AUDITORY AND TINNITUS SEVERITY ASSESSMENT OF TINNITUS PATIENTS IN
KORLE-BU TEACHING HOSPITAL

BISMARK KWABENA ADU-TWUM

(10442317)

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DECLARATION

I BISMARK KWABENA ADU-TWUM do hereby declare that this dissertation being submitted in partial fulfillment of the requirement of masters of science degree (MSc) in Audiology is my own research work performed under the supervision and that, except where otherwise other sources are duly acknowledged with explicit references which are included in the reference list, this work has not been previously accepted in substance for any degree before neither is being submitted currently for any candidature for any degree.

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Signed.............................................. Date ..........................................

BISMARK KWABENA ADU-TWUM (10442317)

(Candidate)

Signed.............................................. Date ..........................................

PROF. GEOFFREY KWABLA AMEDOFU

(Principal Supervisor)

Signed.............................................. Date 25/02/2016

for: DR. NEAL BOAFO

(Secondary Supervisor)

Signed.............................................. Date 25/02/2016

(Head of Department)
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DEDICATION

I dedicate this work to my beloved wife Adelaide Aiden, my daughter Afia Gyamea Adu-Twum and my father Mr. Attah K. Owusu.
ABSTRACT

Background: Tinnitus is the perception of sound or noise without any external stimulation. It is a common problem worldwide affecting about 15% of the general population and approximately 19.3% of Ghanaians experience tinnitus. Tinnitus is found to be more prevalent in people with hearing loss of various degrees and types. However, there are tinnitus patients with normal hearing.

Aim: The aim of the study was to assess the auditory status, tinnitus severity and the existence of any significant associations between audiometric test outcome and tinnitus severity among tinnitus patients in KBTH.

Methods: A cross-sectional design was adopted in selecting 264 (152 males and 112 females) participants of ages 10 years and above. The auditory statuses of participants were assessed with pure-tone audiometry and tympanometry while Tinnitus Handicap Inventory (THI) was used to measure the severity of participants’ tinnitus.

Results: THI scores revealed ‘moderate’ (40.9%) as the most prevalent of the five levels of tinnitus severity. There was a non-significant association between age, gender, type, degree & configuration of hearing condition/loss, tympanograms and tinnitus severity. However, the chi-square test revealed a significant association between type and configuration of hearing condition/loss.

Conclusion: The study concluded that the audiometric and tinnitus severity findings in KBTH-Ghana were useful for the development of appropriate health policies.

Keywords: Tinnitus, Sensorineural, tympanometry, impedance.
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<tr>
<td>ABR</td>
<td>Auditory brainstem response</td>
</tr>
<tr>
<td>dB</td>
<td>DeciBel</td>
</tr>
<tr>
<td>ENT</td>
<td>Ear, nose and throat</td>
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<tr>
<td>HL</td>
<td>Hearing level</td>
</tr>
<tr>
<td>KBTH</td>
<td>Korle-Bu Teaching Hospital</td>
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<tr>
<td>NIHL</td>
<td>Noise induced hearing loss</td>
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<td>PTA</td>
<td>Pure tone average</td>
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<tr>
<td>SD</td>
<td>Standard deviation</td>
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<tr>
<td>SNHL</td>
<td>Sensorineural hearing loss</td>
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<td>THI</td>
<td>Tinnitus Handicap Inventory</td>
</tr>
<tr>
<td>THQ</td>
<td>Tinnitus Handicap Questionnaire</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organ</td>
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<tr>
<td>BSA</td>
<td>British Society of Audiology</td>
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<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
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<td>ASHA</td>
<td>American Speech-Language-Hearing Association</td>
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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

Tinnitus is a derivative of a Latin word “tinnire” meaning ringing (Bailey et al., 2001). It is also a term used to describe sounds that are buzzing, roaring, pulsatile or clicking in nature (Lockwood et al., 2000). Tinnitus can be defined as the perception of sound or noise without any external stimulation (Greenberg, 2001). As a common symptom in ENT outpatient clinics, tinnitus can be very distressing, and has been associated with anxiety and depression symptoms. Jastreboff and Hanzel (1993) reported that tinnitus is a condition present in approximately 15% of the world population, increases to 33% in individuals over 60 years, while carrying negative impact on quality of life for 20% of them. The burden of tinnitus on people in the world therefore cannot be over looked. According to Awuah (2012) and (Seidman & Jacobson, 1996; Xinhua Online Report, 2005; Humes et al., 2006), it is estimated that approximately 19.3% of Ghanaians, 12.5% of Americans, Australians and Europeans and 10.0% Chinese suffer from chronic tinnitus

The lack of a clear understanding of a unique mechanism of generation and perception of tinnitus makes a single classification difficult to envisage (Deshaies et al., 2005). In particular, tinnitus may be subjective or objective in nature. In subjective tinnitus, the patient alone perceives the sound, whereas both patient and other listeners can perceive it in objective tinnitus (Greenberg, 2001). It may also be unilateral or bilateral, where only one or both ears can perceive the sound. According to literature, most individuals presenting with tinnitus symptoms are not bothered. Jastreboff (1996) added that only 25% of tinnitus sufferers seek professional help. Zarenoe and
Lenin (2012) estimated that nearly 20% of patients with tinnitus find the symptoms difficult to bear, which significantly affects their quality of life. Chronic tinnitus is a highly incapacitating condition frequently associated with sensorineural hearing loss (SNHL) (Sand et al, 2010).

Rosenhall and Karlsson (1991) revealed that, most patients with tinnitus do not seek medical attention from professionals until many years of noise exposure. Delays in seeking medical attention could be explained by the time necessary for developing changes in the cochlea (Kujawa and Liberman, 2009) or central auditory system (Munguia et al., 2013). According to Koester et al., (2004) the older individuals might have one or more of such conditions as neurological, cardiovascular, metabolic, psychological, otological, dental, pharmacological, hypertension, middle ear diseases, autoimmune disorders, head injury, side effect of many drugs and diabetes. According to Henry et al., (2001), the effects of tinnitus on quality of life are highly individualized, and personality characteristics may predispose a person to experience tinnitus as a ‘distressing’ symptom. Holgers et al., (2000) investigated factors that may lead to incapacitating tinnitus, and reported that the severity of chronic tinnitus was associated with severe sleep disturbance, anxiety, and depression. In an attempt to measure tinnitus severity, several self-report measures and open-ended problem questionnaires (Tyler, 1993) have been developed to assess an individual's reaction to tinnitus.

Zarenoe (2012) found that the overall scores for the Tinnitus Handicap Inventory (THI) were higher in female patients compared to males. The prevalence of tinnitus in those with hearing loss appears to be greater, and the hearing thresholds are higher. Recent studies investigating the relationship between psychometric measures of tinnitus and audiometric variables have highlighted the possibility that different mechanisms might play a role in tinnitus generation (Pan
et al., 2009; Sereda et al., 2011; Heijneman et al., 2013). In assessing how bothersome tinnitus was by using the Tinnitus Severity Index (TSI) questionnaire, Pinto et al., (2010) found no correlation between audiometric variables and severity of tinnitus. The result of the study suggests that tinnitus patients are heterogeneous, and that several factors affect the impact of this symptom on the quality of life.

1.2 STATEMENT OF THE PROBLEM

Tinnitus is present in almost all human beings. However, in most cases it goes unnoticed in most people in the presence of day-to-day environmental noise (Nagaraja et al., 1997). Few studies have reported on the degree of disability caused by or that goes with tinnitus. Tinnitus constitutes an important public health problem. In general, epidemiological studies estimate the prevalence of tinnitus to be around 10-15% of the adult population (Coelho et al., 2004). It is estimated that between 8-30% of people in the industrialized countries experience tinnitus (Quaranta et al., 2004). According to Shargorodsky (2010), nearly 50 million US adults population reported having tinnitus, and 16 million of them complained of experiencing frequent tinnitus in the past years. The prevalence of frequent tinnitus increased with increasing age, peaking at 14.3% between 60 and 69 years of age. Similarly, Adegbenro et al., (2013) concluded that the prevalence of tinnitus in Nigeria population was 6.1 %. Just like any other condition, tinnitus exerts some negative impact on persons living with it. Rossiter et al., (2006) observed that people with tinnitus have reading difficulties, as their reading span is significantly shorter than that of their counterparts without tinnitus. Furthermore, Rossiter, et al., (2006) suggested that tinnitus has severe effects on cognition to the extent that it reduces the cognitive capacity of patients needing to perform tasks that require voluntary, conscious, effortful, and strategic control. Studies have revealed that tinnitus has devastating effects on human life. In particular, according to Flower et al., (2001), Holgers et al.,
(2000), Tyler, and Baker (1983), chronic tinnitus is accompanied by depression, mental and poor general health. In extreme cases, intractable tinnitus may lead to suicide (Johnston & Walker, 1996) while Anderson et al. (2000), Folmer et al., (2001) also indicated that tinnitus can be accompanied by insomnia. Seydel et al., (2013) established that tinnitus is related to stress and impairment of coping, sense of coherence, and personal resources. Awuah (2012) established annoyance effects of tinnitus as no effect (14%), slight annoyance (6.0%), moderate annoyance (68%) and severe annoyance (12%). Several studies have indicated that tinnitus is highly associated hearing loss. However, Awuah (2012) argued that tinnitus could occur in the absence of hearing loss. In addition, he stated that the severity of hearing loss in those with tinnitus ranged from <25 dB to 90dB. Tinnitus was found to more prevalent in patients with mixed hearing loss (MHL) than other types of hearing loss and that headache and dizziness are the common associated symptoms.

Tinnitus appears to be more prevalent in patients with hearing loss than their counterparts with normal hearing (Zarenoe, 2012). This evidence of high prevalence of tinnitus and the severe negative effects of tinnitus mandate the need for good intervention programs. Coles et al., (1984) have emphasized that allocation of resources for the development of intervention programs and research on any condition requires statistical data on the particular condition. Though there is enormous data available regarding the psychological and audiological profiles of individuals with tinnitus in western world, such studies are very limited in Ghanaian context. Therefore, there is the need for several investigations into the respective health condition in Ghana.
1.3 SIGNIFICANCE OF THE STUDY

The study revealed the auditory characteristics and severity of tinnitus among tinnitus patients reporting to the Hearing Assessment Centre of the Korle-Bu Teaching Hospital (KBTH). This research will help deepen awareness, educate and sensitize the general population about tinnitus at KBTH. This will inform all stakeholders and decision makers in healthcare to design strategies and policies that will help curb the negative effects of tinnitus.

1.4 AIM

The aim of the study was to assess the auditory status, tinnitus severity and the existence of any significant associations between audiometric test outcome and tinnitus severity among tinnitus patients at KBTH.

1.5 OBJECTIVES

The specific objectives for this study were to:

- determine severity level of tinnitus among tinnitus patients in KBTH
- describe the demographic and audiometric characteristics associated with tinnitus
- investigate the association between configuration and type of hearing condition
- determine the existence of any significant associations between gender, age, outcome of tympanometry, type and degree of hearing condition/loss, configuration, tinnitus localization and severity of tinnitus
1.6. RESEARCH QUESTIONS

The following research questions were used in the study:

- What is the severity level of tinnitus among tinnitus patients in KBTH?
- What are the auditory characteristics associated with tinnitus?
- Is there any significant association between hearing configuration and type of hearing condition/loss?
- Are there any significant associations between gender, age, outcome of tympanometry, type and degree of hearing condition/loss, hearing configuration, tinnitus localization and severity of tinnitus?

1.7 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 tinnitus.
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 the relevant literature and covers areas such as classification of tinnitus, distribution of tinnitus among males and females, severity of tinnitus, distributions of tinnitus among various age groups, as well as unilateral and bilateral tinnitus.

2.2 TINNITUS

Tinnitus has been defined in several ways by different authors. Tinnitus is defined as the perception of sound in the absence of an acoustic stimulus. Jastreboff (1990) defines tinnitus as “perception of a sound which emanates exclusively from activity within the nervous system without any corresponding mechanical, vibratory activity within the cochlea”. Dauman and Tyler (1992) proposed that pathologic tinnitus is head noise lasting at least 5 minutes that occurs more than once per week. Jastreboff (1990) postulates that chronic tinnitus is the persistent sensation of hearing a sound that exists only inside the head. Chronic tinnitus is the result of abnormal neural activity within the auditory system and has been referred to as a “phantom auditory sensation” Jastreboff (1990).

As reported in the literature, continuous exposure to the same noise might result in dissimilar patterns of cochlear damage in different subjects (Davis et al., 1989) and that the diffuse loss of outer hair cells (OHC) up to 30% might not have a significant impact on hearing threshold (Bohne., 1982; Hamernik et al., 1989).
Typically, steep high-frequency hearing impairment is associated with a peeping tonal perception and flat or low frequency hearing impairment is accompanied by noise-like tinnitus (Pan et al., 2009). In contrast, objective tinnitus is considered real noise that can be heard by the patient and the examiner (Perry & Gantz, 2000; Lockwood, Salvi & Burkard, 2002). Nicolas-Puel et al., (2002), identified two main types of tinnitus. These are: (1) tinnitus of a stable intensity, usually described as a high-pitched "whistling". They indicate that this type of tinnitus is found mainly in patients suffering from acoustic trauma, presbycusis and other lesion-type deafness, and (2) tinnitus of a fluctuating nature, found in patients with active, variable deafness (e.g., Meniere's disease), which is usually described as a low-pitched "buzzing". Many people, especially in a quite environment or after an exposure to a loud noise or listening to loud music report of hearing sound in their ears or head. These sounds are referred to as tinnitus (McFadden, 1982). It is known that tinnitus can originate from within the auditory system or from para-auditory structures, which may be a pointer to underlying pathological conditions.

In the views of Hammeke et al., (1983), Penner (1989a) and Penner (1989b) tinnitus is a symptom of many pathologies and several different types of tinnitus might coexist even in the same patient. Tinnitus has been described as a phantom auditory perception, and the involvement of non-auditory structures are considered of key importance in clinically relevant tinnitus complaints (Jastreboff, 1990; Jastreboff & Hazell, 1993; Cacace, 2003). Luxon (1993) stated that for some patients’ tinnitus may be trivial whiles to others, it might be a debilitating condition. It is revealed that the quality of the sound perceived could vary enormously from simple sounds such as whistling or humming to complex sounds such as music. It is argued that tinnitus is a symptom of many diseases and not an entity onto itself (Yildirim et al., 2010). This supports the fact that tinnitus is not a disease as suggested by literature.
In an attempt to distinguish between clinically significant and temporary insignificant tinnitus, Davis (1995) suggested that tinnitus must last for not less than 5 minutes in order to establish clinical significance. It should also be emphasized that tinnitus is of different severity; some may not disturb or annoy at all while some may totally or severely affect the quality of life. Some can be continuously present while some may be intermittent. Tinnitus could also be unilateral or bilateral, manifesting itself in one or both ears within the head or outside the body (Hobson et al., 2012). While some people are able to ignore this sound and do not feel severely impaired, others suffer considerably from these symptoms and often may be related to depression, anxiety and insomnia (Crönlein et al., 2007; Langguth et al., 2011) causing severely impaired quality of life.

According to Davis & Rafaie (2000), tinnitus may be associated with normal hearing thresholds or any degree of hearing loss. They further indicated that tinnitus occurs at any age, with higher incidence in the age group between 50 and 70 years. Several systematic reports in the literature describe age as a well-defined risk factor for the development of tinnitus. Oiticica and Roseli (2014) observed a progressive increase in the occurrence of this symptom with increasing age, which was consistent with the findings of Shargorodsky et al., (2010) and Nondahl et al., (2002).

Dauman (1992), McCombe (2001) and Stephens (1991) proposed that there are several different classifications of tinnitus. Dauman (1992) reported that tinnitus that lasts for less than 5 minutes, occurring less than once a week is considered normal and is experienced by most people. On the other hand, tinnitus that lasts for last more than five minutes, occurring more than once a week and usually experienced by people with hearing loss is referred to pathologic tinnitus.
2.2.1 Characteristics of Tinnitus

Tinnitus can be described in many different ways, such as the presence of constant or pulsating, high- or low- frequency sounds, or sometimes as more complicated sounds. Andersson et al., (2005) contend that the sound level varies from barely noticeable to very disturbing sounds, and this perception varies among individuals and within an individual over time. They added that tinnitus is most commonly bilateral. A study conducted by Oiticica and Roseli (2014) to estimate tinnitus prevalence in the city of São Paulo revealed that approximately 32% of 430 respondents claimed to have a constant ringing, while 68% related an intermittent tinnitus. In gender terms, constant tinnitus was more prevalent among men than in women, and increased in prevalence about three times higher with advancing age (Oiticica & Roseli, 2014). According to Han, et al., (2009), tinnitus sound can range from a quiet background noise to a noise that is audible over environmental sounds. Goelen and Van de Heyning (2014) argued that tinnitus types differ with age. They further stated that younger patients are more likely to have a pure-tone tinnitus, and experience a noise-like tinnitus often with age. In addition, Goelen et al., (2014) found that tinnitus is associated with the degree of hearing loss. They added that tinnitus intensifies as hearing loss increases.

2.2.2 Classification of Tinnitus

Classification of tinnitus requires a thorough history and physical examination, supplemented by appropriate diagnostic tests. Tinnitus can be described as subjective or objective. Dobie (2004) defines objective tinnitus as tinnitus that is audible to the patient and another person as a sound emanating from the ear canal. In contrast, only the patient hears subjective tinnitus. Dobie (2004) added that subjective tinnitus is usually considered to be devoid of an acoustic aetiology and associated movements in the cochlear fluids. Both forms of tinnitus may or may not be idiopathic.
Some investigators have argued that tinnitus should be classified by origin, either as somatic or neurophysiologic.

Fowler (1948) categorized tinnitus into two: vibratory and non-vibratory. He described the vibratory tinnitus as mechanical, exogenous-factual, real sound of a physical source such as muscle activity, or vascular alteration within the body, whereas non-vibratory tinnitus was explained as non-factual sound: an illusion of sound caused by an irritation of the auditory neural elements. It could originate from anywhere from the tympanic promontory, along the pathways to the cortex inclusive (Fowler, 1948). People who suffer spontaneous, trauma or noise-induced tinnitus will experience spontaneous resolution, but many will have persistent tinnitus. In some people, tinnitus sensation will be accompanied by tinnitus suffering, with effects on thinking, feeling, and other daily life activities, including sleep (Tyler, 2006).

Tyler (1992) divided pathological tinnitus into acceptable or unacceptable tinnitus and temporary or permanent tinnitus. They explained that acceptable tinnitus does not bother the individual while the unacceptable tinnitus is disturbing to the patient. The acceptability of tinnitus by any patient is strongly determined by the physiological, mechanism and psychological factors (Tyler, 2000). Temporary tinnitus is short-term and attributed it to temporary dysfunction of the patients’ auditory system such as exposure to heavy noise at work or drug. Permanent tinnitus may be constant or intermittent. Tyler (2000) further classified tinnitus by their site of dysfunction or the aetiology as relating to Meniere’s disease, ototoxicity and presbycusis. In contrast, Stephens and Hetu (1991) classified tinnitus into acute, sub-acute and chronic; based on the effects on the patients’ ability and quality of life. According to Salvago et al., (2012), tinnitus can be classified into acute (≤ 3 months), subacute (3-12 months) and chronic (> 12 months) using a duration criteria.
2.2.3 Non-cochlear Models

Attias et al., (2002) stated that non-cochlear theory models involve auditory perception, emotional and reactive systems and a combination of peripheral and central dysfunction. Studies have suggested that tinnitus sound interpretation involved the limbic system and the autonomous nervous system (Jastreboff et al., 1996). It is argued that when tinnitus sound is interpreted in a negative way it makes the individual aware of something abnormal; this awareness allows the sound to be perceived as a distressing symptom. Several researchers have argued that the interpretation of the tinnitus sound could be associated with an adverse episode in the individual’s life (Jastreboff & Jastreboff, 2000; Henry & Wilson, 2001). Others (Eggermont & Roberts, 2004) suggest that tinnitus occurs from the adoption of a temporal pattern in the auditory nerve activity. Down regulation of intracortical inhibition induced by damage to the cochlea or to auditory projection pathways highlights neural processes that underlie the sensation of phantom sound (Eggermont & Roberts, 2004).

Several studies have demonstrated the importance of calcium for the cochlea and its hair cells (Zenner & Ernst, 1993). It is however established that amplified signaling to the brain could arise from increases for calcium in the hair cells. If this signaling occurs in a dysfunctional cochlea, it would lead to increased neurotransmitter release from inner hair cells, and increased activity in the auditory nerve fibers in the form of cascade signaling. Baguley (2002) established that the synchronization of activity in the small nerve fibers could cause the perception of the tinnitus sound.
2.2.3 Cochlear model

Studies conducted by Gold (1948) revealed that a normal cochlea could produce low-intensity tones without acoustic stimulation. Satar et al., (2003) suggested that tinnitus in individuals with normal hearing was often associated with a varying degree of cochlear dysfunction. Psychophysical studies by Thai-Van et al., (2002, 2003) indicate that steeply sloping hearing loss is highly associated with local improvements in frequency discriminate on thresholds, which has been interpreted as a correlate of cortical reorganization. Hair cells play a very important role in the auditory system and are responsible for the discrimination of sounds in the auditory system. Baguley (2002) contends that damages to specific parts of the hair cells can lead to activity reduction in the cortical area at corresponding frequencies. One consequence of this reorganization according to Dietrich et al., (2001) is that a disproportionate number of neurons become sensitive to frequencies in the upper and lower limits of the hearing loss. Cortical reorganization is believed to play a role in the development of tinnitus (Eggermont & Roberts, 2004). Thai-Van et al., (2002) also proposed that only subjects with a hearing loss slope >50dB/octave displayed a significant improvement in frequency discrimination.

Tinnitus is not a single, well-defined disease. It is believed that mechanism of the generation of tinnitus also conforms to the clinical observation that in most cases the tinnitus frequency is in the same frequency area like the hearing loss Adoga et al., (2013).

2.3 EPIDEMIOLOGICAL STUDIES AND PREVALENCE OF TINNITUS

Tinnitus represents a frequent disorder with prevalence rates ranging between 2.4% and 20.1% (Møller et al., 2010). This large range could be attributed to the highly variable definitions used in clinical trials as well as with the different duration and nature of this condition (Langguth et al.,
2007). The prevalence of tinnitus has been estimated based on data obtained from epidemiological studies conducted in different countries across the globe (Hinchcliffe, 1961; Brown et al., 1990; Davis, 1995). The prevalence increases to 33% in individuals aged over 60 years (Jastreboff et al., 1993). It is estimated that nearly 20% of patients with tinnitus find it difficult to bear it, which significantly affects their quality of life (Savastano et al., 2008).

Hinchcliffe (1961) conducted a study of epidemiology of hearing problem including tinnitus, with two random samples of adults between the ages of 18 and 74 years of age. The prevalence of tinnitus was determined in response to whether individuals experienced noise in their ears or heads. In performing different epidemiological studies, Hinchcliffe (1961), Leske (1981), Ringdahl (1989) used questionnaire and enquired whether clients experienced noises in their ears or head. Their findings showed variations in the prevalence of tinnitus and different age groups. In particular, patients aged 18 to 24 years showed a prevalence of 21% while 55 to 65 year olds registered had 39% prevalence. In a United Kingdom survey 22% of the participants said they had heard noises such as buzzing and ringing in their ears or head, while 2% of the total adult population had tinnitus at all the time (Office of Population Census and Surveys, 1983). In determining the prevalence of communicative disorders in the USA on a population of 6,672 persons aged 18 and 79 years, Leske, (1989) reported 32% (70million people of the population 18 years and above) of the adult populations had experienced tinnitus.

Khedr et al., (2010) in a study with 8,484 subjects, found that 439 patients aged over 6 years presented with tinnitus, giving an overall incidence of 5.17 tinnitus cases/100 people. They reported that the prevalence was related to age, with the highest rate (17.5%) among participants above 60 years old. They further added that nearly 88% of patients in this group had hearing loss
in comparison to 42–43% in patients below 39 years. In a descriptive cross-sectional survey in OsunState in Nigeria, Adegbenro et al., (2013) determined the prevalence of tinnitus among a population of 1000 participants. Tinnitus was reported in 61 (6.1%) of respondents and was most prevalent in persons aged 45 years and above, and among the Yoruba ethnic group (14.3%). This result suggests that tinnitus is age dependent. Male preponderance was found with a prevalence rate of 3.9%. The study also showed more prevalence among farmers 33.0% while the lowest prevalence was found among the civil servants and students.

Alexlsson and Rigdahl (1989) conducted a study with a random sample of 3600 people. This study used stratified samples for gender and age between 20 and 80 years of age in the city of Gothenburg. The study centered on the question ‘do you suffer from tinnitus?’ The result showed that 14.2% suffered from tinnitus often or always with 2.4% of the entire population suffering from continuous tinnitus all day. Alexlsson and Rigdahl (1989) however indicated there was no significant correlation between the occurrence of tinnitus and the degree of subjective hearing loss. Quaranta et al., (1996) carried out a study to determine the prevalence of tinnitus among the adult population in five Italian cities. The study, which was mainly based on questions and audiometric assessment to general population, showed a prevalence of 14.5%. The subjects presenting with normal hearing were 8% of the study population.

Tinnitus is a worldwide problem. Many people at a time or another may experience transient tinnitus, which lasts for seconds or minutes; while others experience tinnitus that can last for a lifetime. The prevalence of tinnitus among those over 65 years of age ranges from 12% to 15%. (Coles et al., 1984; McCombe et al., 2001). It is estimated that in Western Europe nearly one of eight persons experiences tinnitus (Seidman et al., 1996; Humes et al., 2006). According to Nicoas-
Puel et al., (2002), there are 5 million tinnitus patients in France alone. It is also estimated that between the 8-30% of people in industrialized countries experience tinnitus (Quaranta et al., 2004). Studies have shown that prevalence in candidates for cochlear implant, is even higher, ranging between 66 and 86% before implantation, with 27% of patients reporting significant impact on quality of life (Quaranta et al., 2004. Andleeb et al., (2014) argued that the prevalence of tinnitus is higher in patients with unilateral SNHL (52%) than in the general population (8-30%). It is estimated that 25.3% (50 million people) of American adults experience tinnitus with 7.9% experiencing it frequently (Shargorodsky, 2010). According to the literature, the prevalence of tinnitus in the general adult population was reported to be between 12% and 49%. However, below the age of 45 years, the prevalence was only 1%. It further indicated that, between 60 and 69 years of age, tinnitus was reported to be 12%, and 25 to 30% in individuals above 70 years of age (Shargorodsky et al., 2010). Chronic tinnitus is a highly prevalent and mostly incapacitating condition frequently associated with SNHL (Sand et al., 2010). Tucker et al., (2005) investigated the effect of gender and race on the perception of tinnitus in silence. They reported that 64% of the subjects perceived sounds after sitting for 20 minutes in a soundproof room.

The hearing threshold is considered the single most important factor affecting the prevalence of tinnitus because it is associated with hearing loss. Heller (2003) established that nearly 12.1% in 60-69 year olds and 4.7% in 20-29 year olds are tinnitus patients. This is assumed because the symptom is considered highly associated with hearing loss. It is established that tinnitus affects almost a third of the population over the age of 55 in developed countries, and is reported as having a severe impact on quality of life in about a third of that number (Awuah, 2012).
2.4 TINNITUS AND HEARING LOSS

Studies have shown that, tinnitus patients and animal models of tinnitus point towards a causal relation between hearing loss and tinnitus. According to Cole, Smith and Davis (1988) hearing impairment is the dominating predicting factor of the occurrence of prolong spontaneous tinnitus. Axelsson and Ringdahl, (1989), Nicolas-Puel et al., (2002) are of the view that majority of tinnitus patients also have a hearing loss. Similarly, Roberts et al., (2008) established that tinnitus patients have elevated hearing thresholds compared to age-matched controls. However, Baskill & Coles (1999) found that the auditory thresholds and perceived severity of tinnitus were poorly correlated. Ayache et al., (2003) and Sobrinho et al., (2004) found between 75 and 90% of patients with otosclerosis experienced tinnitus. The influence of hearing loss on the degree of suffering caused by tinnitus remains uncertain (Baskill and Coles, 1999).

It is reported in the literature that high frequency hearing impairment in the worse ear was the major predictor for tinnitus Davis (1995). Other factors that may lead to tinnitus development include reported running ear, history of childhood otitis media, chronic serious otitis media. Individuals who have experienced running in the ear or discharge are more susceptible to tinnitus than those who have not (Davis, 1995). National Hearing Study (1995) indicated that most patients who had suppurative otitis media and a history of running ears are most likely to have unilateral tinnitus. In contrast, Tyler (2000) is of the view that when both conditions are absent the percentages of unilateral and bilateral tinnitus were almost the same.

An investigation by National Hearing study (1995) showed a correlation between prevalence, severity of tinnitus and the degree of hearing difficulty. Those with slight hearing difficulty are more likely to experience slight tinnitus annoyance and no hearing at all (profound hearing loss)
with severe tinnitus. Nosrati-Zarenoe et al., (2007) believed that idiopathic (hearing loss without any known causes) SNHL showed direct indication of a causal relation between tinnitus and hearing loss, as nearly 80% of patients with idiopathic SNHL also developed tinnitus. Hallberg and Erlandsson (1993) found worse auditory thresholds in patients that reported more concentration difficulties and sleep disorders due to tinnitus, and also observed that bothersome tinnitus was less severe in patients with more severe hearing loss which was similar to the findings of Pinto et al., (2010).

Brown (1990) reported that the prevalence of tinnitus is strongly associated with degree hearing loss. He added that this association increases in the high frequencies threshold increases. Stouffer and Tyler (1990) supported the hypothesis that “whatever caused the hearing loss is the most probable cause of the tinnitus”. Again, they explained that the role of the central auditory system in perceiving and sometimes generating tinnitus could not be overlooked even if most of the times peripheral disorder was present (Coles, 1995). Davis (1995) reported a considerable response of effects between presence of small air-bone gap and tinnitus. He argued that the bigger the air-bone gaps, the higher the probability of reported tinnitus for a given degree of hearing loss. The prevalence of tinnitus in adult population is associated with the extent of the conductive pathology. Eggermont and Roberts (2004) and Roberts et al., (2010) concluded from animal models of tinnitus that damage to structures of the ear and auditory nerve may trigger plastic changes in the brain. This gives rise to aberrant patterns of neuronal activity. They added that as these altered patterns of spontaneous activity resemble sound-evoked activity, they could create the illusion of a sound without actual sound source. The actual tinnitus sensation is therefore generated in the brain, but the corresponding changes in the brain are triggered through an event at the level of the ear (Roberts et al., 2010).
Though tinnitus is seen to be highly associated with hearing loss there are some patients who do not have hearing impairment of any sort Davis (2012). Several studies have tried to explain the origin of tinnitus in these patients. According to Bernea et al., (1990), about 8% of tinnitus patients had within normal hearing (20 dB HL, 250 to 8 KHz). Stouffer and Tyler (1990) found 18% of study sample to have indicated air conduction levels at 1000 and 4000Hz ≤ 25dB. McKee and Stephens (1992) found neurotic personality stronger in tinnitus patients with normal hearing. Another study showed that 7.4 to 20% of tinnitus patients did not exhibit hearing loss at any frequency of conventional pure tone audiometry (Shim et al., 2009). Mitehell et al., (1995) found evidence in the distortion product otoacoustic emission (DPOAE) recording in a group of tinnitus patients with normal hearing. They added that this was suggestive of damage to or loss of outer hair cells and perhaps detachment of the tectorial membrane without inner hair cells or nerve damage. Duchamp et al., (1995) added there could be a possible dysfunction of medial olivo-cochlear efferent system. Jastreboff and Hazell (1993) showed no psychoacoustic differences of tinnitus (intensity, frequency and minimum suppression level) among patients with tinnitus who suffer and those that do not. However, Newman et al., (1994) and Holgers et al., (2005) indicated a small correlation between the intensity of tinnitus and its effect on patients.

2.4.1 Hearing Loss and Severity of Tinnitus

Tinnitus patients may present varying degrees of annoyance with this symptom, with variable impact on the quality of life. Using the THI score, Pinto et al., (2010) found no difference in annoyance due to tinnitus among males and females. Although Erlandsson and Holgers (2001) applied the Tinnitus Severity Questionnaire (TSQ) that assesses the severity of tinnitus, quality of life issues, and concentration difficulties, discomfort in silence, depressive reactions, both findings were agreeable. Dias and Cordeiro (2008) conclude that tinnitus is less prevalent and less severe
milder hearing losses, on the other hand, in higher losses, the chance of the patient developing tinnitus is also higher. Based on the results, they inferred that there is a trend towards having more severe tinnitus on left ears. In investigating the occurrence of tinnitus with the shape of the audiogram, Königa (2006) analyzed a sample where all patients had noise-induced hearing loss, among 30 patients without tinnitus, 24 patients with tone-like tinnitus, and 17 patients with noise-like tinnitus. The investigation revealed that all patients had moderate to severe high-frequency hearing loss, and just a few had moderate hearing loss at low frequencies. The study also found that tinnitus patients had less overall hearing loss than patients without tinnitus did.

Dobie and Sullivan (1998) estimated that the incidence of major depression during life was double in females (20%) compared to males (10%). As the severity of tinnitus is strongly correlated with the presence of depression, Davis (1983) assumed that bothersome tinnitus occurs more often in females. Hiller and Goebel (2006) found significant severity of tinnitus in older male patients with binaural tinnitus and hearing loss. Pinto et al., (2010) in their study to determine the impact of gender, age and hearing loss on severity of tinnitus found no correlation between the severity of tinnitus and the degree of hearing loss. Holgers et al., (2005) however, showed a moderate association between the severity of tinnitus and audiometric parameters, such as the triton mean.

Savastano (2008) evaluated the relation between the THI score and the presence or absence of hearing loss in patients with tinnitus. The study revealed that, in most cases, slight or mild groups in the THI was attributed to individuals with hearing loss; normal hearing patients with tinnitus were more frequent in the moderate and catastrophic groups, which was statistically significant compared to the hearing loss group. Savastano (2008) further established that more severe hearing loss did not correlate with the severity of bothersome tinnitus. This was confirmed by the findings...
of Pinto et al., (2010). According to McKinney, Hazell and Graham (1999) more severe hearing loss in patients with tinnitus was associated with more frequent depression and anxiety, which could affect the impact of tinnitus on their quality of life.

2.5 TYPES OF HEARING IMPAIRMENT ASSOCIATED WITH TINNITUS

Hearing impairment is a deviation or change for the worse in either auditory structure or auditory function, usually outside the range of normal (Gland, 2009). Hearing loss can be categorized by which part of the auditory system is damaged. There are three types of hearing loss: conductive, SNHL and MHL that may be associated with tinnitus.

2.5.1 Conductive Hearing Loss

Conductive hearing loss (CHL) occurs when there is obstruction to the flow of sound energy from the atmosphere through the outer ear canal to the eardrum and ossicles of the middle ear (Swanepoel & Laurent, 2010). Conductive hearing loss usually involves a reduction in sound level or the ability to hear faint sounds, which can often be corrected medically or surgically. It may result from fluid in the middle ear, 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 (Nyarko, 2013).

2.5.2 Sensorineural Hearing Loss

This is a broad term used to describe reduction of auditory threshold sensitivity. The pathology may be located in the cochlear and/or in the auditory nerve and central nervous system auditory structures (retrocochlear) (Swanepoel & Laurent 2010). Most of the time, SNHL cannot be
medically or surgically corrected. This is known to be the most common type of permanent hearing loss. It reduces the patients ‘ability to hear faint sounds. Even when speech is loud enough to hear, It may still not be clear or sound is muffled and may also be caused by any or combination of illnesses, drugs that are toxic to hearing, genetic or hereditary, aging, head trauma, malformation of the inner ear and exposure to loud noise (Nyarko, 2013). The leading cause of adult onset hearing loss was presbycusis (age-related hearing loss) followed by noise-induced hearing loss (Mathers et al., 2000). Amedofu et al., (2006) proposed that the major causes SNHL were noise, fever, presbycusis, sickness, mumps and Menieres disease.

2.5.3 Mixed Hearing Loss

A mixed hearing loss is combined presence of both CHL and SNHL in 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).

2.6 DEGREE OF HEARING LOSS

The degree of hearing loss is quantified for each ear as an indication of severity of hearing loss. The pure tone average (PTA) for air conduction thresholds at 500 Hz, 1000 Hz and 2000 Hz is generally used to classify the degree of hearing loss in each ear (Table 2.1).
<table>
<thead>
<tr>
<th>Pure tone average (in dB HL)</th>
<th>Degree of hearing loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>-5 to 25 dB HL</td>
<td>Normal</td>
</tr>
<tr>
<td>26-40 dB HL</td>
<td>Mild</td>
</tr>
<tr>
<td>41-55 dB HL</td>
<td>Moderate</td>
</tr>
<tr>
<td>56-70 dB HL</td>
<td>Moderate-Severe</td>
</tr>
<tr>
<td>71-90 dB HL</td>
<td>Severe</td>
</tr>
<tr>
<td>&gt;90 dB HL</td>
<td>Profound</td>
</tr>
</tbody>
</table>

ASHA (2011)

Dias and Cordeiro (2008) investigated the existence of a dose-response relationship between hearing loss and tinnitus by determining whether higher levels of hearing loss can be associated with increased tinnitus-related discomfort. Their study revealed that tinnitus prevalence and risk rates increased as pure tone audiometry results got worse. Their findings point to a statistical association between hearing loss and tinnitus, and concluded that the greater the hearing loss, the greater the discomfort introduced by tinnitus. However, Baskill & Coles (1999) suggested that the influence of hearing loss on the severity of tinnitus remains uncertain which was not in support of the findings of Dias & Cordeiro (2008).

2.7 SEVERITY OF TINNITUS AND DEMOGRAPHICS

2.7.1 Age and Severity of Tinnitus

Age-related changes affect the cochlea structure (Schulcnecht, 1964). Similarly, Gulya (1991) found out that the cochlea nucleus is also affected by age-related changes, which can also be a causative factor for tinnitus. A study by Coles (1984b) revealed a significant increase with age in
the prevalence of tinnitus. This was supported by Chung (1984) who reported increase in tinnitus incidence with age. Brown (1990) estimated prevalence for patients of different ages, and found lower rates (1.6%) for 18 to 44 years, 4.9% for 45-64 year olds, compared to higher rate of 8.9% in 65-75 years. He observed a correlation between tinnitus and age and concluded that both are related to hearing and health variables. On average, subjects reporting severe tinnitus were older than those with mild or absent tinnitus, while those with mild tinnitus were younger than those with absent tinnitus ($p = 0.02$). Increasing tinnitus severity was significantly associated with hearing loss. After multivariate adjustment in the model, the presence of hearing loss almost tripled the likelihood of severe tinnitus ($RR 2.9$, 95% CI 1.6 to 5.2). Persons with hearing loss were 1.4 times as likely to report mild tinnitus compared with those without hearing loss ($RR 1.4$, 95% CI 1.0 to 1.9). The risk of mild tinnitus was significantly associated with decreasing age ($RR 0.8$, 95% CI 0.6 to 0.9). Pinto et al., (2010) evaluated the relationship between gender, age and severity of tinnitus using the THI scores [slight: 32.3%, mild: 19.1%, moderate: 20.6%, severe: 13.2%, and catastrophic: 14.7%]. No significant correlation was found between gender ($p=0.30$), age ($p=0.77$) and hearing loss ($p>0.05$ for all averages analyzed) and tinnitus severity. A study by Savastano et al., (2008) evaluated the relation between the THI score and the presence or absence of hearing loss in patients with tinnitus. THI scores revealed that, in most cases, a slight or mild group in the THI was attributed to individuals with hearing loss. Normal hearing patients with tinnitus were more frequent in the moderate and catastrophic groups, which was statistically significant compared to the hearing loss group.

### 2.7.2 Gender and Severity of Tinnitus

From epidemiological viewpoint, it is imperative to consider influence of gender on different medical conditions as it aids in broadening understanding of the aetiology. It also helps to channel
research and public health services to achieve maximum effectiveness (Tyler, 2000). Factors related to internal anatomical and physiological differences in gender and external factors such as occupational noise exposure can affect the prevalence of tinnitus (Tyler, 2000). Several studies have attempted to estimate effect of gender on the severity of tinnitus but there have not been consistent results (Brown, 1990). Tinnitus patients may present varying degrees of annoyance with this symptom, with variable impact on the quality of life. Hiller and Goebel (2006) revealed a higher severity (intensity and annoyance) due to tinnitus in older male patients.

Dobie and Sullivan, (1998) estimated that the incidence of major depression during life was double in females (20%) compared to males (10%). Nagaraja and Arpita (1997) tried to determine any differences between males and females. They hypothesized that “lower the severity of tinnitus lesser are the factors that get disturbed”. In this case, the factors included annoyance, interference with sleep and botheration. The result showed no statistically significant differences between male and female subjects. The study on the 35 subjects revealed that as severity of tinnitus increases the sleep disturbance, annoyance and botheration turned to increase. Hence, a positive relationship was observed between the factors affected by tinnitus and its severity. A research carried out by Goldin et al., (2004) showed no significant gender effects ($p = 0.43$). The findings of Goldin et al., (2004) were consistent with Quaranta et al., (1996) who also concluded no significant association with either severe or mild tinnitus.

Zarenoe (2012) found that the overall scores for the THI were higher in female patients compared to males. Tinnitus loudness and mean hearing loss (pure-tone audiogram; 500 Hz–8000 kHz, measured on both sides) were significantly higher in male than in female patients. On the contrary, Savastano (2004) found no significant difference between males and females. This was in support
of a study by Hiller et al., (2007), which indicated that previous studies have shown no significant
differences between subjects with high degree of tinnitus and those with mild or moderate
annoyance in terms of age and gender. Lindgren et al., (2009) observed that severity of tinnitus
was closely related not only to age and gender, but also to impulse noise exposure and hearing
loss.

A study by Gurr et al., (1990) to investigate the effects of premenstrual period and pregnancy
revealed a significant increase in the prevalence of tinnitus in pregnant women compared with
their non-pregnant counterparts of the same age. In this study, increase in prevalence in pregnant
women was attributed to increase in perilymphatic fluid pressure in the cochlea because of
hormonal changes during pregnancy.

2.8 AETIOLOGY OF TINNITUS

Tinnitus is seen as a symptom with multiple aetiologies. The aetiology of tinnitus remains elusive
though there is increased knowledge of the anatomy and function of the cochlea and the brain.
Moller (2000) proposed that tinnitus may be generated in the ear but severe tinnitus is mostly
generated in the nervous system. Irrespective of where and how tinnitus is generated, it will be
perceived as a sound and thus often referred to the ear. Brummett (1980) and Shea (1981) however,
believed that most forms of disorders involving the auditory system might be associated with
tinnitus though there could be severe tinnitus with no evidence of any aural pathology. Melinek
(1976), Chung (1980) and Christiansson (1993) also proposed that many environmental factors
could cause tinnitus.
Many different studies have shown that many cases of tinnitus present an unclear aetiologic factor. Savastano (2008) reported that there was no link between tinnitus and any known aetiology or anatomical site in 26% of patients analyzed. In addition, Martines et al., (2010) established that 30.8%, of their study population suggested difficulty in aetiological identification was related to the presence of coexisting psychological disorders. Cecile et al., (2002) stated that tinnitus could not definitely be correlated with a known aetiology or anatomical site as evidence showed some tinnitus occurred without any known origin. Cecile et al., (2002) again reported that the great majority of patients (about 90%) presented with tinnitus associated with deafness of known aetiology: chronic noise exposure (23.6%), presbyacusis (18.7%), and Meniere’s disease (15.4%), or Meniere's-like syndrome (10.6%). The study further concluded that the remaining patients had deafness associated with ototoxicity (4%) or genetic hearing loss (3.25%). Multiple facts, such as age, exposure to noise and ototoxicity appear to play a leading role in the causes and persistence of tinnitus (Awuah, 2012).

The opinion of Kajsa-Mia et al., (2000) is that majority of patients with tinnitus experience lessening of their symptoms during an 18-month period after their first consultation. They found out that depression and physical immobility were strong predictors of tinnitus, which never diminished with time. Other studies indicated that tinnitus patients experience increased tolerance over time (Andersson et al., 2001; Snow et al., 2009) and suggested that the aetiology of tinnitus severity could be titled as depression, anxiety-related, somatic, and auditory tinnitus.

2.9 SEVERITY OF TINNITUS

Clinically, the term severity refers to the impact of a health condition on quality of life. According to Meikle (2003), degree of severity would reflect the ‘‘nature and extent of patients’ tinnitus-
related problems”. Newman et al., (1998) categorized tinnitus severity into four levels: none, mild, moderate, and severe. Akyildiz (2002) added that, the severity of tinnitus varied from mild and barely noticeable to severe, in which the patient’s life is seriously affected. The National Study of Hearing (1994-1995) indicates that, approximately 7.1% of patients visit a doctor, of whom 2.5% go to a hospital for treatment. The study suggests that the experienced severity of tinnitus varies among patients (Ooms et al., 2011). Erlandsson et al., (1992); Zoger et al., (2006) argue that psychological factors are important in explaining the differences in the perceived severity of tinnitus.

Tinnitus becomes a problem when it is perceived as a threat, appears continually intrusive, or when patients have difficulty coping with it as a stress factor (Hazell, 1998b). Proper methodology for measuring tinnitus severity has become a major concern to many, as there has not been any standardized one. There are some numbers of published outcome instruments that are used to obtain tinnitus severity ratings, and there is no consensus regarding their use across tinnitus treatment centers (Newman & Sandridge, 2004). The persistence of tinnitus could make serious disturbance and handicap at psychological and socio-professional levels; in fact, in 1-3% of the general population, the tinnitus compromises the quality of life, causing sleep disturbance, work impairment, and psychiatric distress (Andersson et al., 2000).

Ooms et al., (2011) conducted a study to investigate whether tinnitus severity is a problem related to depression using the THI with a sample size of 136. They found that, 14%, 27.2%, 29.4%, and 21.3% of the sample reported a light, mild, moderate and severe handicaps respectively, while 8.1% reported a catastrophic handicap. Although these percentages are comparable to results from other studies, the number of patients reporting a severe or catastrophic handicap is high. Khedr et
al., (2010) established that 39.4% of the 493-tinnitus patients reported of regular sleep disturbance while occasional sleep disturbance was reported in 41.9% of cases. This finding was similar to that reported by Tyler & Baker (1983). They concluded that the more people are bothered by their tinnitus, the more depressive symptoms they reported. Dobie (2004) added that in the most severe cases, tinnitus might be associated with severe depression and anxiety, even to the point of suicidal ideation. Tinnitus can be considered slight when it is only noticed by the patient in some situations; moderated, when the patient notices its existence but he does not feel uncomfortable; intense, when it is unpleasant and causes disorder, jeopardizing daily activities; and severe, when it becomes unbearable, it is unstoppably heard, following the individual all the time. Parnes (1997) reported that only 1% of the population suffers from symptoms that are clinically and emotionally distressing. Tyler et al., (2004), and Dobie (2004) observed that sleep deprivation is one of the primary consequences of tinnitus, in addition to effects on cognition, emotional status and hearing.

Jastreboff and Jastreboff reported tinnitus affected approximately 17% of the general population and created a significant problem in approximately 4–5% of them. Khedr et al., (2010) established in their epidemiological study of chronic tinnitus in Assiut, Egypt that the impact of tinnitus on everyday life varied from mild irritation to total disability. They added that regular sleep disturbance was reported by about 39.4% of cases and occasional disturbance by 41.9%. It was also noticed that life enjoyment was continuously reduced in 15% of patients while occupational performance was continuously affected in 13%. Using the THI scale, the study showed that 15.2% of the subjects complained of severe to catastrophic tinnitus, and the remainder had mild to moderate tinnitus. According to Erlandsson et al., (2000) researches investigating quality of life in patients with tinnitus have found the most significant predictors of quality of life to be directly associated with perceived psychological distress.
Tinnitus represents a marginal physical threat to life. However, it often causes significant and persistent distress (Erlandsson et al., 2000). Slater (1987) is of the view that tinnitus may result in difficulties in focusing attention and lead to frustration and anger. He noted that about 42 of 1,000 tinnitus patients took medications to help them sleep. From the sample of 1,630 Oregon patients, more than 70% reported that their tinnitus caused sleep disturbance (Meikle, 2004). Oiticica and Bittar (2015) concluded in their study to determine the prevalence of tinnitus in the city of São Paulo that the degree of discomfort measured by a Visual Analogue Scale showed moderate tinnitus was most prevalence. McKinney, Hazell and Graham (1999) found that more severe hearing loss in patients with tinnitus was associated with more frequent depression and anxiety, which could affect the impact of tinnitus on their quality of life.

2.10 LOCALIZATION OF TINNITUS

Classically, tinnitus is said to be more likely to occur in the left ear (Coles, 1984; Axelsson., 1995; Shulman., 1991). However, different studies have different outcomes regarding the difference between right and left sides, since some studies have found the right ear to be more affected, while others have shown no difference between right and left. Khedr et al., (2010) found out that more than half (54.7%) of cases had bilateral tinnitus; 23.9% had right tinnitus and 19.8% had left tinnitus with no significant difference between right and left.

Various studies have demonstrated that either the right or left side is more likely to exhibit tinnitus. According to Goyal and Gupta (2015), tinnitus is more noticeable either within the left ear or on the left side. They affirmed that 46% were located in the left ear, 40% right ear while non-lateralized in 14%, the left ear being the ear in which hearing loss on audiometry was more
obvious. However, this spatial localization was not statistically significant. According to Nuttalley et al., (2004) the tinnitus of patients presenting with asymmetrical hearing loss typically lateralizes to the ear with poorer thresholds; however, for patients with more symmetric hearing losses, tinnitus typically does not lateralize.

2.11 TREATMENT OF TINNITUS

The literature shows that most individuals who experience severe and debilitating tinnitus usually seek medical treatment from an otologist, neurologist or psychiatrist with the expectation that they will find a drug or surgical treatment that can completely cure tinnitus and restore silence in their ears or heads (Salvi et al., 2009). Patients are usually told by their physician to learn to live with it or try non-medicinal approaches such as sound therapy and counseling (Salvi et al, 2009) or the use of hearing aids. Sound therapy and counseling do not eradicate tinnitus, it is found to reduce the severity of tinnitus, often by reducing the emotional or psychological impact. Many patients would prefer a “magic pill” that eliminates their tinnitus in a matter of hours or days (Salvi et al, 2009). In Ghana, as the case may be in many other countries, no treatment is available for tinnitus. Persons who report to the various hospitals tinnitus condition are counseled in order to reduce the emotional effects associated with tinnitus.

2.12 TINNITUS-RELATED DISTRESS

Studies have shown that though some patients feel distressed by the fact that they have tinnitus, others manage to habituate to their tinnitus and are not overly bothered by it. This indicates that the presence of tinnitus does not automatically lead to distress (Dobie, 2004). An important factor for tinnitus distress is the emotional reaction to the perceived sound, for example, when the tinnitus
sound is experienced as threatening or potentially harmful the emotional reaction changes the perception of the sound itself and can make it appear more salient or louder.

Using the neurophysiological model, Jastreboff et al., (1996) indicated that, a negative reaction to the tinnitus may result in vicious cycle, and lead to the attribution of importance to the tinnitus signal thus reinforcing its perception. Andersson and McKenna (2006) stated that negative automatic thoughts about the tinnitus and safety behaviors can impede habituation and contribute to tinnitus distress.

2.13 RESEARCH GAP

From the ongoing, it can be observed that various studies have investigated prevalence of age-related tinnitus, gender related tinnitus, severity of hearing loss, which occurs concurrently with tinnitus as well as psychological effects of tinnitus on sufferers (Jastreboff et al., 1990; Savastano et al., 2008; Martines et al., 2010; Awuah, 2012; Adegbenro et al., 2013). However, in Ghana, there is inadequate evidence to support the prevalence of tinnitus, its severity and its effects on sufferers. It is based on this necessity that the current study seeks to investigate the audiological characteristics and severity of tinnitus among patients in Ghana.
CHAPTER THREE

METHODOLOGY

3.1 INTRODUCTION

A description of the method employed in this research study is presented in this Chapter. The details includes the research approach and research design, sample population, sampling techniques, inclusion and exclusion criteria, procedure for data collection, instrumentation and data analysis.

3.2 RESEARCH APPROACH

According to Aliaga and Gunderson (2000), quantitative research is explaining phenomena by collecting numerical data that are analyzed using mathematically based methods (statistics). The quantitative research approach was therefore adopted for this study because the generated data was converted into numerical variables for purposes of statistical analysis. In this study, patients with tinnitus answered questionnaires to ascertain the type and degree of tinnitus. Data collection and analysis occurred in specific steps within each stage. This design therefore facilitated in-depth analysis of the responses generated from the THI.

3.3 RESEARCH DESIGN

A cross-sectional design was adopted in selecting 264 participants for the study. This design allows and provides for one time collection of data (Olsen& Marie, 2004).
3.4 STUDY SITE

The study was carried out at the Hearing Assessment Centre (HAC) of KBTH. This site was chosen because it is a referral hospital where most patients report for hearing assessment. The availability of calibrated test equipment and standard sound treated test booth also made the site ideal for the purpose of this study.

3.5 STUDY POPULATION

The study population comprised all patients diagnosed with tinnitus by ENT doctors of KBTH and referred to the Hearing Assessment Center during the study period. The population of tinnitus patients were aged 18 years and above.

3.6 SAMPLE SIZE

A sample of 264-tinnitus patients reporting to the Hearing Assessment Centre was used in the study.

3.7 SAMPLING TECHNIQUE

Convenience sampling was used in selecting 264 participants for the study. Battalgia (2008) suggests that in convenience sampling, selection criterion relates to the ease of obtaining a sample. Ease of obtaining the sample relates to the cost of locating elements of the population, the geographic distribution of the sample, and obtaining the data from the selected subjects with ease. Vanderstoep and Johnson (2009) explained that convenience sampling involves choosing the participants from the nearest and readily available site. Participants were selected based on the inclusion criteria defined in the study and were all selected from the Centre
3.8 INCLUSION AND EXCLUSION CRITERIA

3.8.1 Inclusion Criteria

The following inclusion criteria were made:

- Patients diagnosed of tinnitus and aged 10 years and above
- Tinnitus patients reporting at the HAC during the study period

3.8.2 Exclusion Criteria

Participants who satisfied the following criteria were excluded:

- Tinnitus patients below 10 years
- Tinnitus patients with any physical condition which did not allow for auditory assessment

3.9 INSTRUMENTATION

3.9.1 Otoscope

The Welch-Allyn 25020 otoscope is a small, hand-held instrument with a light directed through a funnel-like tip (“speculum”) to illuminate the ear canal for examination. The specula are available as 2.5mm (for very small ear canals) or 4mm (for average adult ear canals). The otoscope is powered by a rechargeable battery in the handle, which can be detached and plugged into a standard wall outlet for recharging.

3.9.2 Audiometer

The AC33 inter-acoustics audiometer is a classic two channel clinical audiometer that is perfect for busy audiology clinics, private practice and in hearing aid dispensing offices. It provides pure tone and speech testing with full masking capability and a number of built-in tests with automatic scoring. The easy to read display and functional front panel layout make testing easy and comfortable. The AC33 inter-acoustics audiometer has two fully independent channels, making it
possible to perform a full range of clinical tests, including ABLB, Stenger (tone or speech), binaural speech tests, tone in noise and SIS. The main accessories of the AC33 inter-acoustics audiometer include TDH39 audiometric headset, B71 bone conductor Goose-neck, electrets microphone, APS2 Patient response, button power cable 110 or 220 V (Fig. 3.1).

Fig. 3.1: Block diagram showing pure-tone audiometry
The technical specifications, frequency and intensity ranges are described in Tables 3.1 and 3.2 respectively.

Table 3.1: Technical specifications of the pure tone audiometer

<table>
<thead>
<tr>
<th>Design parameter</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tone audiometer</td>
<td>IEC 60645-1/ANSI S3.6Type 2</td>
</tr>
<tr>
<td>Speech audiometer</td>
<td>IEC 60645-2/ANSI S3.6Type A or A-E</td>
</tr>
<tr>
<td>Safe</td>
<td>IEC 60601-1, class 1,Type B</td>
</tr>
<tr>
<td>EMC</td>
<td>IEC 60601-1-2</td>
</tr>
<tr>
<td>Power</td>
<td>AC 50-60 Hz. 100-120 V, 200-240 V.</td>
</tr>
<tr>
<td>Power consumption</td>
<td>Max. 140 VA.</td>
</tr>
<tr>
<td>Construction</td>
<td>Painted metal cabinet</td>
</tr>
<tr>
<td>Dimensions</td>
<td>(LxWxH): 48x40x15 cm /19x16x6 inches</td>
</tr>
<tr>
<td>Weight</td>
<td>99 kg / 20lbs.</td>
</tr>
</tbody>
</table>

Table 3.2: Maximum frequencies and intensity range of the AC33 audiometer

<table>
<thead>
<tr>
<th>Frequencies</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>750</th>
<th>1KHz</th>
<th>2KHz</th>
<th>3KHz</th>
<th>4KHz</th>
<th>6KHz</th>
<th>8KHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air conduction</td>
<td>90</td>
<td>110</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>100</td>
</tr>
<tr>
<td>Bone conduction</td>
<td>45</td>
<td>60</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>60/80</td>
<td>60/80</td>
<td>50</td>
<td>50</td>
<td>-</td>
</tr>
<tr>
<td>Narrow Band</td>
<td>70</td>
<td>90</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>80</td>
</tr>
</tbody>
</table>

3.9.3 Tympanometer

A tympanometer is an advanced computer based instrument consisting of a processor and a probe for assessing the condition of the eardrum and middle ear (Figure 3.1).
Fig 3.1 Block diagram showing the immittance instrument

The technical specifications of the immittance instrument (middle ear analyzer) is shown in Table 3.3

Table 3.3: Technical specifications of GSI TympStar Version 2 tympanometer

<table>
<thead>
<tr>
<th>Technical Variable</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test standardization</td>
<td>ANSI S3.6</td>
</tr>
<tr>
<td>Probe tone frequencies</td>
<td>226, 678 &amp; 1000 Hz</td>
</tr>
<tr>
<td>Acoustic reflex tones</td>
<td>Pure-tones, broad band &amp; narrow band noise</td>
</tr>
</tbody>
</table>

The probe consists of three small tubes: the first sends air pressure into the ear canal, the second sends a low-level tone and presents the louder tones to elicit the acoustic reflex, and the third contains a microphone to measure the sound reflected back from the eardrum. The probe tip is
fitted with rubber cuffs of various sizes, which are used to seal off the entrance to the ear canal for testing. The processor interprets the amount of sound reflected back from the eardrum and converts it to a measure of the stiffness of the eardrum. The GSI TympStar version 2 meets the ANSI S3.6 standards and specifications for aural admittance instruments.

3.9.4 Questionnaire

Standardized tinnitus questionnaires are used to obtain a global index score of a patient’s perceived tinnitus severity. It is important to acquire a baseline index score using a validated outcome instrument prior to conducting any testing. The THI suggested by Newman et al., (1996) is a standardized tinnitus questionnaire because it is widely used, easy to administer, and well documented in the literature. It is a brief, easily self-administered and psychometrically robust measure with internal consistency reliability (Cronbach’s $\alpha = 0.93$) and test–retest stability ($R=0.92$) that evaluates the impact of tinnitus on daily living (Newman et al., 1998). The THI is a test used by otolaryngologists, audiologists and other clinicians to determine the degree of distress suffered by tinnitus patients (Zemen et al., 2011) and consists of 25 questions. Studies by Newman et al., (1996), McCombe et al., (2001), Dias et al., (2006) and Soundidears, (2006) suggest that the outcomes and assessments can be divided into 3 scales, 5 degrees of severity and 3 response options as shown in Table 3.4.
Table 3.4: Scale, degrees of severity, and response options

<table>
<thead>
<tr>
<th>Scale</th>
<th>Descriptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional (F)</td>
<td>Measures the disorder caused by tinnitus in mental, social, occupational and physical functions.</td>
</tr>
<tr>
<td>Emotional (E)</td>
<td>Measures the emotional responses such as anxiety, anger and depression.</td>
</tr>
<tr>
<td>Catastrophic (C)</td>
<td>Quantifies the desperation and inability to live with or get rid of the symptom, with regard to the attack.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Degree of severity</th>
<th>Indicators</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 1</td>
<td>Negligible/slight tinnitus (0 to 16)</td>
<td>Perceived in quiet environments</td>
</tr>
<tr>
<td>Grade 2</td>
<td>Mild tinnitus (18 to 36);</td>
<td>Easily masked by background noise and easily forgotten when subject is busy</td>
</tr>
<tr>
<td>Grade 3</td>
<td>Moderate tinnitus (38 to 56);</td>
<td>Tinnitus is heard in the presence of background noise and everyday tasks can still be performed in spite of it;</td>
</tr>
<tr>
<td>Grade 4</td>
<td>Severe tinnitus (58 to 76);</td>
<td>Tinnitus is almost always present, the subject’s sleep is disturbed and his or her daily life may be compromised:</td>
</tr>
<tr>
<td>Grade 5</td>
<td>Catastrophic tinnitus (78 to 100).</td>
<td>Tinnitus is heard all the time, the subject’s sleep is altered, and some daily tasks may become difficult to perform</td>
</tr>
</tbody>
</table>

Response options

- Yes = 4 points
- Sometimes = 2
- No = 0 points

3.10 PROCEDURE FOR DATA COLLECTION

Demographic information was gathered from the patients’ case history forms. All 264 subjects complained of tinnitus. During case history taking the subjects answered question such as “Is your tinnitus continuous or fluctuating”? How long have you been experiencing it? In which ear do you perceive the sound? Thorough audiometric examination (otoscopy, air and bone conduction pure-tone audiometry, tympanometry) was carried out on patients. Air and bone conduction tests were conducted from 250Hz to 8 kHz and from 500 Hz to 4 kHz respectively.

3.10.1 Pre Testing of Questionnaire and Administration of the THI Questionnaire

In order to ensure accuracy in the data collected, the questionnaires were pre-tested using 10 participants. It was deduced from the pilot test that an average of 11 minutes was required to complete the questionnaire. Since all 10 participants were able to complete the questionnaire without difficulties, there was no need to modify the questionnaire. Out of 283 administered questionnaires, 264 respondents (93.3%) completed them and had their ears tested in a sound treated booth at the KBTH Hearing Assessment Centre.

3.10.2 Otosocopic Examination

Otosocopic examination was conducted to assess the status of the outer ear of each participant. Participants with conditions such as wax impaction, otitis media, otitis externa and other conditions that did not allow for pure-tone testing were excluded from the study.

3.10.3 Pure Tone Audiometry

Pure-tone threshold audiometry is defined as the measurement of an individual's hearing sensitivity for calibrated pure tones (ASHA 2005). Pure tone audiometry was carried out using calibrated
interacoustic AC33 audiometer in a sound treated booth that satisfied ANSI 1999 standards. Air and bone conduction audiometry were done with an audiometer and transducers that were up to the required specifications of ANSI S3.6-2004 (American National Standards Institute, 2004b) and were of suitable quality to the test technique employed.

Biological calibrations, functional inspection and performance checks were done daily before the beginning of hearing assessment to ensure the equipment were functioning properly (ASHA 2005). Air and bone conduction were done for each ear across all conventional frequencies with the same audiometer and by the same examiner. Pure tone audiometry was performed at test frequencies (250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, 6000 Hz, and 8000 kHz). Degree of hearing loss was classified as mild (26 to 40dBHL), moderate (41 to 55 dB HL) moderately severer (56 to dB HL), severe (71 to 90dBHL) and profound (≥ 90 dB HL).

Audiometric results were grouped into four main categories: normal hearing (thresholds < 25 dB at each of the frequencies tested), conductive hearing loss (CHL), SNHL and MHL. Type of hearing loss was defined taking into consideration comparison between thresholds and the airway and osseous pathway of each ear and classified into CHL, SNHL and MHL in accordance with Silman and Silverman (1970).

3.10.4.1 Pure Tone Audiometry (Air Conduction)

Air-conduction audiometry is done to determine the level of a patient’s hearing threshold at various frequencies. Air-conduction test results can identify the degree of loss but not the type of loss (Martin et al., 2012). In this study, the ascending technique, which is the recommended standard procedure for manual pure-tone threshold audiometry was used. Pure-tone stimuli were presented
between 1 to 2 seconds, with varied intervals between tone presentations. If a patient failed to respond to a signal, the level was increased in 5-dB steps until the first response occurred. After the response, the intensity was decreased 10 dB, and another ascending series began. Hearing threshold was defined as the lowest decibel hearing level at which responses occurred in at least one-half of a series of ascending trials. Two responses out of three presentations were needed to determine the threshold of hearing at a single level as specified by the American National Standards Institute (2004a). The initial test frequency was 1000 Hz. Following the initial test frequency, the examinations were conducted at the other frequencies, followed by a retest of 1000 Hz before testing 500, and 250 Hz. The other ear was tested in the same way (American National Standards Institute, 2004b cited in ASHA 2005).

3.10.4.2 Pure Tone Audiometry (Bone Conduction)

Bone conduction involves placing the bone vibrator on the mastoid process to test the cochlear directly by bypassing the middle ear. Together with the air-conduction, bone conduction is useful in determining types of hearing loss. Ascending method was used (up 5 and down 10) for bone conduction across test frequencies from 500 Hz to 4000 Hz (BSA, 2011).

Bone conduction testing was not done at 250 Hz because it was reported that vibrotactile threshold occurred at 25 dB, which was not a hearing threshold (Boothroyd et al., 1970). Furthermore, bone vibrator radio ear B71 has poor distortion performance at low frequencies (Lightfoot, 2000) and participants hearing threshold may relate to second or third harmonic instead of fundamental (BSA, 2011). In view of the above reasons, testing was done at frequencies higher than 250 Hz. In addition, no testing was done at 6000 Hz and above due to transducer limitations (Lightfoot et al., 1993). Standard bone-conduction vibrator was placed on the mastoid with the proper force applied
(Dirks, 1964; American National Standards Institute, 2004b). The test ear was not covered during standard bone conduction measurements. The contralateral ear was covered when masking was being used.

3.10.5 MASKING AIR AND BONE CONDUCTION

Since it is possible for sounds introduced into the test ear via headphones to be carried by bone conduction across the skull and stimulate the cochlea of the non-test ear, masking was used to establish the true threshold of delectability for both air and bone conductions (British Society of Audiology, 2011). Whenever the transcranial attenuation was 40dBHL or more, masking was introduced in order to isolate the test ear and obtain true thresholds. This was accomplished by presenting masking noise into the non-test ear at the correct intensity to hinder it from detecting the test signals, and at the same time measure the actual threshold of the test ear with the test signals. This was done where the difference between the left and right unmasked air conduction thresholds exceeded 40 Db when supra, circum-aural earphones were used, or 70 dB when insert earphones masking was done.

Masking was repeated done at any frequency where the unmasked bone conduction threshold was more than the air-conduction threshold of either ear by 10 dB. The worse ear (by air conduction) was defined as the test ear and the better ear as the non-test ear for masking. Narrow band noise was used for the masking. Subjects were instructed to listen to the narrow band noise in the non-test ear and indicate when it was heard.

Subjects were also instructed to ignore any noise heard and only respond by raising up a hand when they heard tones (BSA, 2011). As noted by Katz (2009), the initial masking level comprised
air conduction threshold of non-test ear (NTE), occlusion effect and safety factor, making 15 dB HL initial masking level.

3.10.6 Threshold Determination for Masked Air and Bone Conduction

Initial masking level of 10 or 15 dB was introduced into the NTE depending on the threshold. Pure tone level was then re-established and noise levels increased in 5 dB steps for three consecutive times to achieve plateau. Continuous response to tones for three consecutive times in the presence of masking noise suggested threshold of the test ear. Tones were increased in 5 dB steps until response was obtained if there was none in the presence of masking noise (Katz, et al., 2009). The same procedure was repeated for the other ear.

3.10.7 Impedance Audiometry

Impedance audiometry is used to determine the status of eardrum and middle ear cavity. This test also helps in the assessment of acoustic reflex pathway that includes cranial nerves 7, 8 and brain stem. Impedance audiometry does not test the hearing sensitivity of the patient; instead, it is a good predictor of conductive hearing loss (Dempster and Mackenzie, 1991). Impedance audiometry includes tympanometry and acoustic reflex test. Tympanometry is widely used in screening for the detection of otitis media and measuring the movement of the eardrum via the application of air pressure to examine the status of the middle ear. Tympanometry is known to have high sensitivity and specificity in the detection of otitis media. The finding of Watters et al., (1997) in the detection of Type B tympanogram, which is consistent with otitis media, has shown a sensitivity of 91% and a specificity of 79% to 90%.
Tympanometry was performed using the GSI TympStar version 2 Middle-Ear Analyzer. A stimulus tone of 226 Hz protocol was used. Normal ear canal volume, middle ear compliance or admittance peak value and a middle ear pressure ranged from 0.4 – 1.5 cm$^3$, 0.2 – 1.6 cm$^3$ and -100 to +100 daPa respectively (BSA, 2013).

3.11 DATA ANALYSIS

Data obtained from the study was analyzed using descriptive (mean and mode) and inferential statistics (chi-square) using SPSS Version 20.0 software. Chi-square test was used to determine the association between severity of tinnitus and audiometric variables.

3.12 ETHICS

Ethical approval was sought from the Ethics and Protocol Review Committee of the School of Biomedical and Allied Health Sciences. Permission to carry out the research activity was obtained from the management of the Hearing Assessment Center, KBTH. The consent of all participants who agreed to participation was sought. In accordance with ethical considerations, all information obtained from participants was treated as confidential and anonymous.
CHAPTER FOUR

RESULTS

4.1 INTRODUCTION

The results of the study are presented in this Chapter. They include demographics, pure-tone air conduction test and tinnitus severity, mean air and bone conduction thresholds at test frequencies, distribution for tympanograms, degree and type configuration of hearing loss. The descriptive and inferential statistics, which indicate any significant associations between type and configuration of hearing loss and demographics (age, gender), are also presented.

4.2 DEMOGRAPHICS

The age and gender demographics are shown in Table 4.1. More males ($n=152, 57.6\%$) than females ($n=112, 42.2\%$) participated in the study. The ages of the respondents ranged from 10 – 89 years with a mean age of 49.51 ± 10.60 years. The mode of the age distribution was 40 – 49 years ($n=48, 18.2\%$), while the 10-19 years group was least ($n=4, 1.5\%$) represented.

As seen in Table 4.2, the results of the classification of tinnitus among the patients indicated that most ($n=144, 54.5\%$) of the tinnitus presented by the respondents were intermittent in nature while 45.5% ($n=120$) presented with constant tinnitus. Tinnitus was more lateralized to the right ear ($n=52, 19.7\%$) than the left ear ($n=40, 15.1\%$) while 65.2% ($n=172$) presented with tinnitus in both ears.
Table 4.1: Demographic characteristics of respondents

<table>
<thead>
<tr>
<th>Variable</th>
<th>Frequency</th>
<th>Percent (%)</th>
<th>Mean ± s.d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>152</td>
<td>57.6</td>
<td>N/A</td>
</tr>
<tr>
<td>Female</td>
<td>112</td>
<td>42.4</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>264</td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-19</td>
<td>4</td>
<td>1.5</td>
<td>49.51 ± 10.60</td>
</tr>
<tr>
<td>20-29</td>
<td>28</td>
<td>10.6</td>
<td></td>
</tr>
<tr>
<td>30-39</td>
<td>44</td>
<td>16.7</td>
<td></td>
</tr>
<tr>
<td>40-49</td>
<td>48</td>
<td>18.2</td>
<td></td>
</tr>
<tr>
<td>50-59</td>
<td>44</td>
<td>16.7</td>
<td></td>
</tr>
<tr>
<td>60-69</td>
<td>44</td>
<td>16.7</td>
<td></td>
</tr>
<tr>
<td>70-79</td>
<td>44</td>
<td>16.7</td>
<td></td>
</tr>
<tr>
<td>80-89</td>
<td>8</td>
<td>3.0</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.2: Characteristics and lateralization of tinnitus

<table>
<thead>
<tr>
<th>Classification of tinnitus</th>
<th>Frequency</th>
<th>Percent, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermittent</td>
<td>144</td>
<td>54.5</td>
</tr>
<tr>
<td>Constant</td>
<td>120</td>
<td>45.5</td>
</tr>
<tr>
<td>Total</td>
<td>264</td>
<td>100</td>
</tr>
<tr>
<td>Lateralization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right ears</td>
<td>52</td>
<td>19.7</td>
</tr>
<tr>
<td>Left ears</td>
<td>40</td>
<td>15.1</td>
</tr>
<tr>
<td>Both ears</td>
<td>172</td>
<td>65.2</td>
</tr>
<tr>
<td>Total</td>
<td>264</td>
<td>100.0</td>
</tr>
</tbody>
</table>
4.3 AIR AND BONE CONDUCTION THRESHOLDS

Pure tone air and bone conduction thresholds were determined across the range of test frequencies for right and left ears. The results showed that the highest mean air and bone conduction thresholds [air: right ear= 59.02±33.33 dB, left ear= 58.71±35.90 dB], bone: right ear= 34.70±23.20 dB, left ear=35.91±22.82 dB] were registered at 8 kHz and 4 kHz respectively (Table 4.3).

Table 4.3: Mean air and bone conduction thresholds (dB) at test frequencies

<table>
<thead>
<tr>
<th>Test frequency (Hz)</th>
<th>Air-Conduction (Mean ± s.d) (dB)</th>
<th>Bone-Conduction (Mean ± s.d) (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Right Ear</td>
<td>Left Ear</td>
</tr>
<tr>
<td>250</td>
<td>31.97 ± 21.84</td>
<td>36.44 ± 27.28</td>
</tr>
<tr>
<td>500</td>
<td>33.79 ± 21.54</td>
<td>38.11 ± 28.59</td>
</tr>
<tr>
<td>1k</td>
<td>36.82 ± 24.61</td>
<td>39.55 ± 29.09</td>
</tr>
<tr>
<td>2K</td>
<td>38.03 ± 26.86</td>
<td>39.92 ± 30.45</td>
</tr>
<tr>
<td>3K</td>
<td>42.58 ± 29.26</td>
<td>43.03 ± 29.97</td>
</tr>
<tr>
<td>4K</td>
<td>41.06 ± 29.68</td>
<td>46.09 ± 31.43</td>
</tr>
<tr>
<td>6K</td>
<td>52.80 ± 30.14</td>
<td>53.26 ± 32.04</td>
</tr>
<tr>
<td>8K</td>
<td>59.02 ± 33.33</td>
<td>58.71 ± 35.90</td>
</tr>
</tbody>
</table>

The mean lowest thresholds for the same test were registered at 250 Hz (right ear= 31.97±21.84 dB, left ear=36.44±27.28 dB) and 500 Hz (right ear=27.12±18.57 dB, left ear=29.55±20.53 dB) respectively.
From Table 4.4, the degree of hearing loss ranged from Mild to Profound. The most prevalent category of hearing loss was the mild-moderately severe (right ears) and mild-moderate (left ears) hearing loss.

**Table 4.4: Degree of hearing loss**

<table>
<thead>
<tr>
<th>Type of hearing loss</th>
<th>Type of ear (n= 264)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Right (%)</td>
</tr>
<tr>
<td>Normal</td>
<td>19.4</td>
</tr>
<tr>
<td>Mild</td>
<td>16.1</td>
</tr>
<tr>
<td>Moderate</td>
<td>4.6</td>
</tr>
<tr>
<td>Severe</td>
<td>2.3</td>
</tr>
<tr>
<td>Profound</td>
<td>3.5</td>
</tr>
<tr>
<td>Mild-moderate</td>
<td>15.2</td>
</tr>
<tr>
<td>Mild-Moderately-severe</td>
<td>16.4</td>
</tr>
<tr>
<td>Mild-severe</td>
<td>8.9</td>
</tr>
<tr>
<td>Mild-profound</td>
<td>13.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

In addition, respondents with normal hearing, conductive, sensorineural and mixed hearing loss were represented by 16.7% (right ears) and 13.6% (left ears), 1.5% (right and left ears), 71.2% (right ears) and 80.3% (left ears), 10.6% (right ears) and 4.5% (left ears) respectively (Table 4.5). The respective frequency ranges of 250-500 Hz, 1-3 kHz and 4-8 kHz defined low, mid and high frequencies. Most (right ear: 64.8%, left ear: 76.3%) of the hearing loss occurred across the spectrum of the audiogram at low, mid, and high frequencies.
Table 4.5: Distribution of hearing status

<table>
<thead>
<tr>
<th>Hearing status</th>
<th>Type of ear (n=264)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Right (%)</td>
</tr>
<tr>
<td>Normal hearing</td>
<td>16.7</td>
</tr>
<tr>
<td>Conductive hearing loss</td>
<td>1.5</td>
</tr>
<tr>
<td>Sensorineural hearing loss</td>
<td>71.2</td>
</tr>
<tr>
<td>Mixed hearing loss</td>
<td>10.6</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>

High frequency hearing loss constituted 24.1% and 18.2% for right and left ears respectively while mid to high frequency hearing loss also constituted 11.1% and 5.5% for right and left ears respectively (Table 4.6).

Table 4.6: Configuration of hearing loss

<table>
<thead>
<tr>
<th>Configuration of hearing loss</th>
<th>Type of ear (n=264)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Right (%)</td>
</tr>
<tr>
<td>High frequency hearing loss</td>
<td>24.1</td>
</tr>
<tr>
<td>Mid-high frequency hearing loss</td>
<td>11.1</td>
</tr>
<tr>
<td>Low-mid-high frequency hearing loss</td>
<td>64.8</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 4.7 depicts the outcome of the tympanometry tests. Type A was the most prevalent tympanogram (right ear: 87.9%, left ear: 95.5%) while types B and A D registered prevalence of 1.5% for both ears. Type C presented with 9.1% and 1.5% for right and left ears respectively. The THI administered to the 264-tinnitus patients revealed that most patients presented with moderate (40.9%) and severe (33.3%) degrees of tinnitus.
Table 4.7: Outcome of tympanometry (tympanograms)

<table>
<thead>
<tr>
<th>Tympanograms</th>
<th>Type of ear (n=264)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Right (%)</td>
<td>Left (%)</td>
</tr>
<tr>
<td>Type A</td>
<td></td>
<td>87.9</td>
<td>95.5</td>
</tr>
<tr>
<td>Type B</td>
<td></td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Type C</td>
<td></td>
<td>9.1</td>
<td>1.5</td>
</tr>
<tr>
<td>Type AD</td>
<td></td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100</td>
<td>10</td>
</tr>
</tbody>
</table>

Catastrophic severity was least with 6.1% as indicated in Table 4.8.

Table 4.8: Tinnitus Handicap Inventory

<table>
<thead>
<tr>
<th>THI</th>
<th>Percent</th>
<th>Mean ± s.d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>19.7%</td>
<td>-</td>
</tr>
<tr>
<td>Moderate</td>
<td>40.9%</td>
<td>-</td>
</tr>
<tr>
<td>Severe</td>
<td>33.3%</td>
<td>-</td>
</tr>
<tr>
<td>Catastrophic</td>
<td>6.1%</td>
<td>-</td>
</tr>
<tr>
<td>Emotional-score</td>
<td>-</td>
<td>15.22 ± 7.47</td>
</tr>
<tr>
<td>Functional-score</td>
<td>-</td>
<td>22.13 ± 9.10</td>
</tr>
<tr>
<td>Catastrophic score</td>
<td>-</td>
<td>13.48 ± 4.48</td>
</tr>
</tbody>
</table>

The mean emotional, functional and catastrophic scores from the THI ranged from 13.48±4.48 to 22.13±9.10 (Table 4.8).
4.4 TEST OF ASSOCIATIONS

Inferential statistics using chi-square analysis and p-value calculations was used to determine significant associations between the type and configuration of hearing condition among the tinnitus patients (Tables 4.9 – 4.17).

Table 4.9: Association between type and configuration of hearing loss in tinnitus patients

<table>
<thead>
<tr>
<th>Type of hearing loss</th>
<th>Configuration of hearing condition</th>
<th>$\chi^2$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal</td>
<td>High</td>
<td>Mid-High</td>
</tr>
<tr>
<td>Right Ear</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>44</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>CHL</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SNHL</td>
<td>4</td>
<td>48</td>
<td>24</td>
</tr>
<tr>
<td>Mixed</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td>52</td>
<td>24</td>
</tr>
<tr>
<td>Left Ear</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>36</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Conductive</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sensorineural</td>
<td>8</td>
<td>40</td>
<td>12</td>
</tr>
<tr>
<td>Mixed</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>44</td>
<td>40</td>
<td>12</td>
</tr>
</tbody>
</table>

$\alpha=0.01$

From Table 4.9, there was a significant association between type and nature of hearing loss among tinnitus patients in KBTH for right $[\chi^2 (9, n= 304) = 62.36 \ p < 0.01]$ and left $[\chi^2 (9, n= 304) =$
53.74, \( p < 0.01 \) ears. Tables 4.10 and 4.11 showed no significant association between tinnitus severity and gender \( [\chi^2 (3, n=264) = 1.57; p > 0.05] \), and age \( [\chi^2 (21, n=264) = 25.09; p > 0.05] \).

**Table 4.10: Association between gender and tinnitus severity**

<table>
<thead>
<tr>
<th>Gender</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
<th>Catastrophic</th>
<th>Total</th>
<th>( \chi^2 (df=3) )</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>24</td>
<td>60</td>
<td>56</td>
<td>12</td>
<td>152</td>
<td>1.57</td>
<td>0.67</td>
</tr>
<tr>
<td>Female</td>
<td>28</td>
<td>48</td>
<td>32</td>
<td>4</td>
<td>112</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>108</td>
<td>88</td>
<td>16</td>
<td>264</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\( \alpha = 0.05 \)

**Table 4.11: Association between age and tinnitus severity**

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
<th>Catastrophic</th>
<th>Total</th>
<th>( \chi^2 (df=21) )</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-19</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>25.09</td>
<td>0.24</td>
</tr>
<tr>
<td>20-29</td>
<td>16</td>
<td>8</td>
<td>4</td>
<td>0</td>
<td>28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30-39</td>
<td>12</td>
<td>4</td>
<td>24</td>
<td>4</td>
<td>44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40-49</td>
<td>8</td>
<td>12</td>
<td>24</td>
<td>4</td>
<td>48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50-59</td>
<td>0</td>
<td>36</td>
<td>4</td>
<td>4</td>
<td>44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60-69</td>
<td>8</td>
<td>20</td>
<td>16</td>
<td>0</td>
<td>44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>70-79</td>
<td>8</td>
<td>20</td>
<td>12</td>
<td>4</td>
<td>44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80-89</td>
<td>0</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>108</td>
<td>88</td>
<td>16</td>
<td>264</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\( \alpha = 0.05 \)
Similarly, associations between severity of tinnitus and localization, outcome of tympanometry degree of hearing loss, type of hearing loss, and configuration of hearing loss were investigated.

From Table 4.12, there was no significant association between tinnitus severity, and localization \[\chi^2(6, n=264) = 6.58; p>0.05\], and characteristics \[\chi^2(3, n=264) = 4.32; p>0.05\]. The association between tinnitus severity and the outcome of tympanometry (tympanograms) were insiginificantly associated (right ears: \[\chi^2(9, n=264) = 9.22; p>0.05\], left ears \[\chi^2(9, n=264) = 10.38; p>0.05\]) as seen in Table 4.13.

**Table 4.12: Association between tinnitus localization, characteristics and tinnitus severity**

<table>
<thead>
<tr>
<th>Tinnitus localization</th>
<th>Tinnitus severity</th>
<th>(\chi^2) (df=6)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Ear</td>
<td>Mild</td>
<td>8</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Severe</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Catastrophic</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>Left Ear</td>
<td></td>
<td>16</td>
<td>40</td>
</tr>
<tr>
<td>Both Ears</td>
<td></td>
<td>28</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>52</td>
<td>108</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>(\chi^2) (df=3)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermittent</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>Constant</td>
<td>12</td>
<td>48</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>108</td>
</tr>
</tbody>
</table>

\(\alpha=0.05\)
Table 4.13: Association between tympanograms and tinnitus severity for right and left ears

<table>
<thead>
<tr>
<th>Tympanograms</th>
<th>Tinnitus severity</th>
<th>Total</th>
<th>$\chi^2$ (df=9)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mild</td>
<td>Moderate</td>
<td>Severe</td>
<td>Catastrophic</td>
</tr>
<tr>
<td>Right Ear</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type A</td>
<td>48</td>
<td>100</td>
<td>72</td>
<td>12</td>
</tr>
<tr>
<td>Type B</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Type C</td>
<td>0</td>
<td>8</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>Type AD</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>108</td>
<td>88</td>
<td>16</td>
</tr>
<tr>
<td>Left Ear</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type A</td>
<td>44</td>
<td>108</td>
<td>84</td>
<td>16</td>
</tr>
<tr>
<td>Type B</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Type C</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Type AD</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>108</td>
<td>88</td>
<td>16</td>
</tr>
</tbody>
</table>

$\alpha=0.05$

There was also no significant association between degree of hearing loss and tinnitus severity for right [$\chi^2$ (36, $n=264$) = 34.82; $p>0.05$] and left [$\chi^2$ (36, $n=264$) = 44.89; $p>0.05$]) ears (Table 4.14)
Table 4.14: Association between degree of hearing loss and tinnitus severity right ear

<table>
<thead>
<tr>
<th>Degree of hearing loss</th>
<th>Tinnitus severity</th>
<th>$\chi^2$</th>
<th>$p$-value</th>
<th>Total</th>
<th>$(df=36)$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mild</td>
<td>Moderate</td>
<td>Severe</td>
<td>Catastrophic</td>
<td></td>
</tr>
<tr>
<td>Right Ear</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>20</td>
<td>18</td>
<td>16</td>
<td>6</td>
<td>60</td>
</tr>
<tr>
<td>Mild</td>
<td>12</td>
<td>15</td>
<td>8</td>
<td>0</td>
<td>35</td>
</tr>
<tr>
<td>Moderate</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>severe</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>Profound</td>
<td>0</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Mild-Moderate</td>
<td>0</td>
<td>16</td>
<td>19</td>
<td>6</td>
<td>41</td>
</tr>
<tr>
<td>Mild-Moderately Severe</td>
<td>8</td>
<td>21</td>
<td>15</td>
<td>0</td>
<td>44</td>
</tr>
<tr>
<td>Mild-Severe</td>
<td>0</td>
<td>12</td>
<td>7</td>
<td>0</td>
<td>19</td>
</tr>
<tr>
<td>Mild-Profound</td>
<td>10</td>
<td>10</td>
<td>13</td>
<td>4</td>
<td>37</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>108</td>
<td>88</td>
<td>16</td>
<td>264</td>
</tr>
</tbody>
</table>

$\alpha=0.05$
Table 4.15: Association between degree of hearing loss and tinnitus severity left ear

<table>
<thead>
<tr>
<th>Degree of hearing loss</th>
<th>Tinnitus severity</th>
<th>$\chi^2$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mild</td>
<td>Moderate</td>
<td>Severe</td>
</tr>
<tr>
<td>Left ear</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>12</td>
<td>26</td>
<td>14</td>
</tr>
<tr>
<td>Mild</td>
<td>4</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>Moderate</td>
<td>8</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Severe</td>
<td>0</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Profound</td>
<td>8</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Mild- Moderate</td>
<td>4</td>
<td>16</td>
<td>23</td>
</tr>
<tr>
<td>Mild-Moderately Severe</td>
<td>4</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>Mild-Severe</td>
<td>12</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>Mild-Profound</td>
<td>0</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>108</td>
<td>88</td>
</tr>
</tbody>
</table>
There was no significant association between type of hearing loss and tinnitus severity for right ears \( \chi^2 (9, n= 264) = 13.60; p > 0.05 \) and left \( \chi^2 (9, n= 264) = 13.29; p > 0.05 \) (Table 4.16).

**Table 4.16: Association between type of hearing loss and tinnitus severity for both ears**

<table>
<thead>
<tr>
<th>Type of hearing loss</th>
<th>Tinnitus severity</th>
<th>( \chi^2 (df= 9) )</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mild</td>
<td>Moderate</td>
<td>Severe</td>
</tr>
<tr>
<td>Right Ear</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>20</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>Conductive</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sensorineural</td>
<td>28</td>
<td>84</td>
<td>64</td>
</tr>
<tr>
<td>Mixed</td>
<td>0</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>108</td>
<td>88</td>
</tr>
<tr>
<td>Left Ear</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Conductive</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sensorineural</td>
<td>28</td>
<td>96</td>
<td>72</td>
</tr>
<tr>
<td>Mixed</td>
<td>8</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>108</td>
<td>88</td>
</tr>
</tbody>
</table>

\( \alpha=0.05 \)
Table 4.17 depicted no significant association between configuration of hearing loss and tinnitus severity for right [$\chi^2 (9, n= 264) = 13.47; p> 0.05$] and left [$\chi^2 (36, n= 264) = 8.75; p> 0.05$]) ears.

**Table 4.17: Association between configuration of hearing loss and tinnitus severity for both ears**

<table>
<thead>
<tr>
<th>Configuration of hearing loss</th>
<th>Tinnitus severity</th>
<th>$\chi^2$ (df=9)</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mild</td>
<td>Moderate</td>
<td>Severe</td>
</tr>
<tr>
<td>Right Ear</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>20</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>High Frequency</td>
<td>12</td>
<td>32</td>
<td>8</td>
</tr>
<tr>
<td>Mid-High Frequency</td>
<td>0</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>Low-Mid-High Frequency</td>
<td>20</td>
<td>44</td>
<td>64</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>108</td>
<td>88</td>
</tr>
<tr>
<td>Left Ear</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>12</td>
<td>20</td>
<td>12</td>
</tr>
<tr>
<td>High Frequency</td>
<td>12</td>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td>Mid-High-Frequency</td>
<td>0</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>Low-Mid-High Frequency</td>
<td>28</td>
<td>64</td>
<td>64</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>108</td>
<td>88</td>
</tr>
</tbody>
</table>

$\alpha=0.05$ H/L=Hearing Loss
CHAPTER FIVE

DISCUSSIONS

5.1 INTRODUCTION

In this Chapter, the results obtained from the study are discussed with respect to demography and auditory characteristics. The results are compared with the literature to ascertain the veracity and accuracy of the results.

5.2 AGE, GENDER AND SEVERITY OF TINNITUS

The mean age of the tinnitus patients was 49.51 ± 10.60 years. Majority (18.2%) of the respondents were aged 40 – 49 years while the 10-19 years group were least (1.5%) represented. The results are indicative of a variation in the prevalence of tinnitus among the two age categories. This observation is validated by Hinchcliffe (1961) who established variations in the prevalence of tinnitus among different age groups. Many studies have reported age as a predictor for tinnitus. Specifically, Oiticica and Roseli (2014) stated that constant tinnitus increases about 3 times in prevalence with increasing age, while Jastreboff et al. (1993) purported that the prevalence of tinnitus increased to 33% in individuals aged over 60 years. In this study, the prevalence of tinnitus was lower (21.0%) in the younger (18 to 24 years) age group compared to the 39.0% in the older (55 to 65 years) age group. These findings are firmly supported by Jastreboff et al. (1993), and Oitica and Roseli (2014).

A non-significant association between age and tinnitus severity was determined in this study. The earlier works of Coles (1984) and Chung (1984) which reported non-significant association between age and tinnitus severity are supportive of this findings. On the contrary, the findings of
Brown (1990) showed a significant relationship between age and severity of tinnitus. The results from the study revealed that more males (57.6%) than females (42.2%) presented with tinnitus. Tyler (2000) indicated that anatomical and physiological differences in gender and external factors such as occupational noise exposure could affect the prevalence of tinnitus. The results of this study are consistent with the findings of Oiticica and Roseli (2014) who concluded that constant tinnitus was more prevalent among men than in women. Conversely, Goldin et al. (2004) reported that gender has no significant effect on the prevalence of tinnitus.

No significant association between gender and tinnitus severity was established. According to Brown (1990), several attempts to estimate the effect of gender on severity of tinnitus have been reported: the results have however, been inconsistent. In particular, Hiller & Goebel (2006) showed that tinnitus was more severe in males, while Zarenoe (2012) suggested the severity was higher in females. The outcome of the current study agrees with the findings of Nagaraja and Arpita (1997) and Savastano (2004) who reported non-significant associations between gender and tinnitus severity. Similarly, Quaranta et al., (1996) concluded that gender has no significant association with tinnitus severity.

5.3 **TINNITUS CHARACTERISTICS**

Most (54.5%) of the respondents presented with tinnitus intermittent in characteristics while 45.5% presented with constant tinnitus. In the same vein, Oiticica and Roseli (2014) revealed that approximately 32% and 68% of respondents reported constant and intermittent ringing respectively.
5.4 TINNITUS SEVERITY

The THI administered to the 264-tinnitus patients revealed “severe” (33.3%) and ‘moderate’ (40.9%) as the most prevalent of the four levels of tinnitus severity. ‘Catastrophic’ severity was the least represented (6.1%). None of the participants presented with slight tinnitus severity. The outcome of this study do not agree with the work of Pinto et al. (2010) work which established ‘slight’ as the most prevalent (32.3%) tinnitus severity in a study to evaluate the relationship between gender, age and severity of tinnitus using the THI. However, the 19.7% prevalence of mild tinnitus severity estimated in this work is comparable with 19.1% prevalence of mild severity reported by Pinto et al., (2010).

5.5 TINNITUS LOCALIZATION

In the current study, tinnitus was more localized in the right ear (19.7%) than the left ear (15.2%) while 65.2% presented with tinnitus in both ears. According to Coles (1984), Axelsson (1995), and Shulman (1991), tinnitus is more likely to be localized in the left ear. However, the literature supports different outcomes. This means that localization could be more affected in the right ear and less in the left ear, or the converse could occur. Some studies have shown no significant difference between right and left ears. Khedr et al. (2010) found that 54.7% of cases were bilateral tinnitus, which is comparable to 65.2% of bilateral tinnitus reported in this study. There was no significant difference between localization of tinnitus in the right and left ears.

5.6 AUDITORY CHARACTERISTICS OF TINNITUS PATIENTS IN KBTH

5.6.1 Tympanograms and type of hearing loss

Type A tympanogram was the most prevalent (right ear: 87.9%, left ear: 95.5%) while Types B, A_D registered prevalence of 1.5% for right and left ears respectively. Type C presented with 9.1%
and 1.5 % for right and left ears respectively. The distribution of tympanograms is indicative that most (right ears: 71.2%, left ears: 80.3%) of the hearing loss was sensorineural, while normal hearing was next most prevalent hearing condition (right ears: 16.7 %, left ears: 13.6%). Conductive and MHL were the least represented hearing conditions. Nosrati-Zarenoe et al., (2007) suggested that idiopathic SNHL shows direct indication of a causal relationship between tinnitus and hearing loss, as nearly 80% of patients with idiopathic SNHL developed tinnitus. However, Davis (1995) asserted that other factors that may lead to tinnitus development include reported running ear, history of childhood otitis media and chronic serous otitis media. Bernea et al., (1990) reported 8% of tinnitus patients with normal hearing (20 dB HL, 250 Hz to 8 kHz). Stouffer and Tyler, (1990) found 18% tinnitus patients indicated air conduction levels at 1000 and 4000Hz ≤25dB.

The fact that tinnitus was more prevalent among individuals with SNHL in this current study may be suggestive of damage to or loss of cochlear outer hair cells. There was a non-significant association between type of hearing loss, outcome of tympanometry (tympanograms) and tinnitus severity. Similarly, Nagaraja et al., (1997) also concluded in a study to determine tinnitus profile that the severity of tinnitus was independent of type of hearing loss.

5.6.2 Configuration and type of hearing loss
This study found that most of the hearing loss occurred across the spectrum of the audiogram (at low, mid and high frequencies). High frequency hearing loss constituted 24.1% and 18.2 % for right and left ears respectively while mid to high frequency hearing loss was least represented (right ears: 11.1%, left ears: 5.5). The chi-square test established a significant association between configuration and type of hearing loss. This means that most of the hearing conditions were SNHL
occurring across the spectrum of the audiogram. This is in contrast to the literature where high frequency hearing impairment in the worse ear was reported as the major predictor of tinnitus (Davis, 2012).

5.6.3 Degree of hearing loss

Again, degree of hearing loss ranged from mild to profound. The most prevalent category of hearing loss was the mild-moderately severe (right ears) and mild-moderate (left ears) hearing loss. Brown (1990) reported that the prevalence of tinnitus is strongly associated with the degree of hearing loss: the association increases in the high frequencies. More so, the present study revealed a non-significant association between degree of hearing loss and tinnitus severity.
CHAPTER SIX
CONCLUSION, RECOMMENDATIONS AND LIMITATIONS

6.1 INTRODUCTION

A summary of the research findings, limitations, conclusions and appropriate recommendations drawn from the study are presented in this Chapter.

6.2 CONCLUSION

The results from audiometric and tinnitus severity assessments are useful for the development of appropriate health policies in KBTH-Ghana. The study aimed at assessing the auditory status, tinnitus severity. The existence of any significant associations between audiometric test outcome and tinnitus severity among tinnitus patients in KBTH was also determined. In particular, the objectives for realizing the aim of the research study involved:

- determination of severity levels of tinnitus among tinnitus patients in Ghana
- description of the demographic and audiometric characteristics associated with tinnitus
- investigation of the existence of any significant associations between configuration and type of hearing loss
- determination of the associations between gender, age, outcome of tympanometry, type and degree of hearing loss, configuration, tinnitus localization and severity of tinnitus

The results from the study revealed that tinnitus was more prevalent in males (57.6%) and females (42.2%) were diagnosed with tinnitus at the time of data collection. However, there was no significant association between gender and tinnitus severity. Majority (18.2%) of the respondents were aged 40 – 49 years while the 10-19 years group were least (1.5%) represented, while a non-
significant association between age and tinnitus severity was established. Furthermore, most (54.5%) of the respondents presented with tinnitus were of intermittent in characteristic, while 45.5% presented with constant tinnitus. The THI administered to the 264 tinnitus patients revealed ‘moderate’ (40.9%) as the most prevalent tinnitus severity, while ‘‘Mild’ registered 19.7% while ‘Catastrophic’ severity was the least represented (6.1%). None of the participants presented with slight tinnitus severity. In the current study, tinnitus was more localized in right ear (19.7%) than the left ear (15.2%) while 65.2% presented with tinnitus in both ears. Type A tympanogram (right ear: 87.9%, left ear: 95.5%) was most prevalent tympanogram while types B, A_D and C registered prevalence of 1.5% for right and left ears, with 9.1% and 1.5 % for right and left ears respectively.

The most prevalent category of hearing loss was the mild-moderately severe (right ears) and mild-moderate (left ears) hearing loss. Normal hearing was the second most prevalent (right ears: 16.7 %, left ears: 13.6%) hearing condition. Conductive and MHL were the least represented hearing conditions. In the current study, there was a non-significant association between type of hearing loss, outcome of tympanometry (tympanograms) and tinnitus severity. In the same vein, High frequency hearing loss constituted 24.1 and 18.2 % for right and left ears respectively while mid to high frequency hearing loss was least represented (right ears: 11.1%, left ears: 5.5). The chi-square test of revealed a significant association between configuration and type of hearing loss. Again, degree of hearing loss ranged from mild to profound. The present study revealed a non-significant association between degree of hearing loss and tinnitus severity.
6.3 RECOMMENDATIONS

Based on the outcome of the study, the following recommendations were made:

- Further studies on audiometric assessments of tinnitus patients in Ghana should include a control group to allow for more exploratory analysis.

- Electrophysiological measurements such as the otoacoustic emissions (OAE) and auditory brainstem response (ABR) tests should be included in further studies on audiometric assessments of tinnitus patients in Ghana to provide extensive information on cochlear outer hair cells of respondents.

6.4 LIMITATIONS OF THE STUDY

- The lack of a control group in the study design did not allow for more exploratory analysis to be with the data collected.

- Time constraints did not allow for the inclusion of other electrophysiological measurements such as the otoacoustic emissions (OAE) and auditory brainstem response (ABR) tests.
REFERENCES


APPENDIX 1

HEARING ASSESSMENT CENTRE

KORLE BU TEACHING HOSPITAL
P.O. BOX 77
KORLE BU, ACCRA
Tel: 233-21- 038233-6
Fax: 233-21- 038233-6
Email: koreelu@ghua.com
Web Site: www.koreelu.com

17th November, 2014

The Head
Dept. of Audiology, Speech and Language Therapy
School of Biomedical and Allied Health Sciences
College of Health Sciences
University of Ghana

Dear Sir,

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

Permission has been granted Mr. Bismark Adu-Twum to carry out a research project on “Auditory and Severity of Tinnitus Assessments Among Tinnitus Patients in Korle Bu Teaching Hospital”.

He is expected to work closely with Audiologists at the Centre to ensure that protocols are observed and equipment well handled.

Yours Sincerely,

[Signature]

ENT CLINIC
KORLE BU TEACHING HOSPITAL

JEMIMA A. FYYN (MRS.) FWACN
MSc. AUDIOLOGICAL SCIENCE

Cc: Head, ENT UNIT
APPENDIX II

UNIVERSITY OF GHANA
SCHOOL OF BIOMEDICAL AND ALLIED HEALTH SCIENCES
DEPARTMENT OF AUDIOLOGY, SPEECH AND LANGUAGE THERAPY

November 3, 2014

The Head
Hearing Assessment Centre
ENT Department
Korle Bu Teaching Hospital

Dear Sir/Madam,

PERMISSION TO CARRY MSc AUDIOLOGY RESEARCH PROJECT AT THE HEARING ASSESSMENT CENTRE, KBTH

The Department of Audiology, Speech & Language Therapy (DAS&LT) of the University of Ghana School of Biomedical and Allied Health Sciences (SBAHS) presents its compliments to you and has the pleasure requesting your kind consideration of the above subject.

Mr. Bismark Adu-Twum is a 2nd year MSc Audiology student of the Department of Audiology, Speech and Language Therapy of SBAHS, University of Ghana. He is conducting a research project in “Auditory and Severity of Tinnitus Assessments Among Tinnitus Patients in Korle-Bu Teaching Hospital” under the supervision of Prof. G.K. Amedofu and Dr. N. Boafo. His research study has been reviewed and passed by the Department’s Ethics and Protocols Review Group of the School as meeting all ethical requirements.

The Department would be most grateful if you could kindly grant him permission to carry out this important research project for the common good of the University and your Centre. Thank you.

Yours faithfully,

Dr. S. ANIM-SAMPONG

For: (Head of Department)

cc: Dean (SBAHS)
    Prof. G.K. Amedofu          Dr. N. Boafo
APPENDIX III

UNIVERSITY OF GHANA
SCHOOL OF BIOMEDICAL AND ALLIED HEALTH SCIENCES
DEPARTMENT OF AUDIOLOGY, SPEECH AND LANGUAGE THERAPY

October 7, 2014

Mr. Bismark K. Adu-Twum
Dept. of Audiology, Speech and Language Therapy
SBAHS,
Korle Bu

Dear Mr. Bismark K. Adu-Twum

ETHICS CLEARANCE

Following a technical and professional review of your research proposal by the Department Ethics and Protocol Review Committee and by your supervisors, I am pleased to inform you of the Committee’s approval your research proposal entitled:

“Auditory and Severity of Tinnitus Assessments among Tinnitus Patients in Korle Bu teaching Hospital”.

This is an initial approval. You are therefore required to obtain a final approval from the School’s Ethics and Protocol Review Committee per the Schools regulations.

You are required to work closely and in collaboration with your supervisors. Please report all serious adverse events related to this research to the supervisors and this Committee in writing.

Thank you.

Yours sincerely,

[Signature]

DR. S. ANIM-SAMPONG

For: Chairman DASL&T Ethics and Protocol Review Committee

DEPARTMENT OF AUDIOLOGY
SPEECH & LANGUAGE THERAPY
SCHOOL OF BIOMEDICAL AND ALLIED HEALTH SCIENCES
# APPENDIX IV

## Tinnitus Handicap Inventory (THI)

**Name:**

**Date:**

The purpose of these questions is to identify problems your tinnitus may be causing you. To fill out the questionnaire, mark a value next to each question.

<table>
<thead>
<tr>
<th>F1</th>
<th>Because of your Tinnitus is it difficult for you to concentrate?</th>
<th>4</th>
<th>0</th>
<th>2</th>
<th>POINTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>F2</td>
<td>Does the loudness of your Tinnitus make it difficult for you to hear people?</td>
<td>Yes</td>
<td>No</td>
<td>Sometimes</td>
<td></td>
</tr>
<tr>
<td>E3</td>
<td>Does your Tinnitus make you angry?</td>
<td>Yes</td>
<td>No</td>
<td>Sometimes</td>
<td></td>
</tr>
<tr>
<td>F4</td>
<td>Does your Tinnitus make you confused?</td>
<td>Yes</td>
<td>No</td>
<td>Sometimes</td>
<td></td>
</tr>
<tr>
<td>C5</td>
<td>Because of your Tinnitus are you desperate?</td>
<td>Yes</td>
<td>No</td>
<td>Sometimes</td>
<td></td>
</tr>
<tr>
<td>E5</td>
<td>Do you complain a great deal about your Tinnitus?</td>
<td>Yes</td>
<td>No</td>
<td>Sometimes</td>
<td></td>
</tr>
<tr>
<td>F7</td>
<td>Because of your Tinnitus do you have trouble falling to sleep at night?</td>
<td>Yes</td>
<td>No</td>
<td>Sometimes</td>
<td></td>
</tr>
<tr>
<td>C8</td>
<td>Do you feel as though you cannot escape your Tinnitus?</td>
<td>Yes</td>
<td>No</td>
<td>Sometimes</td>
<td></td>
</tr>
<tr>
<td>F9</td>
<td>Does your Tinnitus interfere with your ability to enjoy social activities (such as going out to dinner, to the cinema)?</td>
<td>Yes</td>
<td>No</td>
<td>Sometimes</td>
<td></td>
</tr>
<tr>
<td>E10</td>
<td>Because of your Tinnitus do you feel frustrated?</td>
<td>Yes</td>
<td>No</td>
<td>Sometimes</td>
<td></td>
</tr>
<tr>
<td>C11</td>
<td>Because of your Tinnitus do you feel that you have a terrible disease?</td>
<td>Yes</td>
<td>No</td>
<td>Sometimes</td>
<td></td>
</tr>
<tr>
<td>F12</td>
<td>Does your Tinnitus make it difficult to enjoy life?</td>
<td>Yes</td>
<td>No</td>
<td>Sometimes</td>
<td></td>
</tr>
<tr>
<td>F13</td>
<td>Does your Tinnitus interfere with your job or household responsibilities?</td>
<td>Yes</td>
<td>No</td>
<td>Sometimes</td>
<td></td>
</tr>
<tr>
<td>F14</td>
<td>Because of your Tinnitus do you find that you are often irritable?</td>
<td>Yes</td>
<td>No</td>
<td>Sometimes</td>
<td></td>
</tr>
<tr>
<td>F15</td>
<td>Because of your Tinnitus is it difficult for you to read?</td>
<td>Yes</td>
<td>No</td>
<td>Sometimes</td>
<td></td>
</tr>
<tr>
<td>E16</td>
<td>Does your Tinnitus make you upset?</td>
<td>Yes</td>
<td>No</td>
<td>Sometimes</td>
<td></td>
</tr>
<tr>
<td>E17</td>
<td>Do you feel that your Tinnitus has placed stress on your relationships with members of your family and friends?</td>
<td>Yes</td>
<td>No</td>
<td>Sometimes</td>
<td></td>
</tr>
<tr>
<td>F18</td>
<td>Do you find it difficult to focus your attention away from your Tinnitus and on to other things?</td>
<td>Yes</td>
<td>No</td>
<td>Sometimes</td>
<td></td>
</tr>
<tr>
<td>C19</td>
<td>Do you feel that you have no control over your Tinnitus?</td>
<td>Yes</td>
<td>No</td>
<td>Sometimes</td>
<td></td>
</tr>
<tr>
<td>F20</td>
<td>Because of your Tinnitus do you often feel tired?</td>
<td>Yes</td>
<td>No</td>
<td>Sometimes</td>
<td></td>
</tr>
<tr>
<td>E21</td>
<td>Because of your Tinnitus do you feel depressed?</td>
<td>Yes</td>
<td>No</td>
<td>Sometimes</td>
<td></td>
</tr>
<tr>
<td>E22</td>
<td>Does your Tinnitus make you feel anxious?</td>
<td>Yes</td>
<td>No</td>
<td>Sometimes</td>
<td></td>
</tr>
<tr>
<td>C23</td>
<td>Do you feel you can no longer cope with your Tinnitus?</td>
<td>Yes</td>
<td>No</td>
<td>Sometimes</td>
<td></td>
</tr>
<tr>
<td>F24</td>
<td>Does your Tinnitus get worse when you are under stress?</td>
<td>Yes</td>
<td>No</td>
<td>Sometimes</td>
<td></td>
</tr>
<tr>
<td>E25</td>
<td>Does your Tinnitus make you feel insecure?</td>
<td>Yes</td>
<td>No</td>
<td>Sometimes</td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL YOUR POINTS (ADD THE NUMBERS IN THE LAST COLUMN)**

**Scoring Your Test**

Compare your total with the Grade levels shown here:

- **Grade 1 - Slight (0-16)**: Only heard in a quiet environment
- **Grade 2 - Mild (17-36)**: Easily masked by environmental sounds and easily forgotten with activities.
- **Grade 3 - Moderate (37-56)**: Noted in presence of background noise, although daily activities can still be performed.
- **Grade 4 - Severe (57-76)**: Almost always heard, leads to disturbed sleep patterns and can interfere with daily activities.
- **Grade 5 - Catastrophic (77-100)**: Always heard, disturbed sleep patterns, difficulty with any activities.


**Tinnitus Handicap Inventory (THI)**

*Hearing Healthcare Professional Scoring Page*

1. To score the patient's questionnaire, count the number of “Yes” and “Sometimes” answers and then calculate the total points.

   - # of “Yes” \times 4 = POINTS
   - # of “Sometimes” \times 2 = POINTS

   TOTAL POINTS = THI score

2. To assess the severity of a perceived tinnitus handicap, rate the THI score according to this scale:

   - 0–16 Slight or no handicap (Grade 1)
     - Only heard in a quiet environment.
   - 18–36 Mild handicap (Grade 2)
     - Easily masked by environmental sounds and easily forgotten with activities.
   - 38–56 Moderate handicap (Grade 3)
     - Noticed in presence of background noise, although daily activities can still be performed.
   - 58–76 Severe handicap (Grade 4)
     - Almost always heard, leads to disturbed sleep patterns and can interfere with daily activities.
   - 78–100 Catastrophic handicap (Grade 5)
     - Always heard, disturbs sleep patterns and causes difficulty with any activities.
APPENDIX V

PARTICIPANT INFORMATION FORM

Title of research: auditory and severity of tinnitus assessments among patients in Korle-Bu Teaching Hospital.

Principal Investigator: Bismark Kwabena Adu-Twum

Department of Audiology, Speech and Language Therapy

Professional MSc Audiology

Mob: 0507905654; email: bismarkadutwum@gmail.com

General Information about Research

Under the supervision Prof. Geoffrey Kwabla Amedofu and Dr. Neal Boafo of the University of Ghana School of Biomedical and Allied Health Sciences, I Bismark Kwabena Adu-Twum, a graduate student of the Department of Audiology, Speech and Language Therapy, am conducting research on auditory and tinnitus severity assessment of tinnitus patients in Korle – Bu Teaching Hospital. The purpose of the study is to assess the auditory status, tinnitus severity and the existence of any significant associations between audiometric test outcome and tinnitus severity among tinnitus patients in Korle-Bu Teaching Hospital (KBTH).

Possible Risks and Discomforts

There are no risks for participation in this study since the testing equipment and procedure does give any side effects.
Voluntary Participation and Right to Leave the Research
Participation in this study is voluntary. You have the right to withdraw at any time or refuse to participate entirely without any jeopardy to you whatsoever.

Contacts for Additional Information
For any information, clarification or questions about the study, please contact the principal investigator, Bismark Kwabena Adu-Twum on 0507905654.

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.

Possible Benefits
Participating in the study provides you with the opportunity of knowing your hearing status and the presence or not of any hidden hearing problem and severity of their tinnitus 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.

Your rights as a Participant
This research has been reviewed and approved by the Ethics and Protocol Review Committee of the School of Biomedical and Allied Health Sciences, College of Health Sciences, University of Ghana. If you have any questions about your rights as a research participant you can contact the EPC Office between the hours of 8am-5pm through the landline +233-302-687974/5 or postal addresses: Box KB 143, Korle-Bu, Accra.
APPENDIX IV

INFORMED CONSENT FORM

The document describing the benefits, risks and procedures for the research: Auditory and Tinnitus severity assessment of Tinnitus patients in Korle –Bu Teaching Hospital has been read and / or explained to me. I have been given an opportunity to have any questions about the research asked and answered to my satisfaction. I agree to participate as a volunteer.

_____________________ __________________________
Date Signature or mark of volunteer

If volunteers cannot read the form themselves, a witness must sign here:
I was present while the benefits, risks and procedures were read to the volunteer. All questions were answered and the volunteer has agreed to take part in the research.

_____________________ __________________________
Date Signature of Witness

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

_____________________ __________________________
Date Signature of Person Who Obtained Consent
October 7, 2014

Mr. Bismark K. Adu-Twum
Dept. of Audiology, Speech and Language Therapy
SBAHS,
Korle Bu

Dear Mr. Bismark K. Adu-Twum

ETHICS CLEARANCE

Following a technical and professional review of your research proposal by the Department Ethics and Protocol Review Committee and by your supervisors, I am pleased to inform you of the Committee’s approval of your research proposal entitled:

"Auditory and Tinnitus Severity Assessment of Tinnitus Patients in Korle Bu Teaching Hospital".

This is an initial approval. You are therefore required to obtain a final approval from the School’s Ethics and Protocol Review Committee per the School’s regulations.

You are required to work closely and in collaboration with your supervisors. Please report all serious adverse events related to this research to the supervisors and this Committee in writing.

Thank you.

Yours sincerely,

[Signature]

DR. S. ANIM-SAMPONG

For: Chairman DASL&T Ethics and Protocol Review Committee