# COMPARATIVE STUDY OF THE PREVALENCE OF HEARING LOSS AMONG HEPATITIS B VIRUS INFECTED PATIENTS AND UNINFECTED VOLUNTEERS: A CASE STUDY

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**THIS DISSERTATION IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF SCIENCE AUDIOLOGY DEGREE**

**JULY, 2018**

# DECLARATION

I, **GEORGE KWEKU DANFUL** do hereby declare that this dissertation which is being submitted in fulfilment of the requirements for the Master of Science degree in Audiology is the result of my own research performed under supervision, and that except where otherwise other sources are acknowledged and duly referenced, this work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

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# DEDICATION

I dedicate this work to my capable wife Mrs. Rachel Blassey Danful.

# ACKNOWLEDGEMENT

I owe my very existence to Jehovah God the Sovereign of the universe, for it is His underserved kindness that enabled me to successfully complete this work.

My sincere gratitude goes to my supervisors, Dr. Neal Boafo and Prof. (Major Rtd.) George Awuku Asare for their priceless contributions and guidance to the success of this project work. I wish to also extend the same gratitude to Dr. S. Anim-Sampong.

Next, I wish to thank the staff of the Centre for Hearing and Speech Services (CHSS)-University of Education, Winneba, and the Trauma and Specialist Hospital Winneba, particularly Dr. Yaw Nyadu Offei, Mr. Emmanuel Kwasi Acheampong, Sesi C. Akotey, Cyril M. Honu-Mensah, Ms. Annie Robertson, Daniel K. Boateng, Daniel Tawiah, Helena K. Kuffour and Mr. Maxwell Anderson.

Special thanks to the Board of Trustees Aud-M-Ed-United Kingdom, Prof. E. D. Kitcher, Dr. Yaw Sarpong, Mr. Nai Doku and Mrs. Doris Doku, Mr. Robert L. Felder and Mrs. Thelma Felder, Mr. Nicholas Adu-Antwi, Mr. Jonathan A. Blassey, Mr. Emmanuel T. Alemawor, Mr. Bernard P. Botchway, Mr. Caleb A. Blassey, Mad. Gladys Agbeko, Mr. Benjamin Amenudzi, Mr. Michael A. Darbi, Nathaniel M. Kpono, and Enock Lamptey.

Finally, my gratitude also goes to my colleagues Daniel K. A. Dzokah, Michael D. Tetteh, Benjamin T. Amartey, Catherine Senyasu, and Eunice Appea-Korang.

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# LIST OF ABBREVIATIONS

| | |
|---|---|
| ABR | Auditory Brainstem Response |
| AC | Air Conduction |
| ASHA | American Speech-Language-Hearing Association |
| BSA | British Society of Audiology |
| CHB | Chronic Hepatitis B Virus |
| CHSS | Centre for Hearing and Speech Services |
| CSF | Cerebrospinal Fluid |
| dB | Decibel |
| DNA | Deoxyribonucleic Acid |
| ECV | Ear Canal Volume |
| ENT | Ear, Nose, and Throat |
| HAC | Hearing Assessment Centre |
| HBsAg | Hepatitis B Surface Antigen Test |
| HBV | Hepatitis B Virus |
| HCC | Hepatocellular Carcinoma |
| HCV | Hepatitis C Virus |

| | |
|---|---|
| HL | Hearing Level |
| Hz | Hertz |
| KBTH | Korle Bu Teaching Hospital |
| OAEs | Otoacoustic Emissions |
| PTA | Pure Tone Average |
| SNHL | Sensorineural Hearing Loss |
| SSNHL | Sudden Sensorineural Hearing loss |
| TEOAE | Transient Evoked Otoacoustic Emission Test |
| TM | Tympanic Membrane |
| UEW | University of Education, Winneba |
| WHO | World Health Organization |

# ABSTRACT

**Background**: Worldwide the hepatitis B virus (HBV) infection is considered a major public health concern, infecting about two billion people. Annually, the disease accounts for about one million deaths. The prevalence of the disease is considered high in Africa, affecting about 8% of the population in West Africa and between 5 to 7% in Southern, Eastern, and Central Africa. Ghana has a high prevalence rate of 12.3% with most infected persons seeking medical attention at the terminal stage of the disease. Studies have reported hearing loss among HBV infected persons. Though Ghana is considered a high endemic region, currently no such data exists. This necessitated the study to investigate the prevalence of hearing loss among persons with HBV infection.

**Aim**: The study determined the prevalence of hearing loss among persons with HBV infection compared with uninfected volunteers.

**Methods**: This case-control study recruited 57 persons diagnosed of HBV infection (case group) and 60 uninfected volunteers (control group) between the ages of 18 and 40 years. All the 117 participants undertook tympanometry (middle ear analysis), pure tone audiometry (hearing test), and transient evoked otoacoustic emission (TEOAE) test. Hearing threshold greater than 25 dB was considered a hearing loss. Data were statistically analyzed using student's t-test.

**Results**: There were 31 (54%) males and 26 (46%) females in the case group. The control group included 31 (51.7%) males and 29 (48.3%) females. Among the case group, the mean age was 30 ± 5.6 years and 24.9 ± 4.6 years among the control group. The tympanometry results showed that all 117 participants presented normal middle ear function in both ears. The results of the pure tone audiometry showed a pure tone average (PTA) of 22.19 dB HL for the case group for the right ear and 21.92 dB HL for the left ear, whiles the control group recorded a PTA of 15.42 dB HL for the right ear and 15.89 for the left ear. The PTA of the two groups showed a significant difference ($p<0.001$). Mild sensorineural hearing loss (SNHL) was recorded among the case group at frequencies of 4000 Hz (25.88 dB HL) and 8000 Hz (28.33 dB HL) in the right ear, and 25.18 dB HL and 27.98 dB HL in the left ear at 4000 Hz and 8000 Hz respectively. The difference between the average hearing thresholds of both groups was statistically significant with a $p<0.001$. All 60 uninfected volunteers passed the TEOAE test. While 14 (25%) of the case group participants passed with 43 (75%) referred in the right ear, and 15 (26%) passed with 42 (74%) participants referred in the left ear. Out of the 43 persons diagnosed with mild SNHL, 42 had bilateral hearing loss and 1 had unilateral hearing loss in the left ear.

**Conclusion**: The prevalence of hearing loss among persons infected with the HBV is 75% for the right ear and 74% for the left ear. Based on the findings of this study, persons with HBV infection are more likely to acquire SNHL.

**Keywords**: Hearing loss, hepatitis B virus, sensorineural hearing loss, viral infection.

# CHAPTER ONE

# INTRODUCTION

## 1.1 BACKGROUND OF THE STUDY

Internationally, the hepatitis B virus (HBV) infection is seen as a perilous disease which required immediate medical attention. The HBV causes the disease which can lead to severe damage to the liver and causes hepatocellular necrosis and inflammation (World Health Organization, 2015). The virus has been found in serum, semen, vaginal secretion, saliva, tears, amniotic fluid, sweat, bile, breast milk, cerumen, ear discharge (otorrhea), and blood (Goh, Son, Kong, Chon, & Cho, 2008; Kalcioglu, Durmaz, Ozturan, Bayindir, & Direkel, 2004; Mast, Alter, & Margolis, 1999; Parizad, Khosravi, Parizad, Sadeghifard, & Ghafourian, 2012; Pyrsopoulos & Anand, 2017). Chronic hepatitis B virus (CHB) infection with exacerbated results in systemic viremia (manifestation of virus in the bloodstream) can result in sensorineural hearing loss, possibly due to the inflammation of the blood vessels hampering the blood flow needed for the inner ears to function properly (Huang, Lin, Chang, Chan, & Lee, 2009; Signia, 2016).

Globally, about two billion persons have been infected with HBV, and 350 million are chronic sufferers of the disease (Lavanchy, 2004). Most people suffering from the infection live in low and middle income countries and accounts for about one million deaths annually (Dienstag, 2008; World Health Organization, 2015). Regions such as Sub-Saharan Africa, the Amazon Basin, South East Asia, and China are regarded as high endemic regions. Japan, the Middle East, portions of South America, and portions of Southern and Eastern Europe are seen as moderately endemic regions, while Australia, Western and Northern Europe, and North America are regarded as low endemic regions (Hou, Liu, & Gu, 2005; World Health Organization, 2012).

In Ghana, HBV infection is considered a disease requiring more attention and of public health significance. The prevalence rate of CHB infection is considered high if it is greater or equal to 8%. Ghana has a national prevalence rate as determined by hepatitis B surface antigens (HBsAg) seropositivity of 12.3% (Ofori-Asenso & Agyeman, 2016). Osei, Lokpo, and Agboli (2017) observed high prevalence rate (8.9%) of HBV infection among people between the ages of 30 and 39 years.

Studies conducted in areas in the Middle East and Asia considered as high and moderate endemic areas respectively for HBV have associated the disease with hearing loss. Though Sub-Saharan Africa including Ghana is considered a high endemic HBV region (Ofori-Asenso & Agyeman, 2016), presently no study has been conducted on HBV infection and hearing loss in the region. Hence, this research is aimed at investigating the prevalence of hearing loss among persons with hepatitis B virus infection compared with uninfected volunteers.

## 1.2 STATEMENT OF THE PROBLEM

Viruses can travel through the blood and enter into the inner ear, which might cause severe damages (Huang *et al*., 2009). The existence of the HBV in the inner ear can possibly cause sudden deafness (Huang *et al*., 2009).

Research conducted in countries considered as high endemic regions associated HBV infection to hearing loss, hence the need for this study. Though Ghana has a high prevalence rate of HBV infection, currently, no research has been done on the prevalence of hearing loss among persons who are HBV positive.

In the light of the above considerations, it is imperative that a study is carried out to investigate the prevalence and type of hearing loss among persons with HBV infection compared with uninfected volunteers.

## 1.3 SIGNIFICANCE OF THE STUDY

This research is expected to make available data on the prevalence and type of hearing loss among persons with HBV infection. This will create awareness of the severity of the problem, and help address hearing loss as a public health issue in Ghana.

It is hoped that the study will provide suggestions to physicians to include hearing assessment to the routine tests conducted on patients who have HBV infection. It may provide the basis for clinicians to involve hepatitis B surface antigens (HBsAg) test for patients with sudden sensorineural hearing loss (SSNHL) with unidentified cause.

This study may establish the need for policy-makers to allocate resources to encourage further research in this area of study and promote easy access to hearing assessment facilities.

## 1.4 AIM

The aim of the study was to determine the prevalence of hearing loss among persons with HBV infection compared with uninfected volunteers.

## 1.5 OBJECTIVES OF THE STUDY

The objectives of the study were:

1. To ascertain the differences in pure tone average (PTA) at frequencies 500, 1000, and 2000 Hz between the case and control groups to determine the degree of hearing loss.
2. To determine hearing loss among the control group.

3. To determine the type of hearing loss associated with persons who are HBV positive.

## 1.6 HYPOTHESES

$H_1$: There will be a significant hearing loss among persons with HBV infection.

$H_2$: Persons with HBV infection will have sensorineural hearing loss.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 INTRODUCTION

Hearing loss among persons with HBV infection has been reported in regions of the world with a high prevalence rate of the disease. Related literature on the human ear and hearing, and the association between the HBV infection and hearing loss will be reviewed under this Chapter. The prevalence of hearing loss and HBV infection will also be discussed.

## 2.2 THE HUMAN EAR AND HEARING

One of the complex organs of the body is the ear. It is the organ of hearing and helps us to communicate. The main function of the auditory mechanism is to convert acoustic waves into neural codes that can be interpreted by the brain (Rubel & Fritzsch, 2002). The human ear has the ability to perceive a frequency range of 20 Hz to 20 000 Hz (Rosen & Howel, 2013). Basically, the ear can be put into three different portions namely; outer (external), middle (tympanic cavity), and inner ear (Dhillon & East, 1999).

### 2.2.1 Outer (External) Ear

The outer or external ear is made up of the pinna (auricle) and external auditory meatus or canal. Anatomically, it is like a funnel and ends at the tympanic membrane (TM) which is the boundary separating the outer ear from the middle ear (Sandell, 2014). The pinna (auricle) is the flap-like portion of the ear that is seen at the side of the head. The pinna is a cartilage covered with skin which leads to the skin of the external auditory canal (Lass, 2013). The external auditory canal is S-shaped with the length of about 25 mm to 35 mm and 5 mm to 9 mm in diameter (Lass, 2013). The first third of the ear canal is a cartilage and the inner third is bone. The cartilaginous part of the canal houses the ceruminous gland (secrets earwax) and the sebaceous gland (produces oil). The hair cells and the earwax (cerumen) found in the canal provide protection for the eardrum from insects, dust, and other foreign bodies. Acoustic signals are collected by the auricle and channeled through the external auditory canal on to the TM, which vibrates and send the sound waves to the middle ear.

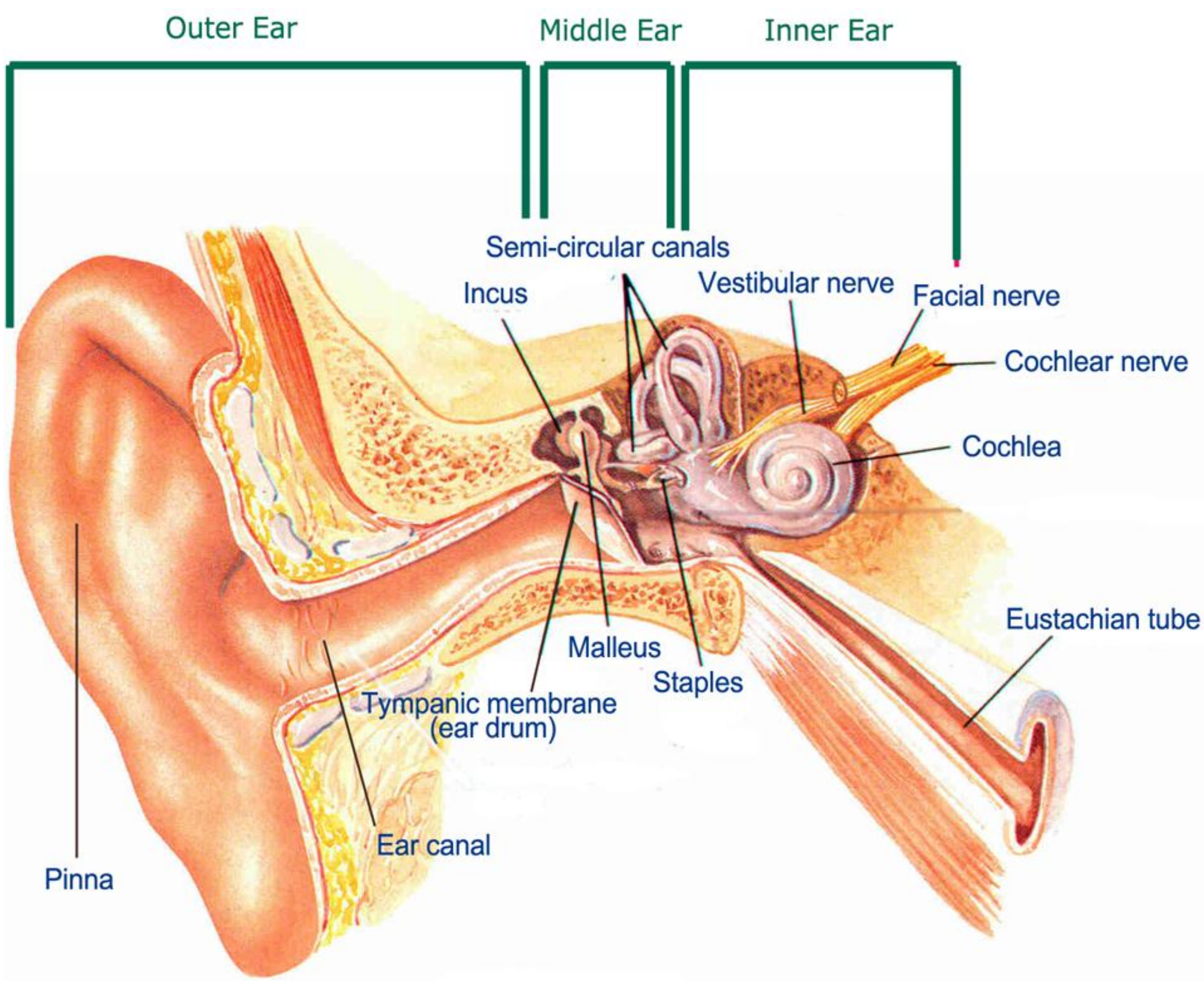


**Figure 2.1: Anatomy of the human ear**

**Source: http://tweetboard.me**

### 2.2.2 Middle Ear or Tympanic Cavity

The middle ear is a chamber filled with air located in the petrous temporal bone (Waugh & Grant, 2006). It is from the TM to the lateral wall of the inner ear and includes the three tiniest bones (ossicles) in the human body (Lass, 2013) namely; the malleus (hammer), incus (anvil), and stapes (stirrup). These three bones come together to form the ossicular chain. The ossicles with their two supporting muscles (tensor tympani and stapedius muscles) function to transmit vibrations from the TM to the oval window of the cochlea while protecting the inner ear from excessively loud noise (Maroonroge, Emanuel, & Letowski, 2000). To avoid the loss of a large amount of energy during the transmission of the vibrations from the TM to the oval window, the ossicular chain is constructed to take advantage of the physical laws of leverage. Air is able to access the middle ear chamber through the Eustachian tube (pharyngotympanic tube) which balances the air pressure in the middle ear and the ear canal.

### 2.2.3 Inner Ear

This part of the ear consist of two sections based on how they function namely; the vestibular system (balancing) and cochlea (hearing) (Waugh & Grant, 2006). It is also known as the labyrinth because it consists of passages like a maze. It is located in the petrous portion of the temporal bone (Lass, 2013).

#### 2.2.3.1 The Vestibular System

The vestibular system is situated at the upper part of the inner ear and responsible for balancing (Olchowik *et al*., 2015). The fluid in the three semicircular canals, the utricle and the saccule is sensitive to linear acceleration, head rotation, and head position. Signals concerning movement are sent to the brain through the vestibular nerve.

### 2.2.3.2 The Cochlea

The cochlea is a spirally coiled canal that looks like snail shell which twists two and a half times. This coiled canal is divided from its base to the top into three separate portions filled with fluid. The three portions are scala vestibuli, scala media (cochlear duct), and scala tympani. The Reissner's membrane separetes the scala vestibuli from the cochlear duct and the basilar membrane also separates the cochlear duct from the scala tympani (Felten, O'Banion, & Maida, 2016). Both scala vestibuli and scala tympani contain a fluid called perilymph whiles the scala media contains endolymph rich in potassium. The organ of corti where true hearing takes place is located along the full length of the cochlear duct. It contains about 3500 minute inner hair cells in a row and 13 500 outer hair cells in three to four rows (Lass, 2013). All these parts of the cochlea help in converting mechanical energy from the middle ear into an electrical stimulus that is transmitted to the brain for interpretation.

The working mechanism is that the footplate of the stapes shakes the oval window setting the perilymph in the scala vestibuli and scala tympani into motion pushing the round window out. As the perilymph in the scala vestibuli moves it pushes against the Reissner's membrane which in turn sets the endolymph in the cochlear duct into motion. This motion and vibration cause displacement of the basilar membrane. Low frequency acoustic signals stimulate the apex of the cochlea, whiles high frequency sounds stimulate the base. The up and down movement of the basilar membrane moves the organ of corti which sits on it. Movement of the organ of corti causes the hair cells to brush the tectorial membrane releasing a chemical at the bottom of the hair cells. This generates electrical impulses that are sent through the spiral ganglion of the auditory nerve to the brain for interpretation.

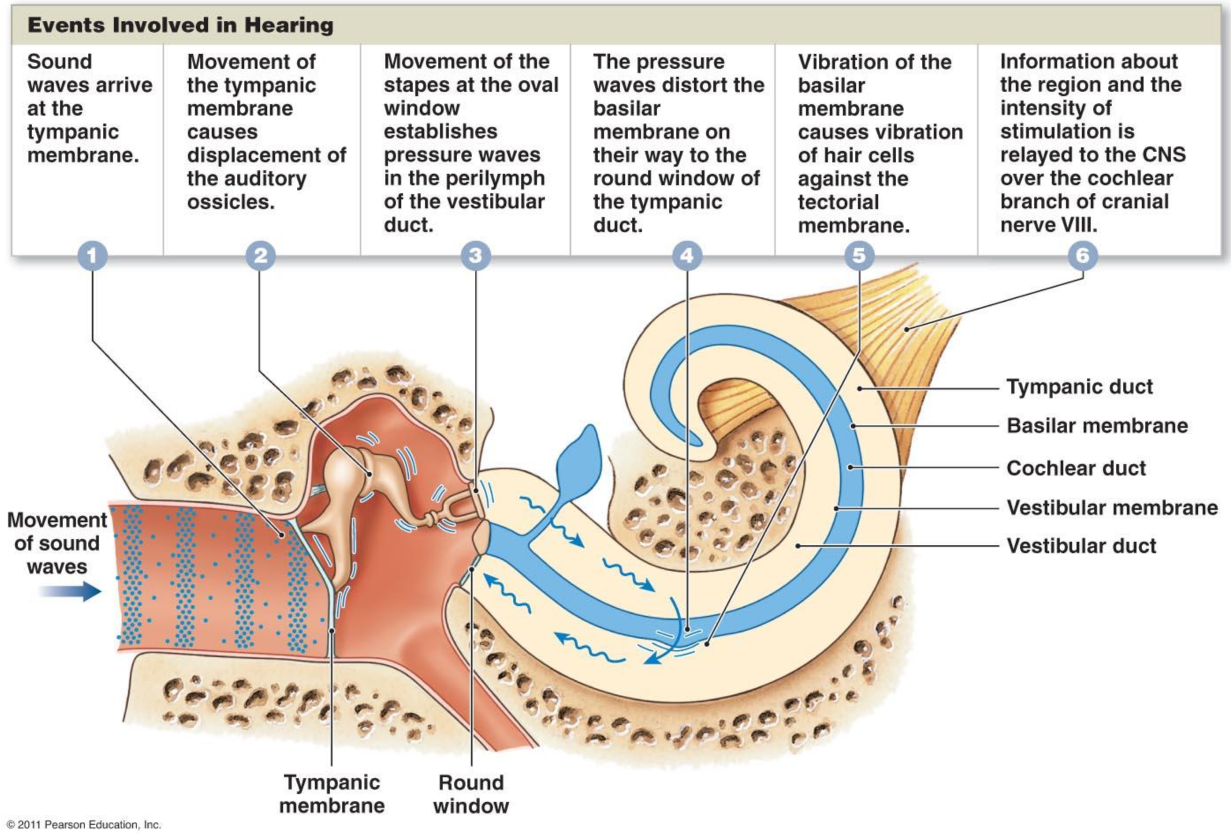


**Figure 2.2: The pathway of sound waves**

**Source: www.onlinebiologynotes.com**

## 2.3 HEARING SENSITIVITY LOSS

Hearing sensitivity loss occurs when the sensitivity of the hearing mechanism reduces so that acoustic signals need to be louder (>25 dB HL) before the person can hear (Stach, 2010). Mainly, the ear can be divided into a conductive part (comprising the outer and middle ears) and the sensorineural part (comprising the inner ear and the auditory nerve) (Martin & Clark, 2012). Hearing loss is as a result of an aberrant reduction of acoustic signal sent to the brain as a result of a dysfunction of the conductive portion and/or sensorineural portion of the auditory mechanism.

When there is a blockage or reduction in the transmission of sound because of a disorder in the outer ear or middle ear, it is termed conductive hearing loss. If the hearing loss originates from a problematic cochlea (sensory organ), neural cells or their associated structures, it is called a sensorineural hearing loss. It can also be caused by a dysfunction of the vestibulocochlear (VIIIth) nerve and/or auditory brainstem. Disorders of the auditory pathway and/or the vestibulocochlear nerve are mostly considered as retrocochlear disorders, since how they are diagnosed, treated, and effect are different considerably from a SNHL caused by cochlear damage (Stach, 2010). If there is a problem with both conductive and sensorineural portions of the ear, then it is referred to as a mixed hearing loss.

### 2.3.1 Types of Hearing Loss

The main types of hearing loss are conductive hearing loss, SNHL, and mixed hearing loss (Duthey, 2013). They are categorized depending on the portion of the auditory system with damage (American Speech-Language-Hearing Association, 2017).

### 2.3.2 Conductive Hearing Loss

Conductive hearing loss happens once acoustic energy is poorly transmitted from the external auditory meatus to the tympanic membrane and the three bones of the middle ear namely malleus, incus, and stapes (Fig. 2.3b on page 13). Typically, the ability to perceive low intensity sounds is affected and can be corrected medically or surgically (Duthey, 2013). As a result, most conductive hearing losses are rarely of a longstanding duration. This makes the effect of conductive hearing loss on communication transitory (Stach, 2010). Possible causes of conductive hearing loss include poor Eustachian tube function, otitis media (middle ear infection), otitis externa (infection of the outer ear), raptured tympanic membrane (eardrum), ossicular chain discontinuity or fixation, impacted earwax, benign tumors or polyps in the auditory canal, existence of a foreign body, and abnormality of the outer ear (absence or malformation).

### 2.3.3 Sensorineural Hearing Loss

Sensorineural hearing loss is as a result of dysfunction of the sensory cells in the cochlea and/or the auditory fibres of the vestibulocochlear (VIIIth cranial) nerves (Figure 2.3c on page 13). When the sensorineural part of the hearing system is damaged, it is unable to convert mechanical energy into electrical impulses (Stach, 2010). Often this type of hearing loss is permanent (American Speech-Language-Hearing Association, 2017). Possible causes of SNHL include acoustic trauma, age-induced hearing loss (presbycusis), hereditary or genetic factors, ototoxic medication, Ménière's disease, some viral and bacterial infections, and head trauma.

### 2.3.4 Mixed Hearing Loss

This is a combination of conductive loss and sensorineural loss in the same ear (Figure 2.3d on page 13). Mixed losses can result from noise-induced hearing loss plus otitis media, head trauma or advanced otosclerosis (Gelfand, 2016).

### 2.3.5 Degrees of Hearing Loss

This refers to the severity of hearing impairment (American Speech-Language-Hearing Assocation, 2015). Table 2.1 indicates the classification of the degree of hearing loss computed from the average hearing thresholds of 500 Hz, 1 KHz, and 2 KHz. This system of classification is commonly used in Ghana.

**Table 2.1: Guideline for describing degree of hearing loss**

| Degree of hearing loss | Threshold Hearing Level (dB HL) |
|---|---|
| Normal | 0 – 25 |
| Mild | 26 – 40 |
| Moderate | 41 – 55 |
| Moderately severe | 56 – 70 |
| Severe | 71 – 90 |
| Profound | 91+ |

**Source: Clark (1981)**

## 2.4 PREVALENCE OF HEARING LOSS

Worldwide, the occurrence of hearing impairment is on the rise (Mulwafu, Kuper, & Ensink, 2016). Globally about 466 million individuals have disabling hearing loss (World Health Organization, 2018). Out of this number, 432 million are adults and 34 million are children. The World Health Organization (WHO) projected that by the year 2050, more than 900 million individuals will develop disabling hearing loss. The highest prevalence rate of disabling hearing loss is recorded in Sub-Saharan Africa, Asia Pacific and South Asia. According to the World Health Organization (2006) about 8% of those suffering from this sensory disability live in low and middle-income countries.

The estimations of the WHO suggests that 15.7% of adults 15 years and above who live in sub-Saharan Africa have a disabling hearing loss (>35 dB) (Mulwafu *et al*., 2016). However, Mulwafu *et al*. (2016) reviewed 28 articles and found that the prevalence rate of hearing loss for a cut-off of 25 dB HL was 17% for population-based studies.

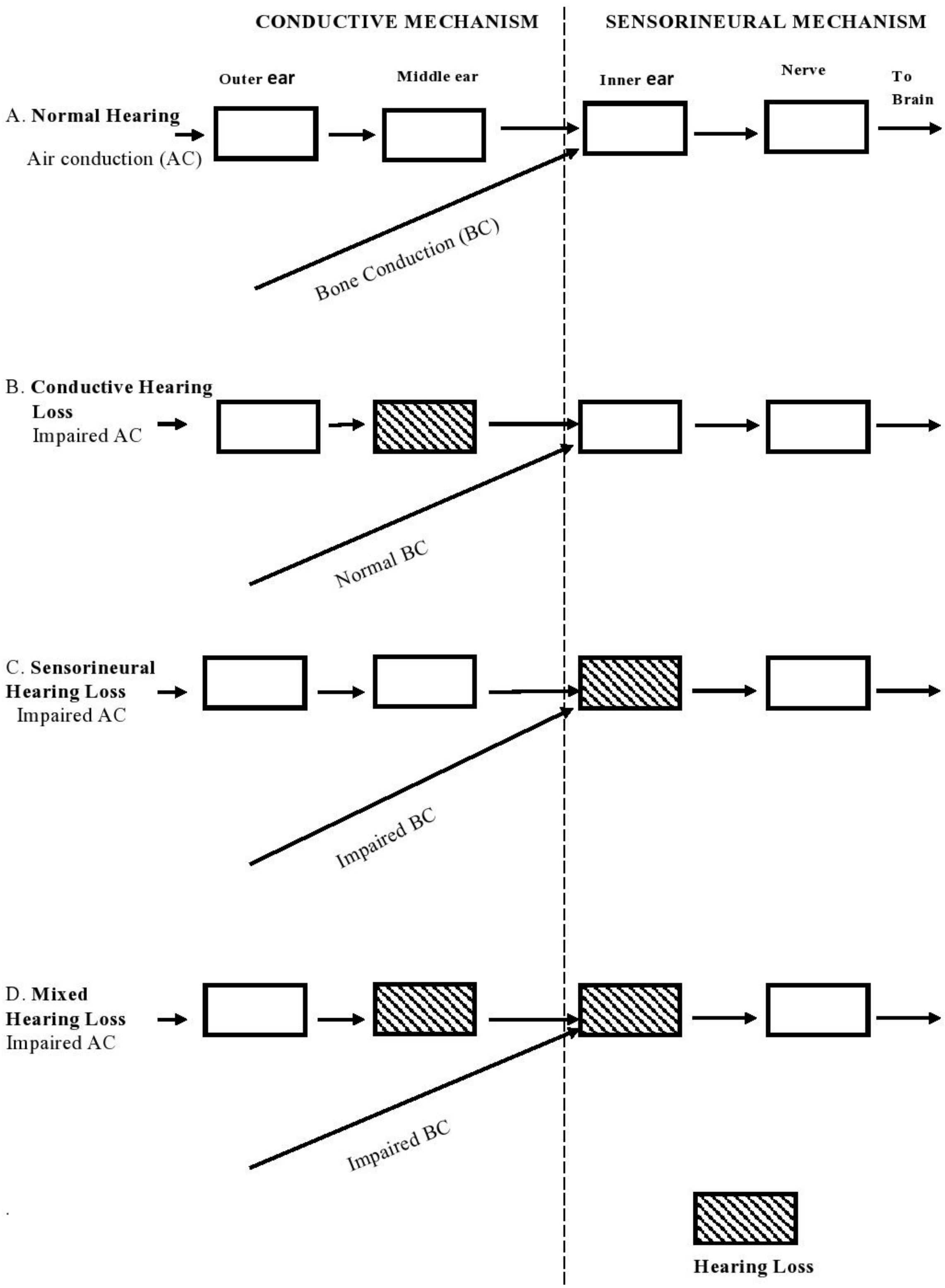


**Figure 2.3: Block diagram of the ear**

**Source: Martin & Clark (2012)**

The Ghana Statistical Service (2013) cited in Offei, Akotey, & Honu-Mensah (2017) stated that the prevalence rate of hearing loss in Ghana is 16.8% among rural dwellers and 12.9% among people living in urban areas. Nyarko (2013) reviewed the records of 715 patients who presented at the Hearing Assessment Centre (HAC) of the Korle Bu Teaching Hospital (KBTH), Accra during the periods of January-December, 2012. Out of the 715 patients, 474 (66.3%) had a hearing loss and most of them were 60 years and above. The type of hearing loss most prevalent was SNHL for both ears, with prevalence rates of 36.7% (right ear) and 40.5% (left ear).

## 2.5 HEPATITIS B VIRUS INFECTION

Any of the five hepatitis viruses (A, B, C, D, and E) can lead to the damage of the liver (WHO, 2012). The HBV infection is caused by the hepatitis B virus, an enveloped deoxyribonucleic acid (DNA) virus that attacks the liver and causes inflammation and death of cells in the liver (hepatocellular necrosis) or cancer (WHO, 2015). This disease can be classified as acute or chronic (Lavanchy, 2004; WHO, 2015). At the acute stage, the liver may be inflamed and lead to the death of some of the cells which can be fatal (WHO, 2015). Chronic hepatitis B (CHB) infection encompasses a spectrum of disease and is defined as persistent HBV infection (the presence of detectable HBsAg in the blood or serum for longer than six months), with or without associated active viral replication and evidence of hepatocellular injury and inflammation (Lavanchy, 2004).

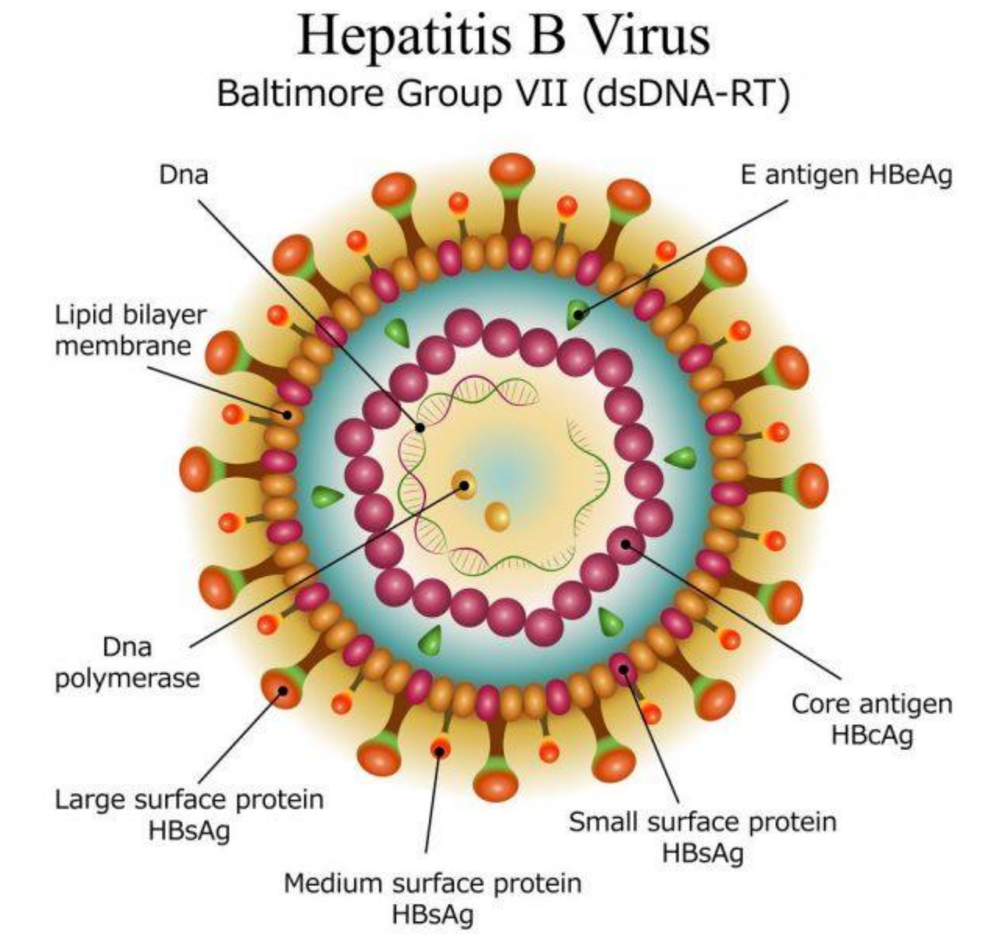


**Figure 2.4: Hepatitis B virus**

**Source: www.std-gov.org**

### 2.5.1 Transmission

Hepatitis B virus is predominantly transmitted through body fluids such as blood, semen, vaginal secretions, and saliva. It can also spread via sexual contact with infected partners, accidental needle sticks or sharing of needles or razors, blood transfusions, tattooing, acupuncture, dental and surgical procedures, and organ transplantation (horizontal transmission) (WHO, 2015). Expectant mothers who contract the disease may transfer it to their neonates during birth. This is known as perinatal transmission (Mast *et al*., 1999; Pyrsopoulos & Anand, 2017).

### 2.5.2 Symptoms

The virus interacts with the immune system of the infected person, which can result in liver injury, hepatocellular carcinoma (HCC) or scarring of the liver (cirrhosis) (Pyrsopoulos & Anand, 2017). Symptoms are; extreme fatigue, vomiting, yellowing of the skin and eyes (jaundice), nausea, abdominal pain, dark urine, and an acute liver failure which can lead to death (WHO, 2017).

### 2.5.3 Prevention

Vaccination against HBV is one of the effective ways to produce immunity to the disease. The vaccines have been available for more than two decades (WHO, 2015). The WHO recommends the immunization of all infants within 24 hours after birth. Behavior modifications by means of using condoms during sexual intercourse, avoiding tattooing and body piercing with an unsterilized instrument or unsafe techniques can help prevent the transmission of HBV. It is also recommended that a person does not share needles, razors, or toothbrush with another person.

## 2.6 PREVALENCE OF HEPATITIS B VIRUS INFECTION

Viral hepatitis has become a universal healthcare concern leading to the death of millions annually. This has necessitated the WHO to set July 28 of every year to commemorate World Hepatitis Day to provide education and create awareness of the causes and prevention the of disease (WHO, 2012). Globally, about two million persons have been infected with the hepatitis B virus (WHO, 2015). According to Lavanchy (2004) about 45% of the world population can be found in areas with high CHB prevalence rate. About 350 million people have CHB virus infection and are in danger of developing severe malady and demise from cirrhosis, liver failure and hepatocellular carcinoma (HCC) (Lavanchy, 2004; Dienstag, 2008). Annually, this accounts for one million deaths worldwide (Dienstag, 2008; WHO, 2012; 2015).

The prevalence of CHB virus infection worldwide is classified as high, intermediate and low endemic (Hou, Lui, & Gu, 2005). Areas with a considerable number of people such as Sub-Saharan Africa, China, the Amazon Basin, and South East Asia are considered high endemic hepatitis B regions, with more than 8% of the population chronically infected (Hou, Lui, & Gu, 2005; WHO, 2012). In parts of Japan, South America, the Middle East, and Southern and Eastern Europe, hepatitis B is considered moderately endemic (Hou *et al*., 2005). Between 10 - 60% of the population have an indication of the disease, and about 2 - 7% are chronically infected (Hou *et al*., 2005). In most affluent areas such as North America, Northern and Western Europe and Australia, the prevalence is low (Hou *et al*., 2005). In these areas, hepatitis B virus infects 5 - 7% of the population, and only < 2% of the population is chronically infected (Hou, Lui, & Gu, 2005).

Most people who become infected with the disease in Asia and Sub-Saharan Africa acquired it from childhood (Lavanchy, 2004). This brings a lot of economic burden on families and even the government due to the high cost of medical bills and loss of productive hours. Though sufficient data on the cost of treating liver problems in Africa is lacking, in 1999 the cost of treating liver diseases in the United States of America is about $ 4175 for a patient in a period of two years (Lavanchy, 2004). The cost of treatment in high endemic areas will likely be higher. Because of the high cost of treatment, most people infected with the disease in Africa do not receive treatment early enough leading to many deaths (Lemoine, Eholie, & Lacorube, 2015).

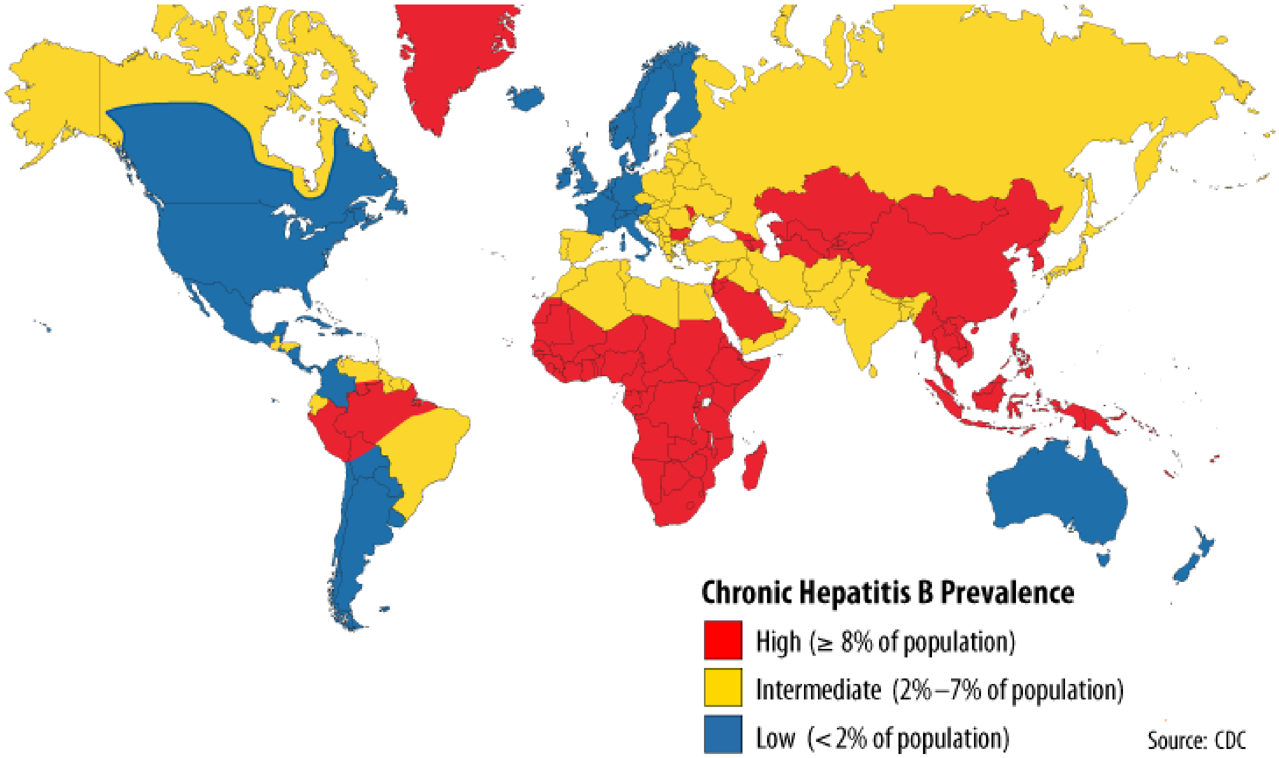


**Figure 2.5: Prevalence of chronic hepatitis B worldwide**

**Source: Centers for Disease Control and Prevention-USA**

### 2.6.1 Prevalence of HBV Infection in Ghana

Chronic Hepatitis B virus infection is high in Ghana, with a national prevalence of 12.3 % (Ofori-Asenso & Agyeman, 2016). Reasons for the perceived high prevalence of the disease in Ghana are limited knowledge about the transmission of the virus (Ofori-Asenso & Agyeman, 2016). Ofori-Asenso & Agyeman (2016) determined the regional prevalence rate of the disease from 1995 to 2015 and found that Ashanti, Greater Accra, Eastern, Northern, Central and Brong-Ahafo regions are 13.1, 10.6, 13.6, 13.1, 11.5 and 13.7 % respectively (Figure 2.6). It must be noted that there was no data for Upper West, Upper East, Western, and Volta Regions.

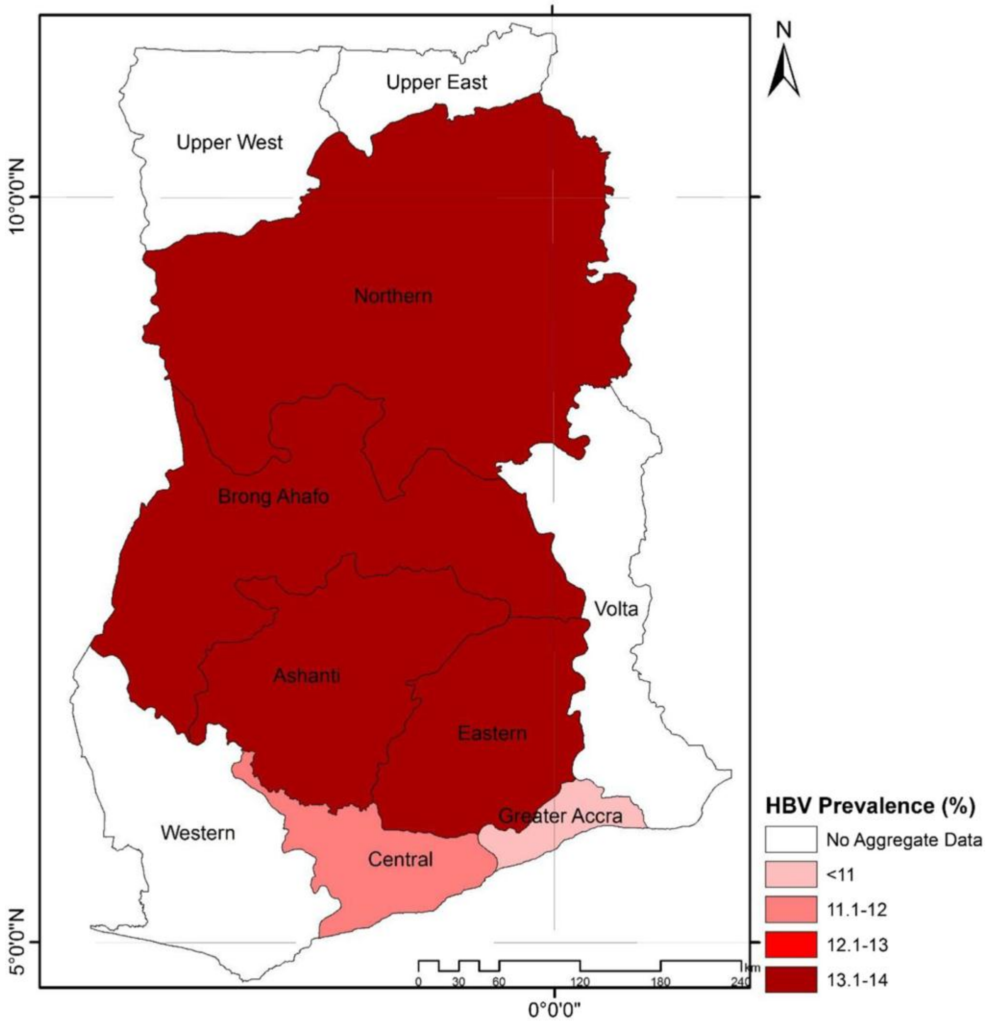


**Figure 2.6: Map of Ghana showing HBV infection in the various Regions**

**Source: Ofori-Asenso & Agyeman (2016)**

## 2.7 ROUTE OF VIRAL SPREAD OF THE COCHLEA

Viruses can advance to the inner ear through the blood and cause an immune-mediated reaction (Huang *et al*., 2009). For example, a high rate of measles, rubella, mumps, varicella-zoster, herpes simplex, influenza viruses (types A & B) and cytomegalovirus was found in a group of persons with a sensorineural hearing loss (Veltri, Wilson, Sprinkle, Rodman, & Kavesh, 1981; Wilson, Veltri, Laird, & Sprinkle, 1983).

Stöver, Yagi, & Raphael (2000) examined the itinerary of virus in the cochlea of a guinea pig to better comprehend the reactions of the virus mediated transgene expression in the inner ear and help in developing an inner ear gene therapy in humans. They injected 25 microliters (µl) of viral vector into the scala tympani of the cochlea and observed that the virus spread from the perilymph of the scala tympani through the cochlear aqueduct to the cerebrospinal fluid (CSF) and also through the contralateral cochlear aqueduct to the other cochlea (Figure 2.7B for a schematic drawing). The same quantity of viral solution was also introduced into the cerebrospinal fluid and it was observed that the viral vector spreads to the bilateral perilymphatic space of the cochleae through the cochlear aqueducts (Figure 2.7C).

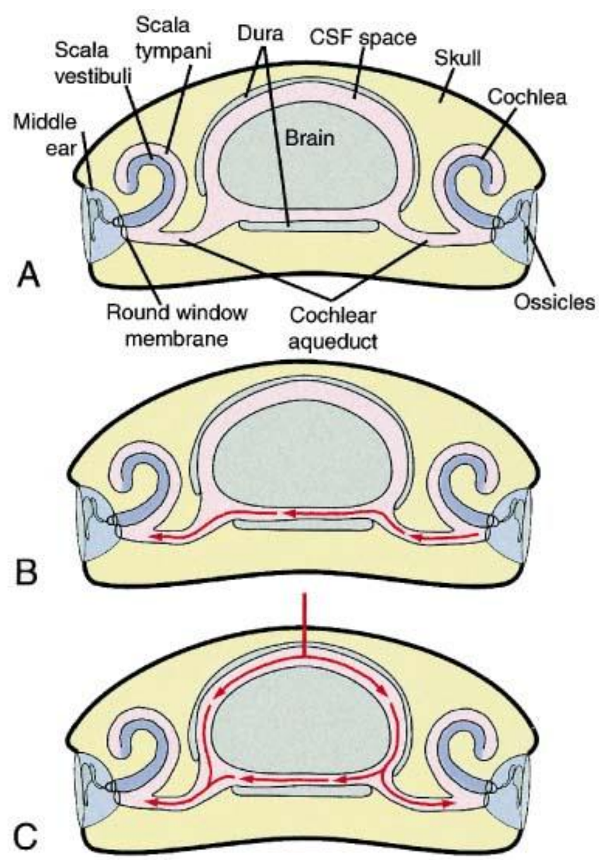


**Figure 2.7: A schematic drawing of the ear anatomy showing viral route**

**Source: Stöver *et al*. (2000)**

## 2.8 ASSOCIATION BETWEEN HEPATITIS B VIRUS INFECTION AND HEARING LOSS

Hepatitis B virus has been found in cerumen (earwax) and ear discharge (otorrhea) (Mast *et al*., 1999; Tayyar *et al*., 2004; Goh *et al*., 2008; Pyrsopoulos & Anand, 2017). Chronic hepatitis B virus infection with exacerbation results in systemic viremia (presence of virus in the bloodstream) causes sensorineural hearing loss, possibly as a result of the inflammation of the blood vessels hindering blood supply to the inner ear (Huang *et al*., 2009; Signia, 2016).

A research conducted by Parizad, Matin, & Parizad (2017) shown that persons with HBV are more likely to acquire hearing loss. They recorded a significant hearing loss at frequencies of 250, 4000, and 8000 Hz among patients who are hepatitis B positive.

Nasab, Fathololoomi, & Alizamir (2012) also in their case-control study in Iran, found that in the audiometric assessment, pure tone average (mean thresholds of 500 Hz, 1 kHz, and 2 kHz) were 22.1 dB HL for the left ear and 23.95 dB HL for the right ear in hepatitis B group and 8.4 dB HL for the left ear and 8.95 dB HL for the right ear in the control group. They concluded that patients who are HBV positive stand a greater chance of acquiring hearing loss and that the disease can cause hearing loss. Chen *et al*. (2017) studied if hepatitis (B/C) virus infection is connected with the possibility of acquiring sudden sensorineural hearing loss (SSNHL) in Taiwan. The hearing thresholds of patients with hepatitis B or C (*n*=170, 942) was compared with a control group (*n*=512, 826), the researchers found that the incidence of SSNHL is much higher in HBV/HCV group compared to the control group. Their study showed the increased risk of SSNHL in a population with HBV/HCV.

## 2.9 RESEARCH GAP

Some studies have associated HBV infection with hearing loss across different parts of the world, currently, there is no data on the effect of HBV infection on the hearing status of those suffering from the disease in the country, though Ghana is categorized as part of countries with a high prevalence rate of CHB virus infection. Hence, this study was aimed at investigating the prevalence of hearing loss among persons with HBV infection.

# CHAPTER THREE

# METHODOLOGY

## 3.1 INTRODUCTION

The methodology and techniques employed in this work are described in this Chapter. These include study design, study site, study population, sample size and sampling technique, data collection procedure, data analysis, and ethical consideration.

## 3.2 STUDY DESIGN

A case-control study design was adopted to achieve the stated objectives. This design helps to ascertain if an exposure is associated with a disease or an outcome, and compares persons who have the disease or outcome (case group) with persons who do not have the disease or outcome (control group) (Lewallen & Courtright, 1999). The study compared the hearing thresholds of 57 persons who are hepatitis B positive (case) with that of 60 volunteers who are hepatitis B negative. All 117 participants were tested for HBsAg at the Trauma and Specialist Hospital, Winneba. Audiological assessment (otoscopic examination, tympanometry, transient evoked otoacoustic emission test, and pure tone audiometry) were conducted on them and the data obtained was used to determine the prevalence and type of hearing loss associated with the hepatitis B patients.

## 3.3 STUDY SITE

The HBsAg test was conducted at the Trauma and Specialist Hospital, Winneba and the hearing evaluation was conducted at the Centre for Hearing and Speech Services (CHSS), University of Education, Winneba (UEW). The Trauma and Specialist Hospital, Winneba in the Effutu

Municipality of the Central Region of Ghana serves as the temporary Central Regional Hospital since the one at Cape Coast was improved to a Teaching Hospital status. The Centre for Hearing and Speech Services-University of Education, Winneba also provides ear and hearing health care for people living in the Central Region of Ghana and others referred from other health facilities across the country for audiological assessment.

## 3.4 SAMPLE POPULATION

The population of this study consisted of persons who tested positive for HBV and volunteers who tested negative between the ages of 18 and 40 years. This is because, people between the ages of 16 and 39 years recorded the maximum infection rate of HBV (Ofori-Asenso & Agyeman, 2016; Osei *et al*., 2017). Furthermore, due to consent issues, only adults were selected. Additionally, adults of 60 years and over were excluded because they are more disposed to hearing loss as a result of aging (presbycusis) (Nyarko, 2013).

## 3.5 SAMPLE SIZE AND SAMPLING TECHNIQUE

Equation 3.1 was used to compute the minimum sample size (67) since the population is non-finite (unknown).

$$\mathbf{n} = \frac{(z)^2\, p\,(1-p)}{e^2} \qquad \textbf{(3.1)}$$

Where *n* is the minimum sample size; *z* is the level of confidence considering a standard normal distribution set at 90% (1.64); *p* is the percentage of the population that presents the characteristics (50% which is 0.5), and *e* is the error margin of 0.1. The minimum sample size was calculated as follows:

$$\mathbf{n} = \frac{(1.64)^2\, 0.5\,(1-0.5)}{0.1^2} = 67$$

The purposive sampling technique was used to obtain the participants between the ages of 18 and 40 years for the study. Patients who attended the Trauma and Specialist Hospital and tested positive or negative for the HBsAg were selected and interviewed to determine whether or not they met the inclusion criteria. The participants who met the inclusion criteria were put into two groups, consisting of 57 HBsAg positive patients (case group) and 60 HBsAg negative patients (control group).

## 3.6 INCLUSION AND EXCLUSION CRITERIA

### 3.6.1 Inclusion Criteria

The case group tested positive and the control group tested negative for HBsAg at the Trauma and Specialist Hospital, Winneba. Both groups were aged 18 and 40 years with no history of hearing loss or deafness in the family, head trauma, ear trauma, diabetes, hypertension, ear infection, tumor, mumps, rubella, measles, autoimmune disease, work experience in a noisy environment, and administration of ototoxic medications within the last three months. Participants had no abnormalities in the ear canal following the otoscopic examination.

### 3.6.2 Exclusion Criteria

Participants outside the age range of 18 - 40 years, and those with a history of ear infection or tumors, ear or head trauma, autoimmune diseases and other causes of hearing loss were excluded from both groups.

## 3.7 PROCEDURE FOR DATA COLLECTION

All the participants underwent otoscopic examination, TEOAE test, tympanometry (middle ear analysis), and pure tone audiometry.

### 3.7.1 Otoscopic Examination

Otoscopic examination is the visual examination of the outer ear (including the pinna and canal) with a light and magnifying glass called an auriscope or otoscope (Offei, Essel, Diedong, Acheampong, & Cobbinah, 2009). This physical examination of the pinna and the ear canal may reveal the presence of fluid, cerumen (earwax), foreign bodies, or infection. Welch Allyn 22820 Otoscope (Figure 3.1) was used to examine the outer ear of participants to rule out any abnormalities. The British Society of Audiology (BSA) (2016) recommended procedure for ear examination was strictly adhered to.


**Figure 3.1: Welch Allyn 22820 Otoscope**

**Source: CHSS – UEW**

#### 3.7.1.1 Subject Preparation for the Otoscopic Examination

Before the otoscopic examination, the participants were asked if they currently experience discomfort in their ears, otalgia (ear pain), otorrhea (ear discharge), being treated for any ear disease or had surgery of the ear. Participants with such experiences were excluded.

The procedure was explained and demonstrated to the participants. No discomfort or pain was experienced or reported by participants during the otoscopic examination.

#### 3.7.1.2 Performing the Otoscopic Examination

The examiner washed his hands thoroughly and worn a pair of gloves to prevent the transfer of infection from the participants to the examiner and the vice versa. The pinna was examined thoroughly with a headlight. The examiner selected appropriate sized speculum and properly attached it to the otoscope. The speculum was always sanitized using rubbing alcohol (Isopropyl Alcohol 70%) before inserted into each ear canal. It was then changed to avoid transfer of infection. In examining the ear, the examiner held the otoscope using the pen style (i.e. bracing against the head) to avoid injuring the participants. Those who failed the otoscopic examination were referred to an Ear, Nose, and Throat (ENT) specialist.

### 3.7.2 Transient Evoked Otoacoustic Emission Test

Transient evoked otoacoustic emission test was conducted on all participants using the Otodynamics Otoport Lite OAE+ABR screener (Figure 3.2) to determine the function of the outer hair cells of the cochlear.


**Figure 3.2: Otodynamics Otoport Lite OAE+ABR Screener**

**Source: CHSS – UEW**

### 3.7.3 Tympanometry

A calibrated Otometrics Madsen Zodiac 901 Middle-Ear Analyzer (Figure 3.3) was used to analyse the function and the condition of the middle ear structures of all participants. The British Society of Audiology (2013) recommended procedure for tympanometry was strictly adhered to. A probe tone of 226 Hz was used. Normal middle ear pressure range was 150 to

+100 daPa, normal middle ear admittance or compliance was 0.3 to 1.6cm$^3$, normal ear canal volume (ECV) was between 0.6 to 1.5 cm$^3$ (British Society of Audiology, 2013).


**Figure 3.3: Otometrics Madsen Zodiac 901 Middle-Ear Analyzer**

**Source: CHSS – UEW**

### 3.7.4 Pure Tone Audiometry

Pure tone audiometry measures the hearing levels at specific frequencies of a given intensity (Gadagbui, 2003). A calibrated Kamplex Diagnostic Audiometer AD 27 (Figure 3.4) with supra-aural TDH39 headphones was used to test the hearing threshold of participants at frequencies of 250, 500, 1K, 2K, 4K, and 8K Hz. Hearing thresholds of participants were recorded on the data collection sheet (Appendix F). The hearing assessment was conducted in a sound treated booth with ambient noise less than 35 dB (A) at the Centre for Hearing and Speech Services, University of Education, Winneba. The procedure recommended by the British Society of Audiology (2011) was followed.


**Figure 3.4: Kamplex Diagnostic Audiometer AD 27**

**Source: CHSS - UEW**

### 3.7.4.1 Subject Preparation for the Hearing Test

The participants were conditioned (instructions given to a subject before pure tone audiometric test) and pressed a response knob/button when the test signal was perceived. The participants were clearly seen through the two sided glass window of the audiometric booth by the examiner during the hearing test.

#### 3.7.4.2 Conducting the Hearing Test

The audiometer was allowed to warm for 10 minutes before the first test. Biologic calibration was conducted prior to testing. The better ear as professed by each participant was tested first. The frequency dial was set at 1000 Hz and intensity dial at 30 decibels (dB). The tone was turned 'on' briefly and then 'off'. Threshold search was conducted, 10 dB reduction in test signal when subject responds and 5 dB increment in the test signal when the tone was not heard until the lowest or softest pure tone perceived by the participants was determined and recorded on the research information sheet. The frequency dial was then changed to 2000 Hz and tested. The procedure was repeated until all subsequent frequencies (4000, 8000, 500, and 250 Hz) were tested in both ears. Test-retest was conducted at 1000 Hz in the first test ear to ensure reliability of the hearing threshold.

## 3.8 ANALYSIS

The International Business Machines (IBM) Statistical Package for Social Scientist (SPSS) version 22 and Microsoft excel 2016 version was used to calculate the mean pure tone average (PTA) of frequencies 500 Hz, 1 kHz, and 2 kHz and mean of each frequency results of the pure tone audiometry of case and control groups, and presented in a table form.

## 3.9 ETHICAL CONSIDERATIONS

Ethical approval was obtained from the Ethics and Protocol Review Committee (EPRC) of the University of Ghana, School of Biomedical and Allied Health Sciences (SBAHS-ASLT/10598208/SA/2017-2018) (Appendix A). Permission was also obtained from the Centre for Hearing and Speech Services and the Trauma and Specialist Hospital (Appendices B and C). Informed consent was obtained from participants (Appendices D and E). The names and other information obtained from participants were replaced with codes and kept confidential.

# CHAPTER FOUR

# RESULTS

## 4.1 INTRODUCTION

The demographic distribution of the participants, tympanometry (middle ear analysis) results, pure tone audiometry results, the transient evoked otoacoustic emission (TEOAE) test results, and the prevalence of hearing loss among participants with hepatitis B virus infection (case group) and those without the disease (control group) are presented in this Chapter.

## 4.2 DEMOGRAPHIC DISTRIBUTION

The demographic distribution of the study participants is presented below.

### 4.2.1 Gender Distribution

The gender distribution of the participants is shown in Table 4.1.

**Table 4.1: Gender distribution of participants**

| Gender | Case group | | Control group | |
|---|---|---|---|---|
| | Number | Percentage | Number | Percentage |
| Male | 31 | 54% | 31 | 51.7% |
| Female | 26 | 46% | 29 | 48.3% |
| Total number | 57 | 100% | 60 | 100% |

From Table 4.1, among the 57 participants in the case group, 54% (*n*=31) were males and 46% (*n*=26) were females. Also, out of the 60 participants in the control group 51.7% (*n*=31) were males and 48.3% (*n*=29) were females. Statistically, there was no significant difference ($p>0.05$) in gender between the two groups.

### 4.2.2 Age Distribution

The age distribution of the participants is presented in Table 4.2.

**Table 4.2: Age distribution of the participants**

| Age Group (Years) | Case group | | Control group | |
|---|---|---|---|---|
| | **Number** | **Percentage** | **Number** | **Percentage** |
| 18 – 25 | 12 | 21% | 44 | 73.3% |
| 26 – 35 | 31 | 54% | 13 | 21.7% |
| 36 – 40 | 14 | 25% | 3 | 5% |
| Total Number | 57 | 100% | 60 | 100% |
| Arithmetic Mean ± s.d. | 30.3 ± 5.6 | | 24.9 ± 4.6 | |

From the Table 4.2, the age group most represented among the case group was 26 – 35 years (*n*=31) representing 54%, and the age group 18 – 25 years (*n*=44) representing 73.3% was most prevalent among the control group. The mean age among the case group was 30.3 ± 5.6 years and 24.9 ± 4.6 years among the control group. The standard deviations of the two groups indicate that the ages of the participants in the control group are much closer to the mean age compared to that of the case group. Statistically, there was a significant difference (*p*-value of <0.001) between the ages of both groups.

## 4.3 TYMPANOMETRY RESULTS

The average ear canal volume (ECV), middle ear compliance, and middle ear pressure of all the participants (*n*=117) are presented in Table 4.3.

**Table 4.3: Tympanometry results of participants**

| Normal Values | Case group | | Control group | |
|---|---|---|---|---|
| | Right Ear | Left Ear | Right Ear | Left Ear |
| ECV ($0.6-1.5cm^3$) | 1.3 | 1.25 | 1.20 | 1.18 |
| Compliance ($0.3-1.6cm^3$) | 1.3 | 1.32 | 0.42 | 0.33 |
| Pressure (-150 - +100 daPa) | 30 | 20 | 10 | 20 |

It can be deduced from Table 4.3 that the ECV, middle ear compliance, and middle ear pressure are within the normal limits in both ears for all 117 participants. These presented "Type A" tympanograms according to the classification of tympanograms by Jerger (1970).

## 4.4 PURE TONE AUDIOMETRY RESULTS

**Table 4.4: Pure tone average (PTA) for 500, 1000, and 2000 Hz**

| Ear | Case group | Control group |
|---|---|---|
| Right | 22.19 dB HL | 15.42 dB HL |
| Left | 21.92 dB HL | 15.89 dB HL |

From Table 4.4, the PTA (average hearing threshold at frequencies 500, 1000, and 2000 Hz) in the case group was 22.19 dB HL for the right ear and 21.92 for the left ear. The control group recorded a PTA of 15.42 for the right ear and 15.89 for the left ear. The PTA of the two groups showed a significant difference ($p<0.001$).

**Table 4.5: Average air conduction (AC) hearing thresholds (dB HL) for all tested frequencies**

| Frequency (Hz) | Ear | Case group | Control group |
|---|---|---|---|
| 250 | Right | 25 | 18.33 |
| | Left | 23.77 | 18.75 |
| 500 | Right | 24.12 | 18.67 |
| | Left | 23.33 | 18.58 |
| 1000 | Right | 20.70 | 14.41 |
| | Left | 21.23 | 15.58 |
| 2000 | Right | 21.75 | 13.17 |
| | Left | 21.23 | 13.5 |
| 4000 | Right | 25.88 | 10.92 |
| | Left | 25.18 | 10.75 |
| 8000 | Right | 28.33 | 11.5 |
| | Left | 27.98 | 11.75 |

It can be observed from Table 4.5 that mild hearing loss was recorded among the case group at 4000 Hz (25.88 dB HL) and 8000 Hz (28.33 dB HL) in the right ear, 4000 Hz (25.18 dB HL) and 8000 Hz (27.98 dB HL) in the left ear. The average hearing thresholds of both case and control groups indicated a significant difference ($p<0.001$) statistically.

## 4.5 TRANSIENT EVOKED OTOACOUSTIC EMISSION TEST RESULTS

**Table 4.6: TEOAE test results**

| TEOAE | Case group | | Control group | |
|---|---|---|---|---|
| | **Right Ear** | **Left Ear** | **Right Ear** | **Left Ear** |
| Pass | 14 (25%) | 15 (26%) | 60 (100%) | 60 (100%) |
| Refer | 43 (75%) | 42 (74%) | | |

From Table 4.6, all 60 participants in the control group passed the TEOAE test in both ears. These show that the outer hair cells of both cochleae functioned properly among the control group. However, among the case group, 14 (25%) participants passed and 43 (75%) referred in the right ear, and 15 (26%) passed with 42 (74%) participants being referred in the left ear. This indicates that one participant in the case group had a unilateral hearing loss in the right ear.

## 4.6 PREVALENCE OF HEARING LOSS AMONG PARTICIPANTS WITH HEPATITIS B VIRUS INFECTION

Equation 4.1 was used to calculate the prevalence of hearing loss among participants with hepatitis B virus infection (case group) for each ear based on the overall hearing threshold.

$$\textbf{Prevalence (\%)} = \frac{A}{B} \times 100\% \qquad \textbf{(4.1)}$$

Where '*A*'= number of participants with hearing loss, and '*B*' is the number of participants in the case group.

$$\text{Prevalence of hearing loss for the right ear} = \frac{43}{57} \times 100\% = 75\%$$

$$\text{Prevalence of hearing loss for the left ear} = \frac{42}{57} \times 100\% = 74\%$$

From Equation 4.1, the prevalence of hearing loss among the case group is 75% (*n*=43) for the right ear and 74% (*n*=42) for the left ear.

# CHAPTER FIVE

# DISCUSSION

## 5.1 INTRODUCTION

Viral infections such as meningitis, measles, mumps, rubella, cytomegalovirus, herpes simplex, varicella-zoster, human immunodeficiency virus (HIV), and influenza viruses cause sensorineural hearing loss (Cohen, Durstenfeld, & Roehm, 2014). Some studies have associated the hepatitis B virus infection with sensorineural hearing loss (Huang *et al*., 2009; Nasab *et al*., 2012; Parizad *et al*., 2017; Chen *et al*., 2017). This research work compared the hearing thresholds of 57 HBV positive patients (case group) with that of 60 uninfected persons (control group) to ascertain the prevalence of hearing loss. Two hypotheses were tested.

## 5.2 HYPOTHESIS 1

$H_1$: There will be a significant hearing loss among persons with HBV infection.

Based on the PTA, the hearing threshold of persons with hepatitis B virus infection was higher (Right ear=22.19 dB HL; Left ear=21.92) compared to the hearing thresholds of the uninfected volunteers (Right ear=15.42 dB HL; Left ear=15.89 dB HL). Although, none of the persons with HBV infection (case group) had a disabling hearing loss (hearing loss >35 dB HL), the overall hearing thresholds showed a mild hearing loss (defined as hearing threshold >25 dB HL) recorded at 4000 Hz (25.88 dB HL) and 8000 Hz (28.33 dB HL) in the right ear, and at 4000 Hz (25.18 dB HL) and 8000 Hz (27.98 dB HL) in the left ear. Statistically, there was a significant difference ($p<0.001$) between the average hearing thresholds of the case group and the control group. With reference to the audiometric and TEOAE tests, 43 (75%) participants in the case group were diagnosed with mild sensorineural hearing loss. Out of this number 42 had bilateral hearing loss and 1 had unilateral hearing loss in the left ear. This indicates that persons infected with HBV are more likely to have hearing loss.

The findings of this study confirm the assertion made by Huang *et al*. (2009), Nasab *et al*. (2012), Parizad *et al*. (2017), and Chen *et al*. (2017), that hepatitis B positive persons are more prone to hearing loss. Nasab *et al*. (2012) recorded a significant hearing loss among HBV infected patients at frequencies of 250 Hz, 4000 Hz, and 8000 Hz, whilst this study recorded a significant hearing loss at frequencies 4000 Hz and 8000 Hz. Parizad *et al*. (2017) tested the hearing of 83 patients diagnosed with HBV infection for a period of one year and compared it to the hearing thresholds of 108 uninfected persons, and found a significant difference ($p$<0.05) between both groups at frequencies 250 Hz, 4000 Hz, and 8000 Hz. Comparing the hearing thresholds of 76 CHB virus infected patients (case group) and 54 people without the infection (control group), Bao (2017) detected a significant difference with $p$<0.01 at frequencies 250 Hz, 2000 Hz, and 4000 Hz. Chen *et al*. (2017) determined that out of 170, 942 persons diagnosed of hepatitis B or C virus infections, 647 (0.38%) developed a SSNHL.

In Africa, the HBV infection is seen as a major health problem with high prevalent rate in West Africa (8%) and between 5 to 7% in Southern Africa, Eastern, and Central Africa (WHO, 2012). Ghana is reporting high prevalence rate (12.3%) of the infection and most infected persons do not seek early treatment causing severe consequences (Ofori-Asenso & Agyeman, 2016). In this study, 57 (48%) of the participants including 31 (54%) and 26 (46%) were infected with the HBV. Compared to females, males are more infected with the disease, this assertion agrees with earlier studies (Chen *et al*., 2017). Participants between the ages of 26 and 35 years were most affected with the HBV infection. Ofori-Asenso & Agyeman (2016) reported that people between 16 and 39 are most infected with the HBV infection in Ghana.

## 5.3 HYPOTHESIS 2

$H_2$: Persons with HBV infection will have sensorineural hearing loss.

From the results of the study, 43 (75%) among the case group (hepatitis B positives) failed the TEOAE test in the right ear and 42 (74%) failed in the left ear. This indicates that the outer hair cells of the cochlea are affected resulting possibly in mild SNHL only at 4000 Hz and 8000 Hz. As described by Kemp (1978), the movement of the outer hair cell when sounds are introduced into the ear emits a soft sound called OAE. People with hearing loss greater than 25 to 30 dB will not produce these OAEs (ASHA, 2018). The outer hair cells help in speech recognition in a noisy environment (Hoben & Parker, 2016). Individuals with hearing loss at 4000 Hz and above may miss high frequency speech sounds such as /s/, /f/, and /th/. As a result, they may not hold a conversation at places with background noise and may have difficulties in understanding the voices of children and females. In addition, the tympanometry (middle ear analysis) results show that the middle ears of the participants functioned properly attributing the mild hearing loss demonstrated at 4000 Hz and 8000 Hz to damage in the inner ear resulting in sensorineural hearing loss.

Various studies have asserted that HBV infection with aggravated results in the bloodstream causes SNHL, possibly due to inflammation of the blood vessels limiting the needed amount of blood to keep the inner ears functioning properly (Huang *et al*., 2009; Nasab *et al*., 2012; Signia, 2016; Parizad *et al*., 2017; Chen *et al*., 2017). As the immune system tries to find and destroy the virus in the blood, the antibodies called immunoglobulin may get into the inner ear leading to a possible hearing loss (Hain, 2003).

Some viruses associated with SNHL include cytomegalovirus (CMV), rubella, lymphocytic choriomeningitis virus (LCMV), human immunodeficiency virus (HIV), measles, varicella zoster virus, and mumps (Cohen *et al*., 2014). These viruses may destroy the inner ear mechanism causing SNHL that can range from mild to profound. The hearing loss can be sudden or progressive, congenital or acquired, unilateral or bilateral. Typically, this type of hearing loss is permanent and may have an adverse effect on communication, academic achievements, productivity, and social life (ASHA, 2017; WHO, 2018).

# CHAPTER SIX

# CONCLUSIONS, RECOMMENDATIONS AND LIMITATIONS

## 6.1 INTRODUCTION

Conclusions deduced from this work, recommendations and limitations of this study are presented in this Chapter.

## 6.2 CONCLUSIONS

Based on the findings of this research work, the following conclusions were made:

- The prevalence of hearing loss among persons diagnosed with HBV infection is 75% for the right ear and 74% for the left ear.
- Persons with HBV infection are likely to acquire hearing loss.
- Sensorineural hearing loss was associated with individuals with HBV infection.
- The outer hair cells of the cochlea are affected since most of the persons with HBV infection failed the TEOAE test.

## 6.3 RECOMMENDATIONS

The following recommendations were made:

- Audiometric evaluation should be added to the routine tests conducted for people infected with HBV.
- Patients with bilaterally SSNHL without known causes should be tested for hepatitis B surface antigens.
- More diagnostic physiological tests such as OAEs and ABR should be conducted to find the effect on the auditory pathway.

- Further studies with larger numbers and better matching of the case and control groups should be conducted.
- More research should be conducted to ascertain the effect of the virus on the hair cells of the cochlea.

## 6.4 LIMITATIONS

Financial constraints, lack of instrument to conduct diagnostic ABR, and unwillingness to volunteer to participate in the study are some of the limitations of the research work.

# REFERENCES


American Speech-Language-Hearing Association (ASHA). (2015). Type, degree, and configuration of hearing loss. Retrieved February 5, 2018, from http://www.asha.org/public/hearing/degree-of-hearing-loss/

American Speech-Language-Hearing Association (ASHA). (2017). Types of hearing loss. Retrieved September 25, 2017, from http://www.asha.org/public/hearing/Types-of-Hearing-Loss

American Speech-Language-Hearing Association (ASHA). (2018). Otoacoustic emissions (OAEs). Retrieved July 24, 2018, from httpa://www.asha.org/public/hearing/Otoacoustic-Emissions/

Bao, S. P. (2017). Association between hepatitis B and hearing status. *European Review for Medical and Pharmacological Sciences*, *21*, 922–927.

British Society of Audiology. (2011). *Recommended procedure: Pure-tone air-conduction and bone-conduction threshold audiometry with and without masking*. Berkshire: British Society of Audiology. Pg. 5–11.

British Society of Audiology. (2013). *Recommended procedure: Tympanometry*. Berkshire: British Society of Audiology. Pg. 6–10.

British Society of Audiology. (2016). *Recommended procedure: Ear examination*. Berkshire: British Society of Audiology. Pg. 4–10.

Chen, H.-C., Chung, C.-H., Wang, C.-H., Lin, J., Chang, K., Lin, F.-H., … Chien, W.-C. (2017). Increased risk of sudden sensorineural hearing loss in patients with hepatitis virus infection. *Plos One*, *12*(4), 1–11.

Clark, J. G. (1981). Uses and abuses of hearing loss classification. *Asha*, *23*, 493–500.

Cohen, B. E., Durstenfeld, A., & Roehm, P. C. (2014). Viral causes of hearing loss: A review for hearing health professionals. *Trends in Hearing*, *18*, 1–17.

Dhillon, R. S., & East, C. A. (1999). *Ear, nose and throat and head and neck surgery* (2nd ed.). Edinburgh: Churchill Livingstone. Pg. 2.

Dienstag, J. L. (2008). Hepatitis B Virus Infection. *The New England Journal of Medicine*, *359*, 1486–500.

Duthey, B. (2013). *Background paper 6.21: Hearing loss*. Geneva: World Health Organization. Pg. 5–14.

Felten, D. L., O'Banion, K. M., & Maida, M. S. (2016). *Netter's Atlas of Neuroscience* (3rd ed.). New York: Elsevier. Pg. 463–477.

Gadagbui, G. Y. (2003). *Screening for hearing and speech impairment in children*. Winneba: Department of Special Education, University of Education, Winneba. Pg. 40–45.

Gelfand, S. A. (2016). *Essentials of audiology* (4th ed.). New York: Thieme. Pg. 30–65.

Ghana Statistical Service. (2013). *2010 population and housing census: National analytical report*. Retrieved from http://www.statsghana.gov.gh/docfiles/2010phc/National_Analytical_Report.pdf

Goh, E. K., Son, B. H., Kong, S. K., Chon, K. M., & Cho, K. S. (2008). Analysis of hepatitis B virus in the cerumen and otorrhea of chronic HBV-infected patients: Is there a hepatitis B virus infectivity? *Journal of Otology & Neurology*, *29*(7), 929–932.

Hain, T. C. (2003). Autoimmune inner ear disease. *American Hearing Research Foundation*, *8*, 115–117.

Hoben, R., & Parker, M. A. (2016). Outer hair cell damage: A completely different listening experience. *The Hearing Journal*, *69*(6), 10–12.

Hou, J., Liu, Z., & Gu, F. (2005). Epidemiology and prevention of hepatitis B virus infection. *International Journal of Medical Sciences*, *2*(1), 50–57.

Huang, C. C., Lin, W. B., Chang, P. H., Chan, K. C., & Lee, T. J. (2009). Sudden deafness as a presenting symptom of chronic hepatitis B with acute exacerbation. *Otolaryngol Head Neck Surg*, *141*(5), 659–660.

Jerger, J. F. (1970). Clinical experience with impedence audiometry. *Archives of Otolaryngology, 92*, 311–324.

Kalcioglu, M. T., Durmaz, R., Ozturan, O., Bayindir, Y., & Direkel, S. (2004). Does cerumen have a risk for transmission of hepatitis B. *Laryngoscope*, *114*(3), 577–580.

Kemp, D. T. (1978). Stimulated acoustic emissions from within the human auditory system. *The Journal of the Acoustical Society of America*, *64*(5), 1386.

Lass, N. J. (2013). *Review of speech and hearing sciences*. Missouri: Elsevier. Pg. 190–192.

Lavanchy, D. (2004). Hepatitis B virus epidemiology, disease burden, treatment, and current and emerging prevention and control measures. *Journal of Viral Hepatitis*, *11*(2), 97–107.

Lemoine, M., Eholie, S., & Lacorube, K. (2015). Reducing the negleted burden of viral hepatitis in Africa: Strategies for global approach. *Journal of Hepatology*, *62*(2), 469–476.

Lewallen, S., & Courtright, P. (1999). Epidemiology in practice: Case-control studies. *Journal of Community Eye Health*, *11*(28), 57–58.

Maroonroge, S., Emanuel, D. C., & Letowski, T. R. (2000). Basic anatomy of the hearing system. In C. E. Rash (Ed.), *Helmet-mounted displays: Sensation, perception and cognition issues* (pp. 279–306). Fort Rucker, Alabama: U. S. Army Aeromedical Research Laboratory.
Martin, F. N., & Clark, J. G. (2012). *Introduction to audiology* (11th ed.). Boston: Peason. Pg. 17–21.

Mast, E. E., Alter, M. J., & Margolis, H. S. (1999). Strategies to prevent and control hepatitis B and C virus infections: a global perspective. *Vaccine*, *17*(13–14), 1730–3.

Mulwafu, W., Kuper, H., & Ensink, R. J. H. (2016). Prevalence and causes of hearing impairment in Africa. *Tropical Medicine and International Health*, *21*(2): 158–65.

Nasab, M. S., Fathololoomi, M. R., & Alizamir, A. (2012). Association between hepatitis B and hearing status. *Oman Medical Journal*, *27*(5), 418–420.

Nyarko, E. A. (2013). *Prevalence of hearing impairment at the Korle-Bu Teaching Hospital*. University of Ghana. Retrieved from http://ugspace.ug.edu.gh

Offei, Y. N., Akotey, S. C., & Honu-Mensah, C. M. (2017). Audiology in Ghana: A situational analysis. *Audacity*, *10*, 36–38.

Offei, Y. N., Essel, J., Diedong, M. N., Acheampong, E. K., & Cobbinah, J. B. (2009). Otoscopic examination. In J. Essel (Ed.), *Handbook of clinical practice in Audiology* (pp. 39–43). Cape Coast: Yaci Publications.

Ofori-Asenso, R., & Agyeman, A. A. (2016). Hepatitis B in Ghana : a systematic review & meta-analysis of prevalence studies. *BioMed Central Infectious Diseases*, *16*, 130.

Olchowik, G., Tomaszewski, M., Olejarz, P., Warchol, J., Rozanska-Boczula, M., & Maciejewski, R. (2015). The human balance system and gender. *Acta of Bioengineering and Biomechanics*, *17*(1), 69–74.

Osei, E., Lokpo, S. Y., & Agboli, E. (2017). Sero-prevalence of hepatitis B infection among blood donors in a secondary care hospital, Ghana (2014): a retrospective analysis. *BioMed Central Research Notes*, *10*(1), 391.

Parizad, E. G., Khosravi, A., Parizad, E. G., Sadeghifard, N., & Ghafourian, S. (2012). Evaluation of Chronic Hepatitis B Infection in Patients with Seronegative HbsAg. *Iran Journal of Public Health*, *41*(2), 100–4.

Parizad, E. G., Matin, H. G., & Parizad, E. G. (2017). The Prevalence of Hearing Loss in Patients with Hepatitis B Infection Compared with Healthy Volunteers. *Iran Journal of Otohinolaryngology*, *29*(92), 127–132.

Pyrsopoulos, N. T., & Anand, B. S. (2017). Hepatitis B. Retrieved September 26, 2017, from http://emedicine.medscape.com/article/177632-overview#showall.

Rosen, S., & Howel, P. (2013). *Signals and systems for speech and hearing* (2nd ed.). Boston: Brill. Pg. 364.

Rubel, E. W., & Fritzsch, B. (2002). Auditory system development: Primary auditory neurons and their targets. *Annual Review Neuroscience*, *25*, 51–101.

Sandell, L. (2014). Neural crest cells in ear development. *Neural Crest Cells*, 167–187.

Signia. (2016). Hepatitis B patients need to know about hearing loss. Retrieved October 2, 2017, from https://www.signiausa.com/2016/07/26/hepatitis-b-patients-need-know-hearing-loss.

Stach, B. A. (2010). *Clinical Audiology: An introduction* (2nd ed.). New York: Delmar, Cengage Learning. Pg. 101–103.

Stöver, T., Yagi, M., & Raphael, Y. (2000). Transduction of the contralateral ear after adenovirus-mediated cochlear gene transfer. *Gene Therapy*, *7*(5), 377–383.

Veltri, R. W., Wilson, W. R., Sprinkle, P. M., Rodman, S. M., & Kavesh, D. A. (1981). The implication of viruses in idiopathic sudden hearing loss: Primary infection or reactivation of latent viruses? *Otolaryngol Head Neck Surgery*, *89*, 137–141.

Waugh, A., & Grant, A. (2006). *Ross and Wilson: Anatomy and physiology in health and illness* (10th ed.). Edinburgh: Elsevier. Pg. 190–194.

Wilson, W. R., Veltri, R. W., Laird, N., & Sprinkle, P. M. (1983). Viral and epidemiologic studies of idiopathic sudden hearing loss. *Otolaryngol Head Neck Surgery*, *91*, 653–658.

World Health Organization (WHO). (2006). *The primary ear and hearing care training resource*. Geneva: World Health Organization. Pg. 2–3.

World Health Organization (WHO). (2012). *Prevention and control of viral hepatitis infection: Framework for global action*. *World Health Organization*. Geneva: World Health Organization. Pg. 5–13.

World Health Organization (WHO). (2015). *Guidelines for the prevention, care and treatment of persons with chronic hepatitis B infection*. Geneva: World Health Organization. Pg. 10–12.

World Health Organization (WHO). (2017). Hepatitis B. Retrieved September 25, 2017, from http://who.int/mediacentre/factsheets/fs204/en/

World Health Organization (WHO). (2018). Deafness and hearing loss. Retrieved March 29, 2018, from www.who.int/mediacentre/factsheets/fs300/en

# APPENDIX A

## ETHICAL CLEARANCE

**UNIVERSITY OF GHANA**
SCHOOL OF BIOMEDICAL AND ALLIED HEALTH SCIENCES

**30th January, 2018.**

Mr. George Kweku Danful,
Dept. of Audiology, Speech and Language Therapy,
SBAHS,
Korle-Bu.

Dear Mr. Kweku Danful,

**ETHICS CLEARANCE**

Ethics Identification Number: SBAHS – ASLT./10598208/SA/2017-2018.

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

**TITLE OF RESEARCH PROPOSAL: PREVALENCE OF HEARING LOSS AMONG PERSONS WITH HEPATITIS B VIRUS INFECTION COMPARED WITH UNIFECTED VOLUNTEERS**

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

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

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

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

This reviewed report is valid till 31st. August, 2018.

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

Thank you.

Yours sincerely,

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

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

COLLEGE OF HEALTH SCIENCES

P. O. Box KB 143, Korle Bu, Accra, Ghana.
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# APPENDIX B


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


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

27th Feb, 2018

The Coordinator
Centre for Hearing and Speech Services
University of Education
Winneba

Dear Sir,

**INTRODUCTION OF MSc AUDIOLOGY RESEARCH STUDENT: MR. G.K. DANFUL**

The Department of Audiology, Speech and Language Therapy of the University of Ghana (UG) School of Biomedical and Allied Health Sciences (SBAHS) presents its complements to the University of Winneba Centre for Hearing and Speech Services.

**Mr. GEORGE KWEKU DANFUL** (10598208) is a final year MSc Audiology student of this Department. He is carrying out a research study under the supervision of Dr. Neal Boafo (Audiologist) and Prof. G. Asare (Chemical Pathologist) both of SBAHS. His topic is **"PREVALENCE OF HEARING LOSS AMONG PERSONS WITH HEPATITIS-B VIRUS INFECTION COMPARED WITH UNINFECTED VOLUNTEERS"**. The study will be conducted at the Winneba Trauma and Specialist Hospital during the period 12th March–30th April 30, 2018. For purposes of easy access to testing equipment and participants' convenience, the UEW Centre for Hearing and Speech Services has been identified as a collaborating clinical testing site for the research study.

The Department considers this as an excellent opportunity to collaborate with your Centre in scientific and clinical research for the common good of both institutions, and the country as a whole. In this regard, the Department is pleased to introduce Mr. G. K. Danful to you and humbly requests your kind permission to use your hearing testing equipment for his research studies during the said period. Your earnest and kind consideration would be greatly appreciated. Thank you Sir.

Yours sincerely,

**Dr. S. ANIM-SAMPONG**
**(Ag. Head of Department)**
cc: Dean, SBAHS


DEPARTMENT OF AUDIOLOGY
SPEECH & LANGUAGE THERAPY
SCHOOL OF BIOMEDICAL AND ALLIED
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UNIVERSITY OF EDUCATION, WINNEBA
FACULTY OF EDUCATIONAL STUDIES
**CENTRE FOR HEARING AND SPEECH SERVICES**
P. O. Box 25, Winneba, Ghana
chss@uew.edu.gh
+233 (020) 6864023


*Date: March 05, 2018*

*Our Ref.: CHSS/ UEW.1/ VOL.1/ 3*
*Your Ref:*

The Ag. Head of Department
SBAHS
Accra

Dear Sir,

**RE: INTRODUCTION OF MSc AUDIOLOGY RESEARCH STUDENT: MR. GEORGE K. DANFUL**

Your letter dated 27th February, 2018 on above subject matter is referred.

I write to inform you that **Mr. George K. Danful** has the permission to use our facilities for his research studies during the period specified.

We look forward to further co-operation with your Centre in the future.

Yours faithfully,

**Yaw Nyadu Offei (Ph.D)**
**(Coordinator, CHSS)**

# APPENDIX C

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

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

27th Feb, 2018

The Medical Director
Trauma and Specialist Hospital
Winneba

Dear Sir,

**INTRODUCTION OF MSc AUDIOLOGY RESEARCH STUDENT: MR. G.K. DANFUL**

The Department of Audiology, Speech and Language Therapy of the University of Ghana (UG) School of Biomedical and Allied Health Sciences (SBAHS) presents its complements to the Directorate of the Winneba Trauma and Specialist Hospital.

**Mr. GEORGE KWEKU DANFUL (10598208)** is a final year MSc Audiology student of this Department. He is carrying out a research study entitled "**PREVALENCE OF HEARING LOSS AMONG PERSONS WITH HEPATITIS-B VIRUS INFECTION COMPARED WITH UNINFECTED VOLUNTEERS**" under the supervision of Dr. Neal Boafo (Audiologist) and Prof. G. Asare (Chemical Pathologist) both of SBAHS. The Winneba Trauma and Specialist Hospital has been selected as a study site for his research during the period 12th March–30th April, 2018. The candidate's research proposal has been assessed by the Department's Ethical Review and Protocol Committee (DEPRC).

The Department considers this as an excellent opportunity to collaborate with the Winneba Trauma and Specialist Hospital in scientific and clinical research for the common good of your hospital, SBAHS, and the country as a whole. In this regard, the Department is pleased to introduce Mr. G. K. Danful to you and humbly requests your kind permission to grant him access to perform his research studies in your hospital. Your earnest and kind consideration would be greatly appreciated. Thank you Sir.

Yours sincerely,

**Dr. S. ANIM-SAMPONG**
**(Ag. Head of Department)**
cc: Dean, SBAHS

DEPARTMENT OF AUDIOLOGY
SPEECH & LANGUAGE THERAPY
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# APPENDIX D

**PARTICIPANT INFORMATION FORM**

**UNIVERSITY OF GHANA**
**DEPARTMENT OF AUDIOLOGY, SPEECH AND LANGUAGE THERAPY**
**SCHOOL OF BIOMEDICAL AND ALLIED HEALTH SCIENCES**
**COLLEGE OF HEALTH SCIENCES, KORLE BU**

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**Title of research**: Prevalence of hearing loss among persons with hepatitis B virus infection compared with uninfected volunteers.

**Principal Researcher**: George Kweku Danful
Department of Audiology, Speech and Language Therapy, University of Ghana
Professional: MSc Audiology
**Mob**ile: 0243117380 **Email**: georgeraldo2006@gmail.com/gkdanful001@st.ug.edu.gh

**General Information about Research**

Under the supervision of Dr. Neal Boafo and Prof. (Major Rtd.) George Awuku Asare, University of Ghana, School of Biomedical and Allied Health Sciences, I, George Kweku Danful, a post-graduate student of the Department of Audiology, Speech and Language Therapy, am conducting research on prevalence of hearing loss among persons with hepatitis B infection compared with uninfected volunteers. The purpose of the study is to test the hearing thresholds of persons diagnosed with hepatitis B virus infection and compare it to the hearing thresholds of uninfected persons.

**Possible Risks and Discomforts**

There are no risks for participation in this study since the testing equipment and procedure are noninvasive and do not give any side effect.

**Voluntary Participation and Right to Leave the Research**

Participation in this research study is voluntary. Participants have the right to withdraw at any time or refuse to participate entirely without any jeopardy**.**

**Contacts for Additional Information**

For any information, clarification or questions about the study, please contact the principal investigator, George Kweku Danful on 0243117380.

**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**

Participants get free hearing test, knowing their hearing status, and any possible presence of hearing problem.

**Alternatives to Participation**

In the event of any noticed problem, participant will be referred for further testing and the necessary management as needed.

**Your rights as a Participant**

This research has been reviewed and approved by the Ethics and Protocol Review Committee (EPRC) 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 EPRC Office between the hours of 8am-5pm through the landline +233-302-687974/5 or postal addresses: Box KB 143, Korle Bu-Accra.

# APPENDIX E

**VOLUNTEER AGREEMENT FORM**

**UNIVERSITY OF GHANA**
**DEPARTMENT OF AUDIOLOGY, SPEECH AND LANGUAGE THERAPY**
**SCHOOL OF BIOMEDICAL AND ALLIED HEALTH SCIENCES**
**COLLEGE OF HEALTH SCIENCES, KORLE-BU.**

The document describing the benefits, risks and procedures for the research: **“Prevalence of hearing loss among persons with hepatitis B virus infection compared with uninfected volunteers”** 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 of volunteer**

**If a volunteer 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**

# APPENDIX F

## DATA COLLECTION SHEET

**UNIVERSITY OF GHANA**
**DEPARTMENT OF AUDIOLOGY, SPEECH AND LANGUAGE THERAPY**
**SCHOOL OF BIOMEDICAL AND ALLIED HEALTH SCIENCES**
**COLLEGE OF HEALTH SCIENCES, KORLE-BU**

**PREVALENCE OF HEARING LOSS AMONG PERSONS WITH HEPATITIS B VIRUS INFECTION COMPARED WITH UNINFECTED VOLUNTEERS**

| Code: | Age: | Gender: | Date: |
|---|---|---|---|

**Pure tone audiometry results**

| | | 250Hz | 500Hz | 1000Hz | 2000Hz | 4000Hz | 8000Hz |
|---|---|---|---|---|---|---|---|
| AC: | Right | | | | | | |
| | Left | | | | | | |
| BC: | Right | | | | | | |
| | Left | | | | | | |

**Tympanometry**

| Normal Values | Right | Left |
|---|---|---|
| ECV (0.6 – 1.5 ml) | | |
| Peak Compliance (0.3 – 1.6 ml) | | |
| Peak Pressure (-150 - +100 daPa) | | |

**Otoacoustic emissions test**

| TEOAE | Pass | Refer |
|---|---|---|
| **Right** | | |
| **Left** | | |