

at least half of all hearing impairment is preventable. A large percentage can be treated through early diagnosis and suitable management (WHO, 2012).

Based on extrapolations on Ghana's population, it is estimated that about 1,678,877 people are hearing impaired (www.rightdiagnosis.com). This statistics for estimating the prevalence or incidence of hearing impairment in Ghana are typically based on extrapolated results from the U.S., U.K., Canadian or Australian prevalence or incidence statistics. In particular, this extrapolation model is automated and does not assume take into account any genetic, cultural, environmental, social, and racial or other differences across the various countries and regions for which the extrapolated hearing impairment statistics refer. Furthermore, the model does not use data sources or statistics about any country other than its population. As such, these extrapolations may be highly inaccurate (especially for developing or third-world countries). It only gives a general indication (or even a meaningless indication) as to actual prevalence or incidence of hearing impairment in the region.

There is therefore the need for accurate prevalence studies to be carried out in Ghana to enable health organizations and audiologists in particular to economically analyze the burden of hearing impairment.

1.3 SIGNIFICANCE OF THE STUDY

Firstly, this research will help deepen awareness of prevalence of hearing impairment at the KBTH and all the other regions that are dependent on KBTH for hearing assessment. This research was designed to help identify the gravity of the problem. The data can be used to quantify or assess the cost of hearing impairment on society. This will help all stakeholders and

decision makers in healthcare to design strategies and policies that will help to prevent the negative effects of hearing disorders.

Secondly, a public health approach to the problem of hearing impairment can be developed using the findings of this study to assist health planners and professionals plan activities. This research enumerates the conditions that should be targeted in order to solve the problems posed by hearing impairment and will also help health planners know the resources required for allocation toward prevention, treatment as well rehabilitation of individuals with hearing impairment.

Finally, the research data can serve as an inferential source of information from which the burden of hearing impairment in other regions of the country can be realized. Economic analysis studies can then be carried out to determine the costs of the burden of hearing impairment and the cost-effectiveness of different intervention against it.

1.4 AIM OF THE RESEARCH

The aim of this research was to determine the prevalence of hearing impairment at KBTH.

1.5 RESEARCH OBJECTIVES

The specific objectives for this study included:

- determination of the number of patients referred annually to KBTH Hearing Assessment Center
- establishing the prevalence of hearing loss among the referred patients
- ascertaining the type of hearing impairment with the highest prevalence rate
- finding the configuration of hearing loss with the highest prevalence

- determination of gender and age groups with the highest prevalence rates.

1.6 RESEARCH QUESTIONS

The research questions posed for the study were as follows:

- Which type of hearing impairment is dominant?
- Which age group records the highest rate of hearing impairment?
- What is the distribution of hearing impairment among the sexes?
- Which degree (type and configuration) of hearing loss is most prevalent?

1.7 PROFILE OF THE STUDY AREA

KBTH is the premier health care facility in Ghana. It is the only tertiary hospital in the southern part of Ghana and it is also a teaching hospital affiliated to the College of Health Sciences, University of Ghana. The Hearing Assessment Center of KBTH is a state of the art facility established in 2005 to provide audiological services to the Greater Accra, Volta, Eastern, Central and Western Regions. Additionally, the Center also provides service to all other patients referred from the other regional hospitals. Patients from other West African countries including Togo and Benin also benefit from the Hearing Assessment Center.

1.8 ORGANIZATION OF WORK

This dissertation is divided into six main chapters organized as follows:

1. Chapter One discusses the nature and background of the research problem and identifies the research topic, its objectives, justification, scope and limitation
2. Chapter Two covers relevant literature related to prevalence of hearing impairment.
3. Chapter Three deals with methods and techniques used for data collection.

4. Chapter Four is devoted to the main results and findings of the data collected.
5. Chapter Five deals with the discussion of the main results enumerated in Chapter Four.
6. Chapter Six deals with conclusions drawn from the study and makes appropriate recommendations to the Regional Health Directorate and the Ministry of Health.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

This Chapter reviews relevant literature and covers areas such as prevalence studies, types of hearing impairment, degree of hearing loss, distribution of hearing loss among males and females. Distribution of hearing loss among various ages, unilateral and bilateral hearing loss, some common causes of hearing impairment and clinical procedures for determining hearing loss are also reviewed

2.2 PREVALENCE STUDIES

Prevalence is the proportion or percentage of people affected by a condition at a point in time. It is arrived at by comparing the number of people found to have the condition with the total number of people studied, and is usually expressed as a fraction or percentage. Prevalence studies can be viewed as a slice through the population at a point in time at which it is determined who has the disease and who does not. In medical and public health literature, prevalence is often used as either point prevalence or period prevalence (Gordis, 2000). Point prevalence is the proportion of a population that has the condition at a specific point in time. Period prevalence on the other hand is the proportion of a population that has the condition at some time during a given period and includes people who already have the condition at the start of the study period as well as those who acquire it during that period.

Prevalence studies are however limited in scope as they do not measure the duration of the disease as well as new cases. Nevertheless, they are important for estimating the burden of disease. In the current study, period prevalence was used to measure the burden of hearing impairment at KBTH.

2.3 TYPES OF HEARING IMPAIRMENT

Hearing impairment is a deviation or change for the worse in either auditory structure or auditory function, usually outside the range of normal (Gelfand, 2009). Hearing loss can be categorized by which part of the auditory system is damaged. There are three types of hearing loss: conductive, sensorineural and mixed hearing loss.

2.3.1 Conductive Hearing Loss

Conductive hearing loss occurs when sound is not conducted efficiently through the outer ear canal to the eardrum and tiny bone (ossicles) of the middle ear. Conductive hearing loss usually involves a reduction in sound level or the ability to hear faint sounds. This type of hearing loss can often be corrected medically or surgically. Some possible causes of conductive hearing loss are fluid in the middle ear from colds, ear infections, allergies, poor Eustachian function, perforated eardrum, benign tumors, impacted earwax, infection in the canal, swimmers ear and absence or malformation of the outer ear, ear canal or middle ear.

According to the American Speech and Hearing Association (ASHA), fluctuating conductive hearing loss nearly always occurs with all types of otitis media. In fact it is the most common cause of hearing loss in young children (ASHA, 2008). A retrospective chart review of 234 infants referred for newborn hearing screening at the Audiology Department of The Townsville

Hospital (Australia) was conducted by Aithal et al, (2012). A total of 211 infants attended the diagnostic appointment for which review appointments to monitor hearing statuses were completed for 46 infants with middle ear pathology or conductive hearing loss. Of the 69 infants presenting with middle ear pathology during initial diagnostic assessment, 18 had middle ear pathology with normal hearing, 47 had conductive hearing loss, and 4 had mixed hearing loss. Prevalence of conductive hearing loss in the newborns was almost 0.3% while prevalence of middle ear pathology (with or without conductive hearing loss) was over 0.4%. A study by Amedofu et al (2005) revealed that, conductive losses were mainly attributed to otitis media, wax, foreign bodies and trauma in Ghana.

2.3.2 Sensorineural Hearing Loss

Sensorineural hearing loss (SNHL) occurs when there is damage to the inner ear (cochlea) or to the nerve pathways from the inner ear to the brain. Most of the time, SNHL cannot be medically or surgically corrected. This is the most common type of permanent hearing loss. This type of hearing loss reduces the ability to hear faint sounds. Even when speech is loud enough to hear, it may still be unclear or sound is muffled. Some possible causes of SNHL are illnesses, drugs that are toxic to hearing, genetic or hereditary, aging, head trauma, malformation of the inner ear and exposure to loud noise.

Adult onset hearing loss was not separately analyzed in the Global Burden of Disease for 1990. The leading cause of adult onset hearing loss was presbycusis (age-related hearing loss) followed by noise-induced hearing loss (Mathers et al., 2000). WHO has identified middle ear infections, excessive noise, inappropriate use of certain drugs, problem during childbirth and vaccine

preventable infections as the major preventable causes of hearing impairment in low and middle-income countries.

A study was conducted by Amedofu et al., (1997) to determine the causes of deafness in Kumasi (Ghana). A total of 128 deaf children aged between 1-5 years referred to the Ear, Nose and Throat (ENT) Clinic at the Komfo Anokye Teaching Hospital (KATH) were seen from January 1992 to June 1993. The procedure adopted included exploration and assessment of individual medical history, otoscopy, pre-audiometric and audiometric evaluation. The researchers found out that 66(51.5%) of the participants had congenital sensorineural hearing loss (CSHL), while the remaining 62(48.5%) had acquired sensorineural hearing loss (ASHL). Of the 66 congenital cases, 44 were due to unknown factors, while the rest were due to post-natal convulsion, measles, meningitis, mumps, fever and jaundice. Results of free-field tests were available in 116 children. Of these, 90 cases had a profound SNHL of which 56 were due to congenital factors, while 38 had a severe-profound SNHL and the remaining 34 originated from acquired causes. Thus, the cases listed under CSHL showed a distinctly higher incidence of profound deafness. The study concluded primary prevention measures against diseases that caused deafness as the most logical and practical way of reducing the incidence of deafness in Ghana.

Another study conducted by Amedofu et al, (2005) on 6,428 patients who visited the ENT Department at KATH revealed that, the overall prevalence of SNHL was more than other types of hearing loss. Noise, fever, presbycusis, meningitis and Meniere's disease were the major causes of SNHL. Conductive hearing loss was attributed mainly to wax, otitis media, meningitis, rubella, congenital anomalies and non-syndromal inherited hearing loss.

2.3.3 Mixed Hearing Loss

A mixed hearing loss occurs when both sensorineural and conductive impairments coexist in the same ear. It may be caused by the presence of two separate disorders in the same ear (e.g., noise-induced hearing loss plus otitis media) or by a single disorder that affects the conductive and sensorineural systems such as otosclerosis (Gelfand, 2009). A report by ASHA on the incidence and prevalence of hearing loss and hearing aid use in the United States revealed that, authoritative data concerning the general incidence and prevalence of mixed hearing loss are unavailable in the allied health or medical literature (ASHA, 2008).

2.4 DEGREE OF HEARING LOSS

The severity of a hearing loss depends on the degree of loss. A pure-tone average (PTA) is usually calculated for each ear. The PTA, which is simply the mean of the air-conduction thresholds at 500, 1000 and 2000 Hz, is an attempt to summarize the degree of hearing loss (Gelfand, 2009). Categories typically used to describe the degree of hearing loss at KBTH Hearing Assessment Center are presented in Table 2.1.

Table 2.1: Degrees of hearing loss used at the KBTH

| Pure tone average (in dBHL) | Degree of hearing loss |
|------------------------------------|-------------------------------|
| -5 to 25 dB HL | Normal hearing |
| 26-40 dB HL | Mild Hearing Loss |
| 41-55 dB HL | Moderate Hearing Loss |
| 56-70 dB HL | Moderate-Severe Hearing Loss |
| 71-90 dB HL | Severe Hearing Loss |
| >90 dB HL | Profound Hearing Loss |

Amedofu et al., (2003) indicated that, of the 145 respondents found with hearing impairment greater than 25dB HL, 66.9% ($n=97$) had a mild hearing impairment, 17.9% ($n=26$) had moderate hearing impairment, while 7.6% ($n=11$) each had severe hearing impairment, and profound hearing impairment. The majority of people therefore had mild hearing impairment. A related study conducted by Marfo, (2009) on the prevalence of hearing impairment at the Offinso Municipality of Ghana revealed that of 135 respondents found with hearing impairments greater than 25dB HL. The majority of the respondents (42%, $n=57$) had mild hearing impairment, whereas minority of them (4%, $n=6$) had profound hearing impairment. Forty participants (30%) were found to have moderate hearing impairment, 11% ($n=15$) had moderately severe hearing impairment, and 13% ($n=17$) presented with severe hearing impairment.

2.5 GENDER DISTRIBUTION OF HEARING LOSS

According to the National Institute on Deafness and other Communication Disorders (NIDCD), men are twice as likely to develop hearing loss as women, especially men between the ages of 20-69 years. Men tend to lose hearing in the higher frequencies first, while women tend to lose hearing in the lower frequencies first. But there has been inconsistency in various studies citing gender as a risk factor for hearing loss. While some have found females to be at a higher risk, others have not found this to be the case (Akeem et al, 2010).

A cross-sectional and longitudinal population study of hearing loss and speech discrimination scores by Moller (2006) in an unselected population of individuals aged 70 showed that both these groups of individuals had speech discrimination scores somewhat lower in men than in women. Exposure to noise affected hearing in men more than in women and appeared as a slightly greater hearing loss for high frequencies. The reason for these gender differences may be

that many men have noise-induced hearing loss (NIHL), but there may be other factors related to hormonal influence on the progression of age-related change in the cochlea and possibly differences in the age-related change in the neural processing of sounds. Another study by Agrawal et al, (2008) to determine hearing loss prevalence among U.S. adults evaluated differences by demographic characteristics and known risk factors for hearing loss (smoking, noise exposure, and cardiovascular risks) and established that odds of hearing loss were 5.5-fold higher in men than women. Other indications of high prevalence of hearing loss among persons older than 70 years have been reported (Helzner et al, 2005) while other studies (Borchgrevink et al, 200) have described the gradual or non-linear dependence of prevalence with age.

Nevertheless, there have been conflicting studies on the prevalence studies among men and women in Ghana. In particular, the National Academy on An Aging Society (NAAS) reported that men of all ages are more likely than women to have hearing loss (Fig. 2.1) (NAAS, 1999).

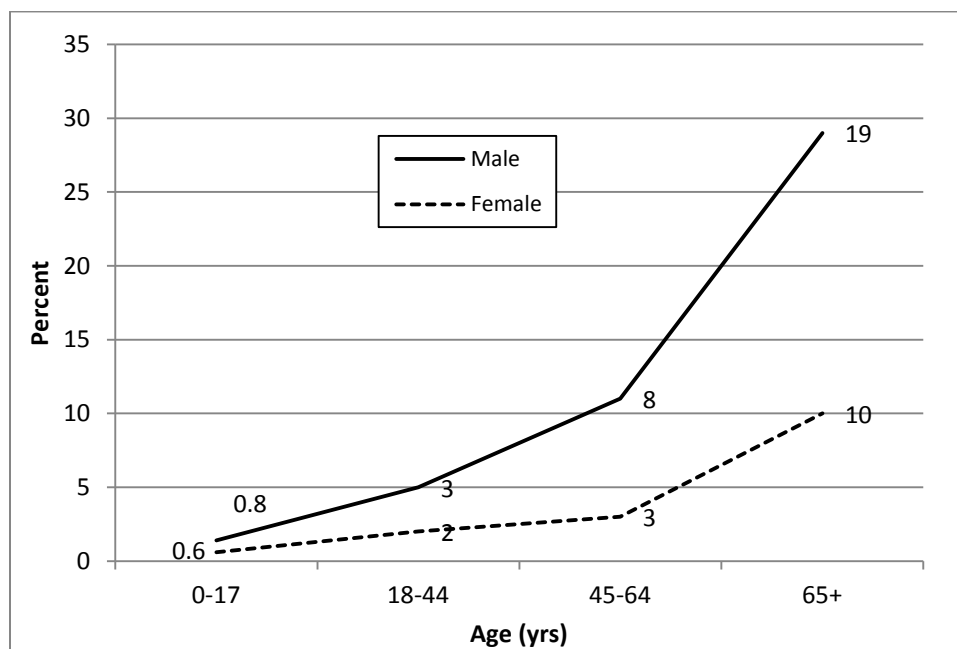


Fig. 2.1: Prevalence of hearing loss by age group and gender (Source: National Academy on an Aging Society. Analysis of data from the 1994 National Health Interview Survey of Disability, Phase I, 1994).

A study conducted by Marfo (2009) on the prevalence of hearing impairment at the Offinso Municipality indicated that out of 135 respondents with hearing impairments, 44% ($n=59$) were female while 56% ($n=76$) were male. The same observations have also been detailed by Cruikshanks et al, (1998), and further affirmed by Wilson et al (2010). In contrast, Amedofu et al (2005) revealed that there were more hearing impaired females than males in a different study.

2.6 AGE DISTRIBUTION OF HEARING LOSS

2.6.1 Age Related Hearing Loss

Age related hearing loss (presbycusis) is a bilateral loss of auditory sensitivity that progresses from high to low frequencies with ageing. However, the rate of hearing decline is not linear and is highly variable, and the variance in hearing level is only weakly associated with age. Hearing loss is a common disorder associated with aging and is ranked as the third most prevalent chronic condition in elderly people after hypertension and arthritis. Its prevalence and severity increases with age, rising from about 30-35% of adults aged 65 years and older to an estimated 40-50% of adults aged 75 and older (Cruikshanks et al., 1998). These observations suggest that age-related changes do not occur uniformly and that more than one pathological process may be acting upon the auditory system. This variety may also be taken as indirect evidence of the complex interaction of genetic and environmental factors in the etiology of presbycusis. Adding to the complexity, both the peripheral and central auditory pathways can be affected in presbycusis.

In Australia, prevalence rates for hearing loss are associated with increasing age, rising from less than 1% for people aged younger than 15 years to 75% for people aged over 70 years. With an ageing population, hearing loss is projected to increase to 1 in every 4 Australians by 2050. Studies by Agrawal et al, (2008) on 5742 adults aged 20 to 69 years who participated in the

audiometric component of the United States National Health and Nutrition Examination Survey from 1999 to 2004 revealed that in the youngest age group (20-29 years), 8.5% exhibited hearing loss and the rest were among the older age groups which indicated higher prevalence. The same observation has been reported by Lee et al, (2005) and confirmed by Curhan et al, (2010) that the prevalence of hearing loss increases with age, with hearing thresholds worsening on average by 1 dB per year after age 60 years, and decline rates greater in men aged 48-59 years.

Verras and Mattos (2007) identified presbycusis as the most frequent cause of hearing loss in the elderly in Brazil, causing verbal communication impairment, and discovered that the prevalence of presbycusis interfering in the life quality of this population increased with increasing number of elderly people. This study agrees with Marfo's (2009) work which reported that out of 135 respondents in Ghana, 28% ($n=38$) belonged to the 0–20 years group, 8% ($n=11$) were aged 21–40 years, 20% ($n=27$) were aged 41–60 years, and 22% ($n=59$) were above 60 years. Other published articles (NAAS, 1999) have confirmed same and particularly emphasized that hearing loss is highly associated with aging.

2.6.2 Hearing Loss in Children

Undetected hearing loss in infants and young children compromises optimal language development and personal achievement. However research demonstrates that when hearing loss is identified early (prior to 6 months of age) and followed immediately (within 2 months) with appropriate intervention services, the outcome in language development, speech development, and social-emotional development will be significantly better (Yoshinago –Itano et al., 1998)

A study conducted by Amedofu and Brobby (determined the prevalence of hearing-impairment among pre-school children in Kumasi, Ghana. A total of 960 children were screened using audiometry and otoscopy. The study revealed that 8.2% ($n=79$) children failed the audiometric screening test and were referred for clinical examination. Only 48.8% ($n=37$) reported for further evaluation and 72.9% ($n=27$) were found to have a hearing loss greater than 25 dB HL.

Epidemiological data on the prevalence of hearing impairment in children indicate that in developing countries, early newborn hearing screening programs are being conducted in various countries. This is because significant hearing loss is one of the most common major abnormalities present at birth. KBTH has started a neonatal hearing screening program for all babies including those at the Neonatal Intensive Care Unit (NICU).

2.7 UNILATERAL AND BILATERAL HEARING LOSS

Unilateral hearing loss (UHL) occurs when the hearing in one ear is within normal limits and the other ear has a hearing loss ranging from mild to profound. Individuals with unilateral hearing loss may have trouble localizing sounds. Localization is important when listening in groups of people and is helpful in identifying who is talking at any moment as well as for safety. Another effect is difficulty in understanding speech in noisy situations. Two normal hearing ears help to filter out noise to hear speech better. An individual presenting with a UHL can often hear speech from a distance, but may not always understand what is being said.

The impact of UHL on the academic performance was investigated by Oyler et al (1988). They investigated a school district of 54,000 students and found out that 106 students had a UHL. A review of their academic performance provided evidence that a unilateral hearing loss can place

a child at risk for academic failure, especially when in the severe-to-profound range and/or involving the right ear.

ASHA estimates that approximately 1 out of every 10,000 children is born with a UHL, and nearly 3% of school-age children have UHL. Studies investigating purely UHL in other countries have found a much lower prevalence of 3% in adults with conductive losses being more common than sensorineural hearing loss (Al Khabori and Khandekar, 2007). Single-sided sensorineural hearing loss has an estimated incidence of 9,000 cases a year (Baguley et al., 2006).

Bilateral hearing loss occurs in both ears. It is estimated that more than 1.2 million children between the ages of 5 and 14 have a moderate to severe bilateral hearing loss in sub Saharan Africa (McPherson, 1997).

2.8 COMMON CAUSES OF HEARING IMPAIRMENT

Most congenital and childhood onset of hearing loss is caused by various diseases included in the Global Burden of Disease Study. Examples include otitis media, meningitis, rubella, congenital anomalies and non-syndromal inherited hearing loss. Adult onset hearing loss was not separately analyzed in the original Global Burden of Disease for 1990. The leading causes of adult onset hearing loss are presbycusis (age related-hearing loss) followed by noise-induced hearing loss (Mathers, Smith and Concha, 2000).

2.8.1 Occupational Noise Exposure

Noise-induced hearing loss (NIHL) is an irreversible sensorineural hearing loss associated with exposure to high levels of excessive noise (Kitcher et al, 2012) and this is one of the most

common and most complex and far-reaching problem in the health and safety employment hazards in both industrialized and developing countries (Amedofu, 2007). One of the most predisposing factors to NIHL is occupational noise. Occupational noise is a frequently encountered on-the-job.

WHO reported the fraction of adult-onset hearing loss attributable to occupational noise exposure and indicated per its global analysis that 16% of deafness was due to occupational noise, with a higher proportion (22%) in males than in females (11%) owing to differences in occupational categories, economic sectors of employment and working lifetime (WHO, 2004). Approximately 89% of the total NIHL burden is found in persons in the 15-59 year age group, with the remaining 11% are over 60 years. Overall, more than four million disability adjusted life years (DALYs) were lost to noise-induced hearing loss (WHO, 2004).

A study conducted by Boateng and Amedofu (2004) on industrial noise pollution and its effect on the hearing capabilities of workers in saw mills, printing presses and corn mills in Ghana showed that such workers were exposed to hazardous noise. Results from their study indicated that 22.9% of corn mill workers, 20.5% of workers in saw mills and 8% of workers in printing presses had high frequency hearing loss at 4 kHz which is consistent with noise-induced hearing loss. Another study was carried out by Amedofu (2004) to determine the impact of hazardous noise on workers in a surface gold mining company in Ghana. The procedure adopted included a noise survey, case history, otoscopy and conventional pure-tone audiometry. Five main areas were surveyed for hazardous noise. The results showed that four areas produced noise levels above 85 dBA. Of the 252 workers at the company, 23% ($n=59$) had a typical noise-induced hearing loss at 4 kHz.

In a study to assess the prevalence of early NIHL and the awareness of the effects of noise on health among stone crushing industry workers in Ghana, Kitcher et al., (2012) noted that 87.5% of the stone crushing workers had sound knowledge on the health hazards of working in a noisy environment. However, the researchers posited that only 5.5% of these workers actually used hearing protective devices even though the noise levels at their work stations, excluding the administrative offices, ranged between 61.2 dB(A) and 99.6 dB(A). Kitcher et al., (2012) concluded that workers in the stone crushing industry were exposed to hazardous noise, which was contributory to the high prevalence of early noise-induced sensorineural hearing loss.

2.8.2 Otitis Media

Inflammations of the middle ear are called otitis media and constitute the most common cause of conductive hearing loss. Otitis media affects people of all ages, but the incidence among children is particularly high (Gelfand, 2009). It is the most common medical diagnosis for children accounting for 6 million office visits in 1990 for children between the ages of 5 and 15 years in the United States (Stoll and Fink, 1996). Adults too may have otitis media with effusion, although the prevalence decreases significantly with age (Fria et al, 1985).Katz et al, 2009 posited that, during the active infection of otitis media, a patient's hearing loss may fluctuate, usually varying between 0 and 40 dB. The average degree of hearing loss is approximately 25dB.

A prospective cross-sectional study conducted by Awuah et al, (2012) on 51 patients at KATH showed that, hearing loss occurs in majority of sufferers of acute otitis media (AOM). The prevalence of AOM was low in adults but high in children (91.3%).

2.8.3 Impacted Cerumen

This is an accumulation of wax in the ear canal that interferes with the flow of sound in the eardrum. It occurs naturally in many patients who produce excessive amounts of cerumen, which builds up over time (Gelfand, 2009). Impacted cerumen commonly produces conductive hearing loss, itching, tinnitus, vertigo and external otitis. The hearing loss worsens as the cerumen builds up, and can reach 45dB when the canal is completely occluded, Gelfand (2009).

2.9 CLINICAL PROCEDURES FOR DETERMINING HEARING LOSS

2.9.1 Patient History Intake

It is very important for a clinician to take an extensive history of the patient. This will enable the clinician to know whether there are predisposing factors of hearing loss and also which test battery will be employed (Katz et al., 2009).

2.9.2 Pure Tone Audiometry

Audiometers are used to make quantitative measures of air conduction (AC) and bone conduction (BC) thresholds. AC thresholds assess the entire auditory pathway and are usually measured using earphones, BC thresholds are measured by placing a vibrator on the skull. Its goal is to bypass the outer and middle ears and stimulate the cochlea directly. When sound is delivered by an earphone, the hearing sensitivity can be separately assessed in each ear (Katz et al, 2009).

2.9.3 Otoacoustic Emissions

Otoacoustic emissions (OAEs) are sounds that are produced by the cochlea in the ear and can be measured using sensitive microphones placed in the ear canal (Gelfand, 2009). Kemp (1979)

demonstrated that OAE's are produced either spontaneously without any stimulation or evoked from the cochlea. Energy produced by outer hair cell motility serves as an amplifier within the cochlea, contributing to better hearing. OAEs are produced by the energy from outer hair cell motility that makes its way outward from the cochlea through the middle ear, vibrating the tympanic membrane, and propagating into the external ear canal. Normal outer hair cells are therefore essential for perfectly normal auditory function.

Two types of OAEs may be measured clinically. These are transient-evoked OAEs (TEOAEs) and distortion product OAE's (DPOAEs). TEOAEs are produced in response to very brief (transient) stimuli, such as clicks or tone bursts, presented usually at an intensity level of 82-83 dB SPL (Gelfand, 2009). TEOAEs reflecting cochlear (outer hair cell) activity are generally recorded over the frequency range of 500 to about 4000 Hz. DPOAEs are elicited by simultaneously presenting to the ear two stimulus tones of different frequencies abbreviated f_2 and f_1 , that are closely spaced and presented simultaneously at moderate intensity levels. DPOAEs can be recorded across a frequency region of 500 to 8,000 Hz and sometimes even higher frequencies.

OAEs are non-invasive and technically simple to record, usually requiring only a few minutes for both ears. Sedation is not indicated for OAE measurement, even in children. It is a physiologic measure that does not require cooperation. During OAE testing, a soft disposable probe tip is gently inserted into the outer portion of the external ear canal. An airtight seal between the probe tip and the ear canal is not necessary. A miniature speaker within the probe assembly (two speakers for DPOAEs) generates in the ear canal sound stimuli at a moderate intensity level. The stimuli vibrate the tympanic membrane and mechanical energy is transmitted

through the middle ear to the cochlea. Tiny waves in the cochlear fluids vibrate a thin membrane, activating outer hair cells located on the membrane. Energy associated with outer hair cell movement, in the frequency region of the stimulus, is propagated back through the middle ear system and, as sound, into the ear canal. A miniature microphone within the probe assembly detects OAE-related sound, as well as any other sound in the ear canal during the recording (Gelfand, 2009)

When OAE's are absent, it may or may not indicate a problem with hearing. A study was conducted by Abdel-Hamid et al, (2007) in Egypt. OAE was used to screen 4,000 individuals. Those that failed the test were 19.81 % and they were referred for further evaluation. Hearing loss was detected in 16.2%.

2.9.4 Tympanometry

Tympanometry involves measuring the acoustic admittance of the ear with various amounts of air pressure, Gelfand (2009). Acoustic admittance is the ease of sound flow through the middle ear and acoustic impedance is the opposition of flow of sound energy. Tympanometry therefore is a clinical procedure that measures middle ear pressure. The instrument used is the tympanometer and the graph drawn is known as a tympanogram.

Ear canal pressure is expressed in units called deca-Pascals or daPa. As air pressure in the ear canal is increased or decreased from atmospheric condition (0 daPa) in a person with a normal middle ear, the acoustic admittance is decreased or the acoustic impedance is increased. In cases of disorders that dampen or stiffen the middle ear system, such as serous otitis media with effusion, the tympanogram may be reduced in amplitude or flat in configuration. In contrast, a

discontinuity of the ossicular chain will be associated with a tympanogram having greater amplitude than normal (Wiley and Fowler, 1997).

2.10 CONCLUSION

From the literature review, one can see that some prevalence studies have been conducted at KATH, but none have been conducted for the KBTH. There is therefore the need for such a study to be conducted. The methodology adopted for this study is presented in the next Chapter.

CHAPTER THREE

METHODOLOGY

3.1 INTRODUCTION

This Chapter describes the approach employed in conducting the research. It includes the study design, study area, study population, sampling design, data collection techniques, and research instrument and data analysis.

3.2 STUDY SITE

The Hearing Assessment Center of KBTH was chosen as the study site. The Center serves a population of over 4 million living in Greater Accra Region and all other patients who are referred from other regional hospitals for hearing assessment.

3.3 STUDY DESIGN

This research was a retrospective study which reviewed existing data to determine the prevalence of hearing impairment from January 2012- December 2012 at KBTH. This covers a total period of one year. The study assessed the number of people with hearing impairment over that period of time and focused on the audiometric configuration, type and degree of hearing loss and their correlation with gender and age. The variables studied are indicated in Table 3.1

Table 3.1: Study variables

| Study Variables | |
|--|--|
| Age | Prevalence of hearing loss among the designated ages of 0-9, 10-19, 20-29, 30-39, 40-49, 50-59, 60 years and above |
| Gender | Prevalence of hearing loss among males and females |
| Degree of hearing loss | Prevalence of the various degrees of hearing loss- mild, moderate, severe, profound, mild to moderate, etc. |
| Configuration | Prevalence of the various configuration of hearing loss- conductive, sensorineural and mixed |
| Unilateral versus bilateral hearing loss | Prevalence of unilateral and bilateral hearing losses |
| Tympanograms | Prevalence of the various types- types A, As, B, C and D |
| OAE | The pass and refer rates |

3.4 SAMPLING

The study included a retrospective review of the records of all patients who visited the Hearing Assessment Center from January 2012- December 2012. All patient records were reviewed regardless of age or gender of the patients.

3.5 SAMPLE SIZE

Because the study is a retrospective study, the sample size cannot be calculated using para analysis or a statistical formula. All the patients who visited the facility during the period of study will form the sample size.

3.6 PROCEDURE FOR DATA COLLECTION

All the audiograms of patients visiting the Hearing Assessment Center were collected and analyzed. The procedure used was therefore an all-inclusive criterion.

3.7 INCLUSION AND EXCLUSION CRITERIA

3.7.1 Inclusion Criteria

All patients who visited the Hearing Assessment Center of KBTH from January 2012 to December 2012 were included in the study.

3.7.2 Exclusion Criteria

All patients who attended the assessment Center at periods outside January 2012 to December 2012 were excluded from the study.

3.8 RESEARCH TOOLS

3.8.1 Audiograms

The audiograms of patients who visited the Hearing Assessment Center during the period covered by the study were reviewed. The audiogram is a graph showing the results of the pure-tone hearing tests. It illustrates the type, degree, and audiometric configuration of hearing loss. The frequency or pitch of the sound is referred to in Hertz (Hz). The intensity or loudness of the sound is measured in decibels (dB).

Each vertical line from left to right represents a pitch, or frequency, in Hertz (Hz). The graph starts with the lowest pitches on the left side and moves to the very highest pitches (frequencies)

tested on the right side. The range of frequencies tested by the audiologist are 125 Hz, 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 3000 Hz, 4000 Hz, and 8000 Hz (Fig.3.1).

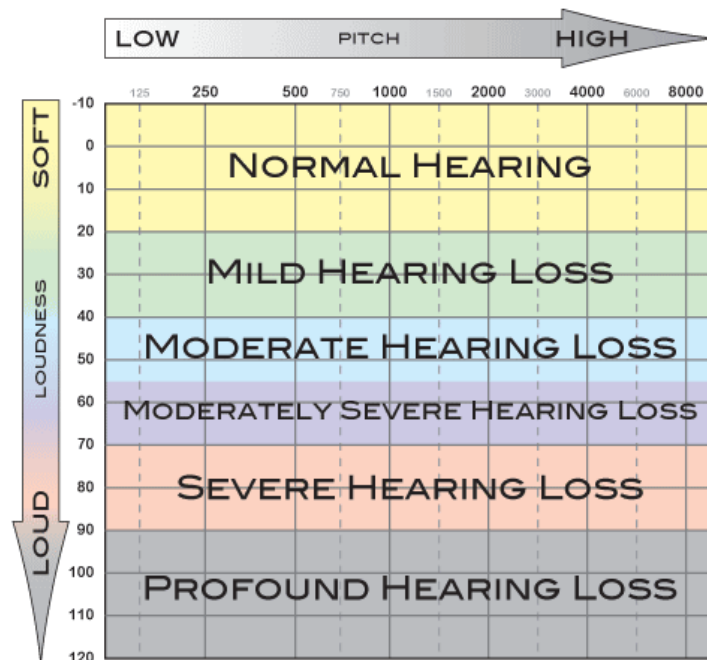


Fig. 3.1: Audiometric configuration of hearing loss (Source: www.ASHA.org)

Audiograms are often classified by categories based on the degree of hearing loss. The frequencies used for this purpose are usually 500, 1000 and 2000 Hz, often referred to as the three frequency puretone average (Katz et al., 2009). Although KBTH sets the upper limit for normal hearing at 25 dBHL, Northern and Downs (2002) suggest using 15 dBHL as the upper limit for normal hearing for children between 2 and 18 years of age and a higher limit for adults.

Another way of classifying audiograms is by the type of hearing loss (Katz, 2009). The type of hearing loss is determined by comparing the amount of hearing loss for air conduction and bone conduction thresholds. A sensorineural hearing loss has an equal amount of loss for AC and BC thresholds (Fig.3.2). By contrast, a conductive hearing loss has better BC thresholds than AC

thresholds. The degree of conductive loss is described by the decibel difference between air and BC thresholds (Fig.3.3).

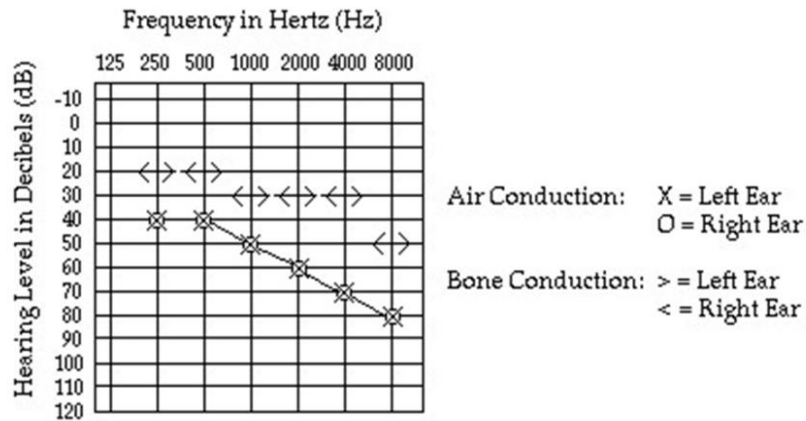


Fig. 3.2: An audiogram of sensorineural hearing loss

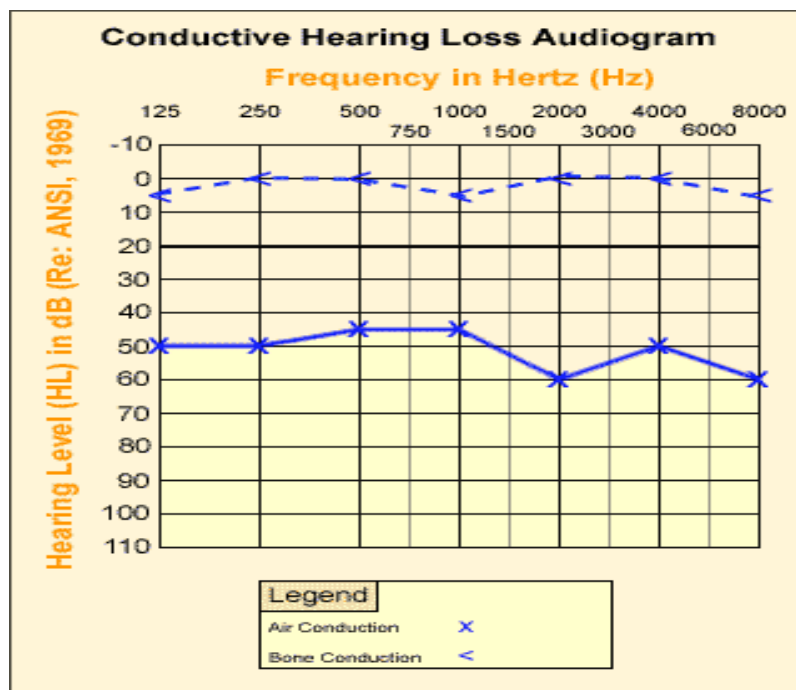


Fig. 3.3 Audiogram of conductive hearing loss (Source: OSHA)

A mixed hearing loss has an air- bone gap and thresholds for BC falls outside the range of normal hearing (Katz et al., 2009) and looks at what is represented below (Fig.3.4).An

audiogram is summarized verbally by the degree, type and audiometric configuration of the hearing loss for both ears (Katz et al., 2009). A hearing loss occurring in one ear is known as a unilateral hearing loss and if it occurs in both ears it is described as a bilateral hearing loss (Gelfand, 2009).

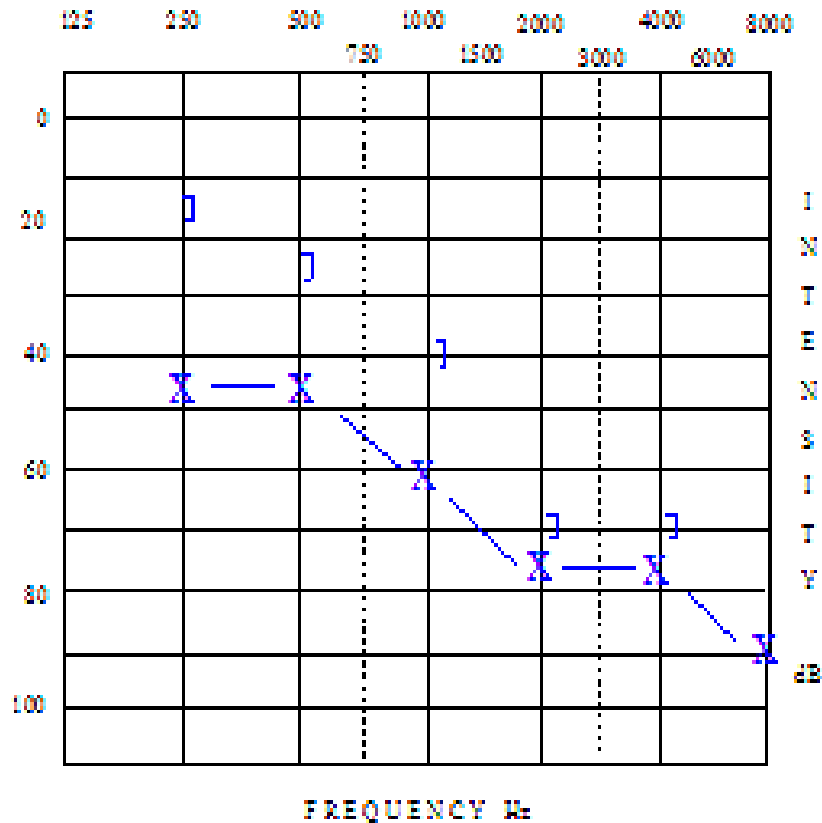


Fig 3.4 Audiogram of a mixed hearing loss

3.8.2 Tympanograms

Tympanograms are classified according to the ear canal volume, the static compliance, the peak pressure and the gradient. The equivalent ear canal volume (ECV) is an estimate of the volume of air medial to the probe, which includes the volume between the probe tip and the tympanic membrane if the tympanic membrane is intact, or the volume of the ear canal and the middle ear space if the tympanic membrane is perforated (Fowler & Shanks, 2002). Tympanometric peak

pressure (TTP) or middle ear pressure (MEP) is the ear canal pressure at which the peak of the tympanogram occurs (Margolis & Hunter, 2000). Static compliance (SC) “is the greatest amount of acoustic energy absorbed by the middle ear system (the vertical peak of the tympanic tracing)” (Onusko, 2004).

Type A tympanograms have a distinctive peak in the vicinity of atmospheric pressure and are typical of normal patients as well as those with otosclerosis. If the type A tympanogram has a shallow peak, it is classified as As which is generally associated with otosclerosis, but very deep type A tympanograms are designated as type AD. Type B tympanograms have a flat atmospheric pressure and are characteristics of patients with middle ear fluid and perforations or impacted cerumen. Type C tympanograms have a negative pressure and are associated with eustachian tube disorders and also in cases of middle ear fluid (Gelfand, 2009).

3.8.3 Otoacoustic Emission Results

OAE results are represented as either pass or refer. “Pass” test results indicate that OAEs are present, and one can assume the individual's hearing is at least 30 dB or better. If there is damage to the outer hair cells producing a mild hearing loss, then OAEs may not present. The test result is "Refer," and the patient may be at risk for possible communication handicaps and can benefit from further diagnostic assessment and possible rehabilitation (Northern and Downs, 1991).

3.9 DATA MANAGEMENT PLAN

The data in this study were managed to protect the identity of the participants. The names of patients were not used in the data analysis. Codes were used for the various parameters as well as the names of the participants. The codes were only managed by the author.

3.10 ANALYSIS

The data were analyzed using the Statistical Package for Social Scientist (SPSS) version 16.0. The software was used to compute simple descriptive statistics, percentages and frequency tables. The correlation between the various parameters will also be established. The prevalence was calculated via the formula:

$$P = \frac{N_{HL}}{N_C} \quad (3.1)$$

where N_{HL} = persons with hearing loss during the specified time period

N_C = number of people attending the clinic during the specified period

3.11 ETHICAL CONSIDERATIONS

Ethical clearance was obtained from the Ethics and Protocol Review Committee of the School of Allied Health Sciences before the commencement of the data collection. Permission to commence data collection was granted by the School of Allied Health Sciences (Appendix III). Permission to access patient data records was granted by the head of ENT Department of KBTH (Appendix II). Assurance was given concerning confidentiality with regard to handling data.

3.12 DISSEMINATION OF RESULTS

Per the requirements of the University of Ghana, copies of the research dissertation will be submitted to the Department of audiology of the School of Allied Health Sciences. The findings of the research will be published in professional journals.

CHAPTER FOUR

RESULTS

4.1. INTRODUCTION

The results of the study are presented in this Chapter. In particular the key or major aspects such as demographics, types of hearing loss, audiometric configuration of hearing loss, OAE evaluation and tympanometry.

4.2 DEMOGRAPHICS

4.2.1 Gender Demographics

The gender distribution of patients' attendance to the Hearing Assessment Center for the is represented in Table 4.1. Out of the 715 patients who reported to the KBTH Hearing Assessment Center, 51.9% ($n= 371$) (51.9%) were males and 48.1 ($n=344$) were females.

Table 4.1: Gender difference and Frequency of attendance of patients

| Gender | Frequency of attendance (number) | % attendance |
|--------|----------------------------------|--------------|
| Male | 371 | 51.9 |
| Female | 344 | 48.1 |
| Total | 715 | 100.0 |

4.2.2 Age Demographics

The frequency of attendance of the various age differences of patients as well as the distribution of hearing loss (in both ears) among the various gender and age categories are presented in Tables 4.2 and 4.3 respectively. The most prevalent group of patients presenting with hearing loss to the clinic where children (35.9%, $n=256$) aged 9 years and below, while the prevalence of

adults aged 50-59 years, and above 60 years were 11.1% ($n=79$) and 8.4% ($n=60$) respectively.

Patients with no recorded age demographics accounted for 5.2% ($n= 38$) of the population.

Table 4.2: Age difference and frequency of attendance of patients

| Age (years) | Frequency of attendance (number) | % attendance |
|--------------|----------------------------------|--------------|
| 0 – 9 | 256 | 35.9 |
| 10-19 | 72 | 10.1 |
| 20-29 | 76 | 10.6 |
| 30-39 | 74 | 10.4 |
| 40-49 | 59 | 8.3 |
| 50-59 | 79 | 11.1 |
| More than 60 | 60 | 8.4 |
| Other | 38 | 5.2 |
| Total | 715 | 100.0 |

Table 4.3: Frequency distribution of hearing loss for gender and varying age categories

| Patients with normal hearing | | % attendance | Patients diagnosed with hearing loss | | % attendance |
|------------------------------|--------|-----------------------|--------------------------------------|----------------|----------------|
| 241 | | 33.7 | 474 | | 66.3 |
| Demographic variable | | Types of hearing loss | | | |
| | | Conductive (a/b) | Sensorineural (a/b) | Mixed (a/b) | Total (a/b) |
| Gender | Male | 23/15 | 77/89 | 46/43 | 146/147 |
| | Female | 21/14 | 97/103 | 42/51 | 160/168 |
| Age (years) | 0-9 | 6/4 | 6/6 | 3/2 | 15/12 |
| | 10-19 | 9/6 | 24/24 | 14/15 | 47/45 |
| | 20-29 | 5/3 | 24/32 | 8/7 | 37/42 |
| | 30-39 | 5/6 | 16/20 | 10/6 | 31/32 |
| | 40-49 | 6/3 | 23/24 | 7/10 | 36/37 |
| | 50-59 | 9/4 | 29/32 | 14/20 | 52/56 |
| | ≥ 60 | 4/3 | 52/54 | 32/35 | 88/92 |

Legend: a/b signifies Right Ear/Left Ear

From Table 4.3, 33.7% ($n=241$) of patients reporting to the clinic for hearing assessment had normal hearing while 66.3% ($n=474$) were diagnosed with hearing loss. The most prevalent hearing loss for both left and right ears was recorded for patients aged 60 and above (88/92: conductive=4/3; sensorineural= 52/54; mixed=32/35). The 0-9 years group that showed the least prevalence of hearing loss (15/12: conductive=9/6; sensorineural=24/24; mixed=14/15).

Per gender, the results further showed that the total prevalence of the hearing loss cases for males was 146/147 (conductive=23/15; sensorineural=77/89; mixed=46/43). Comparatively, a higher prevalence of 160/168 number (conductive=21/14; sensorineural=97/103; mixed=42/51) was recorded for the female population.

4.3 TYPES OF HEARING LOSS

The results of the estimated prevalence of types of hearing loss evaluated in both ears are presented in Table 4.4.

Table 4.4: Prevalence of types of hearing loss evaluated for both ears

| Type of hearing loss | Frequency (f) | Percent (%) |
|----------------------|---------------|-------------|
| Normal (NH) | 168/159 | 35.4/33.5 |
| Conductive (CHL) | 44/22 | 9.3/6.1 |
| Sensorineural (SNHL) | 174/192 | 36.7/40.5 |
| Mixed (MHL) | 86/93 | 18.1/19.6 |
| Other | 2/1 | 0.4/0.2 |
| Total | 474 | 100 |

Legend a/b signifies Right Ear/Left Ear

Table 4.4 depicts that the most prevalent type of hearing loss for both right and left ear was SNHL 36.7%/40.5%. The prevalence of MHL was 18.1%/19.6% while the least prevalent was

CHL (9.3%/6/1%). Patients with NH were evaluated for at 35.4%/33.5% both right and left ears respectively. The distribution of the hearing loss types in both ears is shown in Fig 4.1.

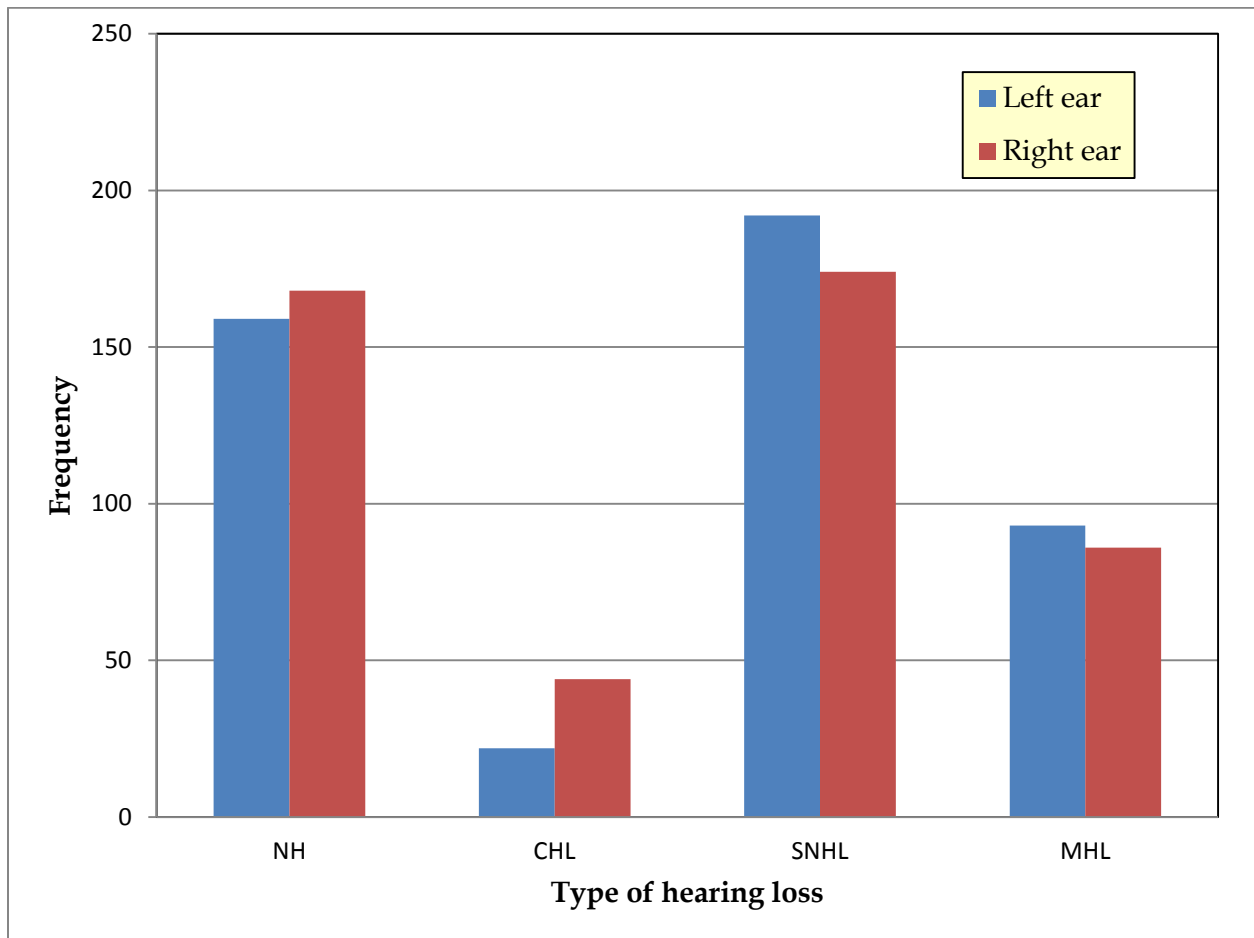


Fig. 4.1: Distribution of types of hearing loss in both ears

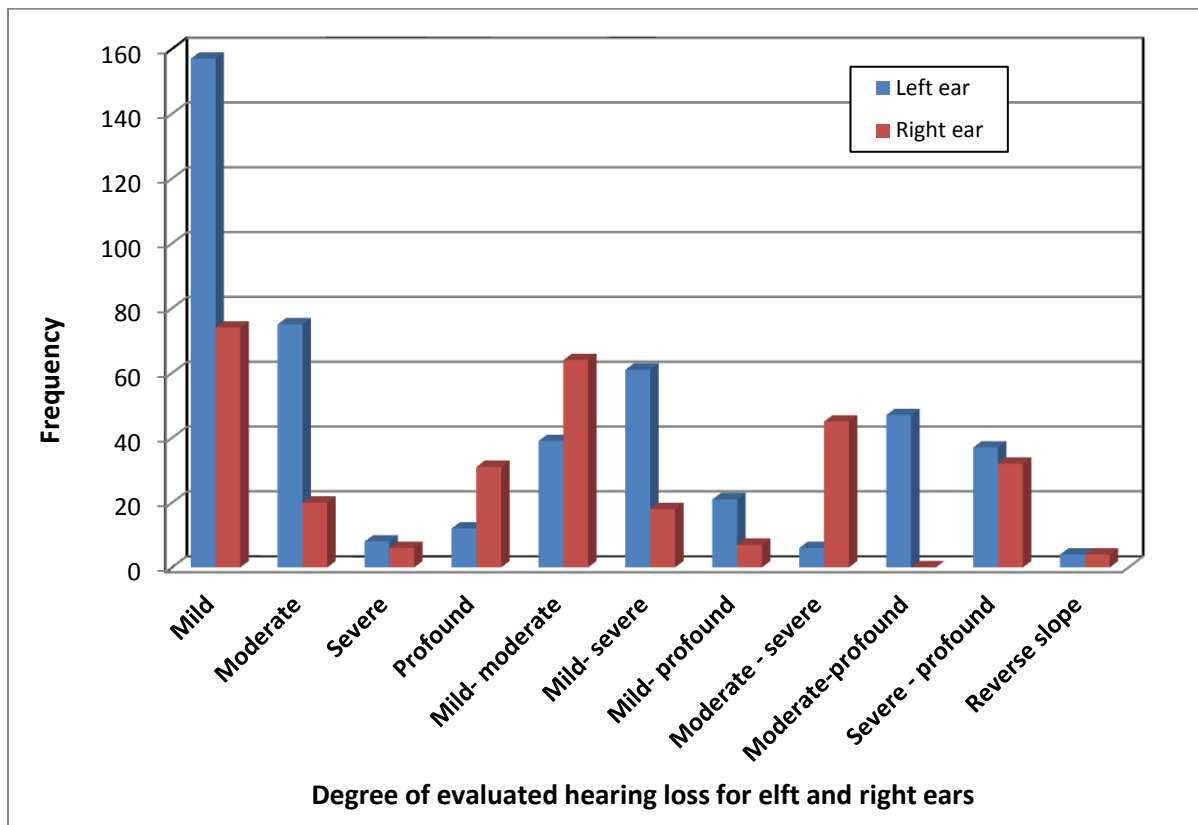
4.4 AUDIOMETRIC CONFIGURATION OF HEARING LOSS

Several patients presented with different configurations of hearing loss in both ears. The recorded statistics and the distribution of evaluated degree of hearing loss are presented in Table 4.5 and Fig. 4.2 respectively.

Table 4.5: Audiometric configuration of evaluated hearing loss for right and left ears

| Degree of Hearing Loss | Frequency (f) | Percent (%) |
|------------------------|---------------|-------------|
| Normal | 165/157 | 35.4/33.6 |
| Mild | 74/75 | 45.9/16.1 |
| Moderate | 20/8 | 4.3/1.7 |
| Severe | 6/12 | 1.3/2.6 |
| Profound | 31/39 | 6.7/8.4 |
| Mild to Moderate | 64/61 | 13.7/13.1 |
| Mild to severe | 18/21 | 3.9/4.5 |
| Mild to Profound | 7/6 | 1.5/1.3 |
| Moderate to Severe | 45/47 | 9.7/10.1 |
| Severe to Profound | 32/37 | 6.9/7.9 |
| Reverse slope | 4/4 | 0.9/0.9 |
| Total | 466/467 | 100 |

Legend a/b signifies Right Ear/Left Ear

**Fig. 4.2: Degree of evaluated hearing loss in left and right ears**

From Table 4.5, the most prevalent configurations of evaluated hearing loss were mild hearing loss (45.9%/16.1%) and moderate hearing loss (13.7%/13.1%) for both right and left ears. This was followed by mild to moderate configuration of hearing loss (13.7%/13.1%). The third most prevalent configuration of hearing loss was moderate to severe (9.7%/10.1%). The reverse slope was the least prevalent (0.9%/0.9%) for evaluated right and left ears. There was 35.4%/33.6% normal configuration of hearing loss for both right and left ears evaluated.

4.5 OTOACOUSTIC EMISSION AND TYMPANOMETRY ANALYSIS

OAE and tympanometry tests were conducted on the subjects. The evaluated results for “pass” and “refer” OAE rates and tympanometry among the population are shown in Table 4.6 and Fig. 4.3 respectively.

Table 4.6: Evaluated OAE passes/referrals and types of middle ear disorders

| Test variable | | Frequency (a/b) | Percentage a/b |
|-------------------|----------------|--------------------|-------------------|
| OAE Test | Pass | 123/121 | 51.5/50.8 |
| | Refer | 115/116 | 48.1/48.7 |
| Total | | | 100 |
| Tympanometry Test | A | 358/354 | 73.4/72.5 |
| | A _s | 16/13 | 3.3/2.7 |
| | A _D | 5/8 | 1.0/1.6 |
| | B | 72/67 | 14.8/13.7 |
| | C | 37/46 | 7.6/9.4 |
| Total | | | 100 |

Legend: a/b signifies right ear/left ear

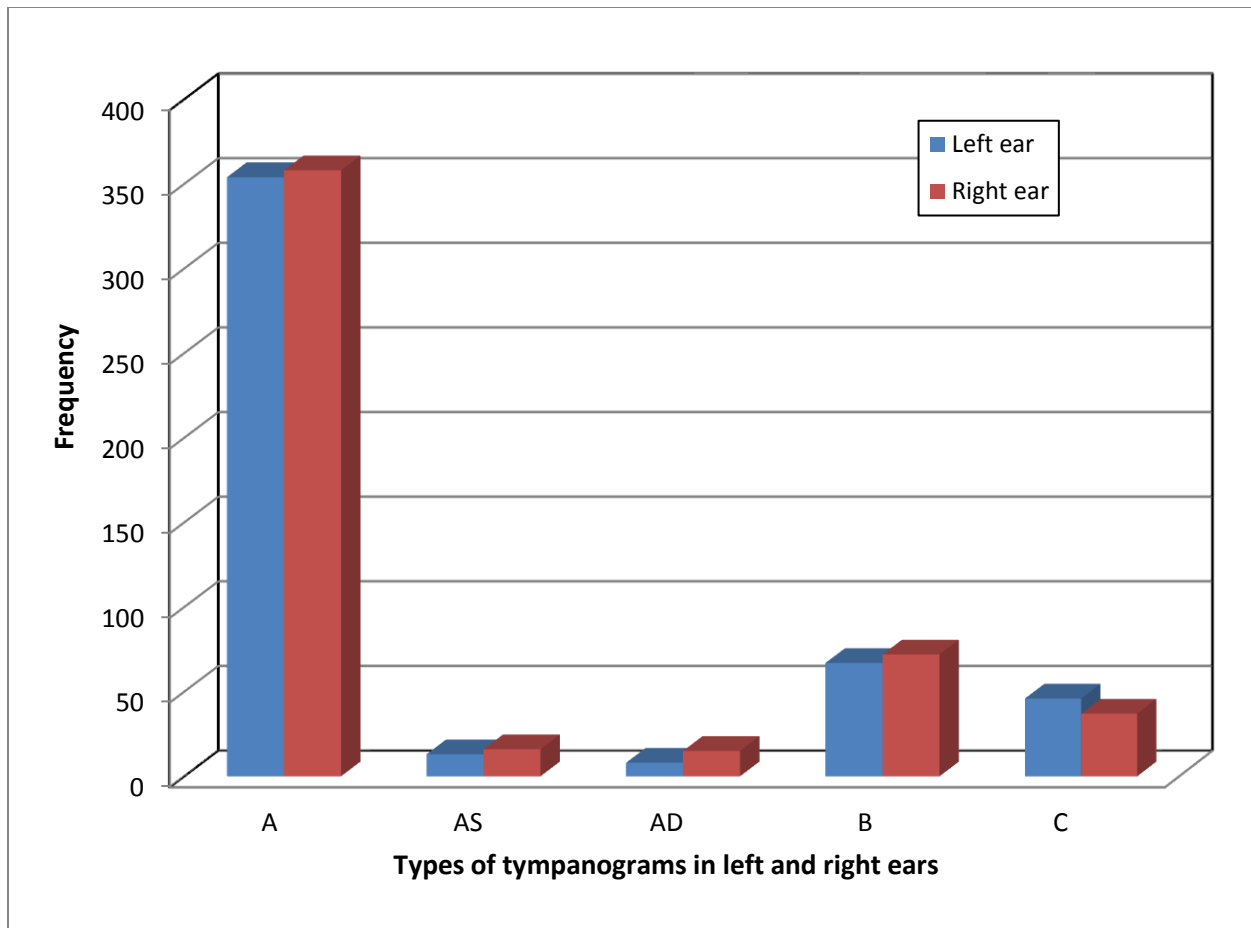


Fig. 4.3: Tympanometry in left and right ears

Over half (51.5%/50.8%) of the patients undergoing OAE test passed while 48.1%/48.7% of them referred. Analyzed data from the tympanograms showed that 73.4%/72.5%, 3.3%/2.7%, and 1.0%/1.6% of them were classified as Type A, Type A_s, and Type A_D respectively. Comparatively, fewer patients were categorized into Type B (14.8%/13.7%) and Type C (7.6%/9.4%).

A discussion of the results is presented in Chapter Five where comparisons with the literature and other published materials are made.

CHAPTER FIVE

DISCUSSION

5.1 INTRODUCTION

In this Chapter, the results obtained from the study are discussed. Comparisons are weighed against the literature and other published to ascertain the veracity and accuracy of the results.

5.2 DEMOGRAPHIC PATTERN OF HEARING LOSS

Age and gender demographics were considered in studying the prevalence of hearing loss at the defined study site.

5.2.1 Gender Distribution of Hearing Loss

A total number of 715 patients reported to the Hearing Assessment Center of KBTH for hearing screening between the periods of January 2012-December 2012. Over 66.3% ($n=475$) of the sample population presented with hearing loss. The male population accounted for 51.9% ($n=372$) of the number while the lower fraction of 48.1% ($n=344$) were females. Although more males visited the Center, the prevalence of hearing loss in one or both ears was higher in females than in males. In particular, 160 females had hearing loss in the right ear and 168 in the left ear compared to 146 and 147 for the male population. This result is consistent and in agreement with the findings of Amedofu et al (2005) which established in an evaluated study of 6,426 patients that there were more hearing impaired women than men.

It is however contrary to the findings detailed by Cruikshanks et al, (1998), Wilson et al (2010), Marfo (2009) and NAAS (1999) that men of all ages are more likely than women to have

hearing loss. As noted by Akeem et al (2010), there have been inconsistencies in various studies citing gender as a risk factor for hearing loss: some have found females to be at a higher risk, while others found the contrary as the case. The results of this study therefore consistent with and thus confirms the observed variation or contradictions of gender related hearing loss reported in the literature.

5.2.2 Age Distribution of Hearing Loss

Out of 715 patients who reported to the Center for hearing loss and as shown in Table 4.2, the most prevalent group of patients presenting with hearing loss where children (35.9%, $n=256$) below 9 years of age, while the prevalence of adults aged 50-59 years, and above 60 years were 11.1% ($n=79$) and 8.4% ($n=60$) respectively. Patients with no recorded age demographics accounted for 5.2% ($n= 38$) of the population.

From Table 4.3, a lower fraction (33.7%, $n=241$) of patients had normal hearing. On the contrary, a relatively larger group (66.3%, $n=474$) were diagnosed with hearing loss, with the most prevalent being patients aged 60 and above with hearing loss for both left and right ears was recorded for patients (88/92: conductive=4/3; sensorineural= 52/54; mixed=32/35). The 0-9 years group showed the least prevalence (15/12: conductive=9/6; sensorineural=24/24; mixed=14/15).

The findings of this study clearly show that prevalence of hearing loss increased with age. This is consistent with the literature (Mitchell et al, 2011) and in line with Marfo's (2009) work on the prevalence of hearing impairment in the Offinso Municipality of Ghana which revealed found a 44% prevalence of hearing loss among adults aged over 60 years. The findings of this study also

agree with the work of Cruikshanks et al., (1998) which reported that prevalence and severity of hearing loss increased with age, rising from about 30-35% of adults aged 65 years and older to an estimated 40-50% of adults aged 75 and older, and is also consistent with other studies (Lee et al., 2005; Curhan et al., 2010) that the prevalence of hearing loss increases with age, with hearing thresholds worsening on average by 1 dB per year after age 60 years, and decline rates greater in men aged 48-59 years. Other literature (Helzner et al, 2005; Borchgrevink et al, (2005) have been published to confirm the results of high prevalence of hearing loss among older persons and described the gradual or non-linear dependence of the prevalence with age.

5.3 TYPES OF HEARING IMPAIRMENT AMONG THE STUDY POPULATION

The various types of hearing impairment were evaluated for both the right and left ear separately. The overall data gathered suggested that, SNHL was the most common for both the left and right ear, with prevalence rates of 36.7% and 40.5% in the right and left ears respectively.

This finding that SNHL is the most prevalent type of hearing loss is consistent with Amedofu et al (2005) evaluated work on 6,426 patients in Ghana, and further emphasized in various studies (Salvago et al, 2013).

5.4 UNILATERAL VERSUS BILATERAL HEARING LOSS

Out of the 474 patients who had hearing loss, 23.3% presented with unilateral hearing loss. The distribution of the unilateral hearing loss was 13.6% for right ear and 17.7% for left ear. About 68.7% presented with bilateral hearing loss. The fact that hearing loss tends to be a bilateral condition is also supported in a study by Abdel-Hamid et al (2007). The study found out that,

bilateral hearing loss was present in less than 76% of the population with hearing loss a while unilateral hearing loss was present in over 24%.

5.5 AUDIOMETRIC CONFIGURATION OF HEARING LOSS

The most prevalent evaluated audiometric configuration of hearing loss was mild hearing loss (45.9%/16.1%) for both right and left ear (Table 4.5). The result agrees with the published findings of by Amedofu et al (2005) and Marfo (2009) which rep mild hearing loss as the most prevalent audiometric configuration of hearing loss.

The reverse slope was the least prevalent for both right and left ears evaluated. There was 35.4%/33.6% normal configuration of hearing loss for both right and left ears respectively.

5.6 OTOACOUSTIC EMISSIONS

From Table 4.6, 51.5%/50.8% of the population passed OAE test while 48.1%/48.7% referred for the right and left ear respectively. Majority of those who underwent the OAE test were children from 0-9 years. The high referral rate estimated in this study is consistent with the study conducted by Abdel-Hamid et al (2007) where 16.2% of OAE failures actually presented with a type of hearing loss.

5.7 TYMPANOMETRY

Majority of the patients recorded a normal tympanogram. From Fig. 4.3, the Type A classified tympanogram was most prevalent (73.4%/72.5%). Comparatively, fewer patients were categorized into Type B (14.8%/13.7%) and Type C (7.6%/9.4%) while Type A_D was least (1.0%/1.6%) prevalent.

The results of the study are suggestive that among patients who recorded abnormal tympanograms, majority had a Type B configuration indicating presence of fluid in the middle ear. This finding is significant because the majority of the patients who came visited the Center also suffered a type of hearing loss. Generally, middle ear problems including otitis media contributes largely to hearing impairment. The observation of the presence of this problem in this study is emphasized in detailed in a prospective cross-sectional study on 51 patients at KATH conducted by Awuah et al, (2012) where hearing loss occurred in majority of patients suffering acute otitis media.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 INTRODUCTION

The summary of the research findings, conclusion and recommendations are presented in this Chapter.

6.2 CONCLUSION

This study was conducted to evaluate the prevalence of hearing loss at KBTH. The results revealed that out of the total number of 715 patients who visited the Hearing Assessment Center during the specified period of the study, 66.3% ($n=474$) presented with different types of significant hearing loss of which SNHL was most prevalent with rates of 36.7% and 40.5% in the right and left ears respectively. This prevalence of 66.3% is alarming.

The results further revealed that although more males reported to the clinic than females, the prevalence of hearing loss was higher in females than males. This find is consistent with some studies and contrary to others as expected from the contrasting literature. Children below nine years most frequented the Center, but had the least prevalence of hearing loss. The highest prevalence of hearing loss among the age groups was recorded for those who are above 60 years and was followed by the category above 50 years. This finding was however consistent with published literature. In addition, mild configuration of hearing loss was determined as the most prevalent audiometric configured hearing loss. As expected the least configuration constituted

the reverse slope category. Bilateral hearing loss was more prevalent than unilateral hearing loss. Relatively more patients passed the OAE test than failed. The most and least prevalent types of tympanometry were Type A and A_D respectively.

Hearing loss is a frequent sensory disability affecting persons of all ages and gender. The results of this study demonstrate that hearing loss is a very common problem affecting older adults. This information is very important and presents a potential contribution for effective planning and resource investment in auditory rehabilitation services in Ghana. A couple of strategies have been advocated for mitigating the disability. In particular, Cruickshanks et al (1998) have proposed the need for epidemiologic studies to understand the genetic, environmental and gender-related determinants of age-related hearing loss and to identify potential intervention strategies. Hederstierna et al, (2007) have also suggested that hormone replacement therapy (HRT) may present the capability to offer a protective effect on hearing impairment in postmenopausal women, as well as new guidelines for classification of audiometric configuration in age-related hearing loss.

6.3 RECOMMENDATIONS

Based on the outcomes of this study, the following recommendations are suggested:

- The results are very important and presents a potential contribution for effective planning and resource investment in auditory rehabilitation services in Ghana
- The results of the study clearly identify the need for extensive patient history records for purposes of evaluating causes of hearing impairment.

- National surveys on the prevalence of hearing impairment should be conducted to assess the national impact of hearing loss. This can be done by using the WHO protocols set out to guide individual countries to conduct prevalence studies.
- The economic impact of hearing loss on the economy must be assessed.
- Since there are conflicting results on the prevalence of hearing impairment among men and women, a study to determine why there are more women with hearing loss than men should be conducted.
- The Ministry of Health should consider expanding the Hearing Assessment Center of KBTH and provide necessary equipment since there is a large burden of hearing impairment and most of these patients will need further evaluation and assistance.
- Satellite offices should be set up in order to assist with the hearing needs of patients in outlying areas.
- Since the study established that the majority of hearing losses are permanent and sensorineural in nature, funding for hearing aids and rehabilitation services should be considered.
- Attention should be given to the elderly patients since they were found to have the highest prevalence of hearing loss. An aural rehabilitation clinic should be set up to assist the elderly.
- The Ministry of Health must support the early identification program that has already started at the KBTH and provide more OAE and ABR machines to enable the continuity of the program.
- More audiologists must be trained to help serve the needs of individuals who might be suffering from hearing impairment and those who already have one.

REFERENCES

- Abdel-Hamid, O., Khatib, O.M.N., Aly, A., Morad, M., Kamel, S. (2007). Prevalence and patterns of hearing impairment in Egypt: a national household survey. *Eastern Mediterranean Health Journal*. 13(5).
- Access Economics (2006). Listen, Hear! The economic impact and cost of hearing loss in Australia. (<http://www.accesseconomics.com.au/publicationsreports/showreport.php?id=71>)
- Agrawal, Y., Platz, E.A., Niparko, J.K. (2004). Prevalence of hearing loss and differences by demographic characteristics among US adults: data from the National Health and Nutrition Examination Survey, 1999-2004.
- Akeem, O.L., Taiwo, A., Oye, G. (2010). The prevalence and correlates of self-reported hearing impairment in the Ibadan study of ageing. *Transaction of the Royal Society of Tropical Medicine and Hygiene*. 104(8): 518-523.
- Al Khabori, M., and Khandekar, R. (2007). Unilateral hearing impairment in Oman. *Ear Nose and Throat Journal*, 86(5): 274, 277-80.
- Attias, J., Al-Masri, M., Abukader, L., Cohen, G., Merlov, P., Pratt, H., Othman-Jebara, R., Abere, P, Raad, F., Noyek, A. (2006). The prevalence of congenital and early-onset hearing loss in Jordanian and Israeli infants. *International Journal of Audiology*, 45 (9): 528-536
- Amedofu, G.K., (2007). Effectiveness of hearing conservation program at a large surface gold mining company in Ghana. *African Journal of Health Sciences*, 14 (1-2): 49-53.
- Amedofu, G.K., (2002): Hearing-Impairment Among Workers in a Surface Gold Mining Company in Ghana. *African Journal of Health Science*, 9:91-97.
- Amedofu G.K., Brobby G.W., Ocansey, G. (1997). The causes and prevalence of pre-school deafness in Ghana. *African Journal of Health Science*, 4(1):29-32.

- Amedofu, G.K., Ocansey, G. Antwi, B. (2006). Characteristics of hearing impairment among patients in Ghana. *Africa Journal of Health Science*, 13(1-2):110-6.
- Amedofu, G.K, Opoku-Buabeng, Osei-Bagyina, A. et al., (2003). Hearing loss among school children in Ghana. *Ghana Medical Journal*, 37, 148-152.
- American Speech and Hearing Association (ASHA) (2008). Types of hearing loss. <http://www.asha.org/public/hearing/disorders/types.htm>. Accessed 18th Jan. 2013.
- Awuah, P., Duah, I.M., Amedofu, G.K. Prevalence of hearing loss in patients with acute otitis media. *Journal of Science and Technology (Ghana)*. ISSN: 0855-0395.
- Baguley, D. M., Bird, J., Humphriss, R. L., Prevost, A. T. (2006). The evidence base for the application of contralateral bone anchored hearing aids in acquired unilateral sensorineural hearing loss in adults. *Clinical Otolaryngology*; 31(1): 6-14.
- Boateng, C.A, Amedofu, G.K., (2004). Industrial noise pollution and its effects on the hearing capabilities of workers: A study from saw mills, printing presses and corn mills. *African Journal of Health Science*. 11(1-2):55-60.
- Borchgrevink, H.M., Tambs, K., Hoffman, H.J. (2005). The Nord-Trøndelag Norway audiometric survey 1996-98: unscreened thresholds and prevalence of hearing impairment for adults >20 years. *Noise Health*. 7(28):1-15.
- Cruickshanks, K. J., Wiley, T. L., Tweed, T. S., Klein, B. E. K., Klein, R., Mares-Perlman, J. A., et al. (1998). Prevalence of hearing loss in older adults in Beaver Dam, Wisconsin. The Epidemiology of Hearing Loss Study. *American Journal of Epidemiology*, 148, 879–886.
- Curhan, S.G., Eavey, R., Shargorodsky, J., Curhan, G.C. (2010). Analgesic use and the risk of hearing loss in men *The American Journal of Medicine*, 2010; 12(123);,231-237

- Fowler, C. G., & Shanks, J. E. (2002). Tympanometry. In J. Katz (Ed.), *Handbook of clinical audiology* (5th Ed.). Baltimore: Lippincott Williams & Wilkins.
- Fria, T.J., Cantekin, E.I., Eichler, J.A. (1985). Hearing acuity of children with effusion. *Archives of Otolaryngology*.11:10–16. PubMed.
- Gelfand, S.A. (2009). *Essentials of Audiology*.(3rd Ed.) New York: Thieme Medical Publishers, Inc.
- Gordis, L. (2000). *Epidemiology*. (5th Ed.) Pennsylvania: W.B Saunders Company.
- Hayes, D., Northern, J.(1996). *Infants and Hearing*. San Diego, Calif.: Singular Publishing Group, Inc.
- Hederstierna, C., Hulcrantz, M., Collins, A., Rosenhall, U. (2007). Hearing in women at menopause. Prevalence of hearing loss, audiometric configuration and relation to hormone replacement therapy. *Acta Oto-laryngologica*, 127(2), 149-155
- Helzner, E.P., Cauley, J.A., Pratt, S.R., et al. (2005). Race and sex differences in age-related hearing loss: The Health, Aging and Body Composition Study. *J Am Geriatr Soc*. 53(12):2119-2127.
- Katz, J. (2002). *Clinical audiology*. (5th Ed). Maryland: Library of congress cataloguing-in-publishing data.
- Kitcher, E.D., Ocansey, G., Tumpi, D.A. (2012): Early occupational hearing loss of workers in a stone crushing industry: Our experience in a developing country. *Noise Health*. 14:68-71.
- LaForge, R.G., Spector, W.D., Sternberg, J. (1992). The relationship of vision and hearing impairment to one-year mortality and functional decline. *Journal of Aging and Health* 4(1):126-148.

- Lee, F.S., Matthews, L.J., Dubno, J.R., Mills, J.H. (2005). Longitudinal study of pure-tone thresholds in older persons. *Ear Hear.*26:1-11
- Margolis, R. H., Hunter, L. L. (2000). Acoustic Immittance Measurements. In R. J. Roeser, M. Valente & H. Hosford-Dunn (Ed.), *Audiology Diagnosis*. New York: Thieme Medical Publishers, Inc.
- Marfo, A. (2009) . Prevalence of hearing impairment at Offinso Municipality. Dissertation for the degree of MSc. Kwame Nkrumah University of Science and Technology.
- Mathers, C., Smith, A., Concha M, (2013). Global burden of hearing Loss in the year 2000. Retrieved online from www.who.int/healthinfo/statistics/bod_hearingloss.pdf, accessed 18th January, 2013).
- McPherson, B., Holborow, C.A. (1985). A study of deafness in West Africa: The Gambian hearing health project. *International Journal of Pediatric and Otorhinolaryngology*, 10 (2): 115-135.
- Mehra, S, Eavey R.D and Keamy D.G. (2009). The epidemiology of hearing impairment in the United States: newborns, children, and adolescents. *Otolaryngology Head Neck Surgery*, 140:461–472. PubMed
- Mitchell, P., Gopinath, B., Wang, J.J., McMahon, C.M., Schneider, J., Rochtchina, E., Leeder SR (2011). Five-year incidence and progression of hearing impairment in an older population *Ear Hear.* 32(2):251-7
- Moller, A.R. (2006). *Hearing: Anatomy, physiology and disorders of the auditory system*. 2nd Ed. Amsterdam: Academic press.

- Mulrow, C. D., Aguilar, C., Endicott, J. E., Tuley, M. R., Velez, R., Charlip, W. S., DeNino, L. A. (1990). Quality-of-life changes and hearing impairment. A randomized trial. *Annals of Internal Medicine*, 113, 188–194. (Retrieved from <http://www.asha.org/Aud/Articles/Untreated-Hearing-Loss-in-Adults>)
- National Academy on An Aging Society (1992). Chronic Conditions: A challenge for the 21st century No. 2
- Northern, J., Downs M. Hearing in Children (1991). 4th Ed. Baltimore, Md: Williams and Wilkins.
- Onusko, E. (2004). Tympanometry. *American Family Physician*, 70 (9), 1713 – 1720.
- Oyler, R.F., Oyler A.L and Matkin, N.D.(1988). Unilateral hearing loss-demographics and educational impact. *Language, Speech, and Hearing Services in Schools* Vol.19 201-210.
- Ruben R.J (2000) “Redefining the survival of the fittest: communication disorders in the 21st century” *The Laryngoscope* 110:241-245.
- Salvago, P., Martines, E., Martines, F. (2013). Prevalence and risk factors for sensorineural hearing loss: Western Sicily overview. *Eur Arch Otorhinolaryngol.* 270(12):3049-56
- Saunders, J.E., Vaz, S., Greinwald, J. H., Lai, J., Morin, L., Mojica, K. (2007). Prevalence and etiology of hearing loss in rural Nicaraguan children. *Laryngoscope*, 117(3):387-98.
- Seely, D.R., Gloyd, S.S., Wright, A.D., Norton S.J. (1995). Archives of Otolaryngology. *Head and Neck Surgery*, 121 (8): 853-8.
- Stoll, L., Fink, D. (1996). Changing our schools: Linking school effectiveness and school improvement. Open University Press, Buckingham, U.K.
- Veras, R.P., Mattos, L.C. (2007). Audiology and aging: literature review and current horizons. *Brazilian Journal of Otorhinolaryngology*, 73(1):122-8.

Wiley, T.L., and Fowler, C.G. (1997). Acoustic immittance measures in clinical audiology: A primer. San Diego: Singular Publishing Group, Inc.

Wilson, R.H., Noe, C.M., Cruickshanks, K.J., Wiley, T.L., Nondahl, D.M. (2010). Prevalence and degree of hearing loss among males in Beaver Dam cohort: Comparison of veterans and nonveterans. *Journal of Rehabilitation Research & Development*. 47(6), 505-520

World Health Organization (2012), Deaf and Hearing impairment, Geneva (Retrieved online <http://www.who.int/mediacentre/factsheets/fs300/en/index.html>)

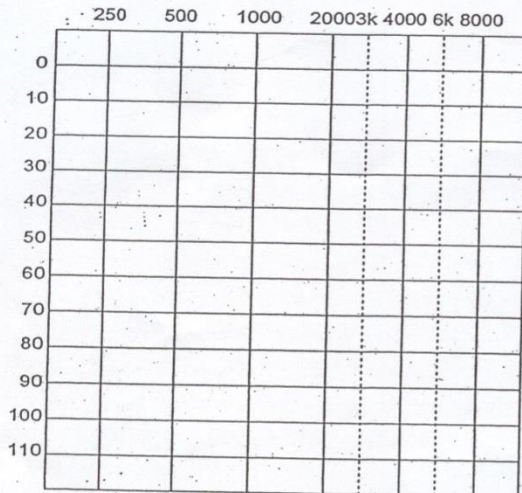
Yoshinaga-Itano, C., Sedey, A.L., Coulter, D.K. and Mehl, A.L. (1998). Language of early- and later-identified children with hearing loss. *Pediatrics*, 102(5):1161-71.

APPENDIX I

| | | |
|---|------|------|
| DATE: | | |
| AUDIOMETER: | | |
| EXAMINER: | | |
| NAME: | | |
| ADDRESS: | | |
| PHONE: | DOB: | SEX: |
| REFERRED BY: | | |
| TEST RELIABILITY: <input type="checkbox"/> GOOD <input type="checkbox"/> FAIR <input type="checkbox"/> POOR | | |

**KORLE BU TEACHING HOSPITAL
HEARING ASSESSMENT CENTRE
AUDIOLOGICAL EVALUATION**

Korle Bu Teaching Hospital
PO Box 77
KORLE BU, ACCRA
Tel: 233-302-660340
Email: korlebu@ghana.com
Web Site: www.korlebu.com



AUDIOGRAM KEY

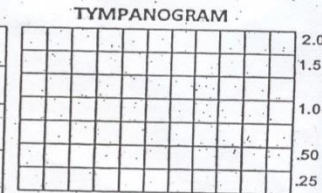
| | R | L |
|--------------|---|---|
| A/C UNMASKED | O | X |
| A/C MASKED | Δ | □ |
| B/C UNMASKED | < | > |
| B/C MASKED | [|] |
| SOUNDFIELD | S | |

SPEECH

| | RIGHT | LEFT |
|-----------|-------|------|
| SAL | | |
| SRT | | |
| DISCRIM/% | | |
| UCL/MCL | | |

TYMPANOMETRY

| NORMAL VALUES | RIGHT | LEFT |
|-----------------------------------|-------|------|
| ECV (0.2-2.0 ml) | | |
| PEAK COMPLIANCE (0.2-2.0 ml) | | |
| PEAK PRESSURE (-150 to +100 daPa) | | |



OTOACOUSTIC EMISSIONS

| OAE | PASS | FAIL |
|-------|------|------|
| RIGHT | | |
| LEFT | | |

ACOUSTIC REFLEX

| ACOUSTIC REFLEX | 500 | 1k | 2k | 4k |
|-----------------|-----|----|----|----|
| RIGHT | | | | |
| LEFT | | | | |

IMPRESSIONS:

RECOMMENDATIONS:


AUDIOLOGIST

APPENDIX II: PERMISSION TO CARRY OUT RESEARCH AT STUDY SITE

**SCHOOL OF ALLIED HEALTH SCIENCES
COLLEGE OF HEALTH SCIENCES
UNIVERSITY OF GHANA
DEPARTMENT OF AUDIOLOGY**

Phone: +233-0302-687974/5
Fax: +233-0302-688291

My Ref. No. SAHS/
Your Ref. No.



P O Box KB 143,
Korle Bu

March 21, 2013

The Head
Hearing Assessment Centre
Korle Bu Teaching Hospital

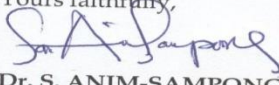
Dear Sir,

PERMISSION TO CARRY MSc RESEARCH PROJECT AT THE HEARING ASSESSMENT CENTRE, KORLE BU TEACHING HOSPITAL

Ms. Elsie Akosua Nyarko a 2nd year MSc Audiology student in the Department of Audiology of the University of Ghana School of Allied Health Sciences (SAHS).

She is conducting her MSc research dissertation project in the area of prevalence of hearing impairment at the Korle Bu Teaching Hospital under the supervision of Prof. J. Ribera and Dr. S. Anim-Sampong (SAHS). The Ethical and Protocols Review Committee of the School has reviewed and passed his work as meeting all ethical requirements.

The Department would be most grateful if you could kindly grant her permission to carry out this important research project from March – July 2013 for the common good of the University and the hospital. Thank you.

Yours faithfully,

Dr. S. ANIM-SAMPONG
(Academic Coordinator)

cc Dean (SAHS) Vice-Dean (SAHS) Dr. E.D. Kitcher (ENT, KBTH)

APPENDIX III: ETHICAL CLEARANCE

**SCHOOL OF ALLIED HEALTH SCIENCES
COLLEGE OF HEALTH SCIENCES
UNIVERSITY OF GHANA
ACADEMIC AFFAIRS**

**Phone: +233-0302-687974/5
Fax: +233-0302-688291**

**My Ref. No. SAHS/10373993
Your Ref. No.**



P. O .Box KB 143
Korle Bu
Accra
Ghana

26th July, 2013.

Ms. Elsie Akosua Nyarko,
Dept. of Audiology,
SAHS,
Korle Bu.

Dear Ms. Nyarko,

ETHICS CLEARANCE

Ethics Identification Number: SAHS – ET./10373993/AA/5A/2012-2013.

Following a meeting of the Ethics and Protocol Review Committee of the School of Allied Health Sciences held on Wednesday 14th February, 2013, I write on behalf of the Committee to approve your research proposal as follows:

TITLE OF RESEARCH PROPOSAL: “Prevalence of Hearing Impairment at the Korle-Bu Teaching Hospital”

This approval requires that you submit six-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.

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

Thank you.

Yours sincerely,



Dr. (Maj. Rtd.) George Asare
(Chairman, Ethics and Protocol Review Committee)

cc Dean
 Co-ordinator, Dept. of Audiology
 Senior Assistant Registrar