HEARING LOSS AMONG SCHOOL-AGE CHILDREN IN OBAFEMI OWODE LOCAL GOVERNMENT AREA, OGUN STATE

BY

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A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF MASTERS OF PUBLIC HEALTH (MPH) DEGREE IN FIELD EPIDEMIOLOGY

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CERTIFICATION

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DEDICATION

I dedicate this work to the Almighty God and to my parents Elder & Mrs E. O. Udofia.

ACKNOWLEDGEMENT

I am grateful to God who has made my academic pursuit a success. With a grateful heart I say THANK YOU LORD. I want to use this medium to thank my parents Elder/Mrs. E. O. Udofia and siblings – Inyene, Edikan, Udeme and Enwongo who have been there for me, may the good Lord bless and increase them.

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I specially want to appreciate my friends who have helped me and made my stay in school worthwhile. They are Aderemi Adetunmbi, Akaninyene Udo, Elizabeth Umoh, Adenike Idowu, Genesis Okpako, Hogan Uduak, Gbolade Ogunsanya, Omone Ogbiti, Imaofon Essienudoh, Bimbo Akinyuwa, Omosefe Osaze, Helen Ngoodo and others too numerous to mention.

ABSTRACT

Hearing loss is a major public health issue affecting nearly 250 million people globally, and 75% of the sufferers live in developing countries. Despite the high prevalence and incidence rate of hearing loss, developing countries like Nigeria have carried out little audiological assessment of school age children. Early identification and appropriate intervention in children with hearing loss will limit further loss and improve speech and learning ability. This study was carried out to investigate the prevalence, types and factors associated with hearing loss among school age children in Obafemi Owode Local Government Area in Ogun State.

A cross sectional survey was done and 305 pupils were selected through a multistage cluster sampling technique. Two research instruments – questionnaire and a diagnostic audiometer was used to obtain data on socio-demographic characteristics, hearing loss prevalence and predisposing factors. The collected data was analyzed using the SPSS software. Association between categorical variables and hearing loss was analyzed using the chi-square test and logistic regression model. The level of significance was set at 5%.

The age of respondents was 10.95 ± 1.98. The proportion of school children with hearing loss in the right and left ears was 27.5% and 31.8% respectively. Among these subjects with hearing loss, 46.4% were males and 53.6% were females. Mild and moderate hearing losses were found among the children. The commonest type of hearing loss was low frequency hearing loss with a prevalence of 64.9% and 71.1% on their right and left ears respectively. Variables which remained significant in association with hearing loss on multiple logistic regression analysis include being less than 10 years old (OR= 0.40, 95% CI= 0.23-0.68),

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history of ear discharge in the right ear (OR= 2.80, 95% CI= 1.23-6.38) and left ear (OR= 2.72, 95%= 1.33-5.56), history of ear injury (OR= 2.28, 95% CI= 1.09-4.74), history of head trauma in the right ear (OR= 4.54, 95% CI= 1.97-10.44) and left ear (OR= 3.62, 95% CI= 1.79-7.32), measles (OR= 11.26, 95% CI= 4.79-26.49), meningitis (OR= 26.52, 95% CI= 10.52-66.86), noise exposure in the right ear (OR= 8.32, 95% CI= 3.99-17.38) and left ear (OR= 2.74, 95% CI= 1.45-5.17).

The prevalence of hearing loss among school children is high with ear infection, trauma, infectious diseases and noise being the major risk factors. Health education on these preventable causes of hearing loss should be periodically given to the general public to reduce the disease burden.

Word Count: 400

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LIST OF ABBREVIATIONS

HL- Hearing loss

PTA- Pure Tone Audiometry

COM- Chronic Otitis Media

WHO- World Health Organization

CHAPTER 1

INTRODUCTION

1.1 Background:

Hearing impairment is a partial or total inability to hear (Encyclopedia Britannica Inc., 2011). It exists when there is diminished sensitivity to the sounds normally heard (Elzouki et al, 2012). Students with hearing loss are the largest single population of children requiring special services in schools and majority of these children are being mainstreamed into regular classrooms (Better Hearing Institute, 1999). Evidence indicates that high incidence and prevalence of hearing loss elicits concern all over the world. It is the commonest birth defect. Hearing impairments are categorized by their type, their severity, and the age of onset (before or after language is acquired). Furthermore, a hearing impairment may exist in only one ear (unilateral) or in both ears (bilateral). There are 3 main types of hearing impairment namely: conductive hearing impairment, sensorineural hearing impairment, and a combination of the two called mixed hearing loss (Elzouki et al, 2012).

Hearing impairment has a significant impact on both the individual and the society. In children, it can significantly delay speech and language development, and lead to communication, emotional and educational problems (Bess et al, 1998); and cause work related difficulties for adults (Lasak et al, 2014). It is caused by many factors that are either congenital or acquired - genetics, aging, exposure to noise, illness, chemicals and physical trauma. The causes of unidentified hearing impairment in children include minimal sensorineural (damage to the cochlea or the hearing nerve) and fluctuating conductive hearing loss problems (blockage or damage in the outer ear, middle ear or both), with the most

frequently found in school-age children being cerumen impaction (ear wax buildup or blockage), otitis media effusion (thick or sticky fluid in the middle ear, but no infection), noise-induced hearing loss, unilateral hearing loss, and late-onset sensorineural hearing loss (Flanary et al, 1999). Thus, hearing testing may be used to determine the severity of the hearing loss which is usually described as mild, moderate, severe and profound, and the results are expressed in decibels (dB).

In 2001, the WHO estimated that 250 million people worldwide had hearing impairment of which two thirds were in developing countries (WHO, 2002). It is reported that over 12,000 babies in the US leave hospital each year with undetected hearing loss, and that 500,000 young children develop profound hearing loss before learning a spoken language (Hear This Organisation, 2002).

In developing countries like Nigeria, the general awareness of hearing impairment is low, lack of resources has resulted in very few screening programmes and the incidence of hearing impairment among the people is high (The Hearing Profile of Nigerian School Children, 2000). Mba (1995) opines that hearing impairment ranks among the leading causes of chronic disability in Nigeria.

Hearing assessment is a part of an ear examination that evaluates a person's ability to hear by measuring the ability of sound to reach the brain, that is, it provides an evaluation of the sensitivity of a person's sense of hearing and is most often performed by an audiologist using an audiometer. A range of different techniques are used to detect hearing problems. Some hearing tests are only used for children, they include: automated otoacoustic emissions (AOAE) tests, automated auditory brainstem response (AABR), and play audiometry tests.

However some tests such as pure tone audiometry, speech perception and tympanometry can be used to test adults as well as children. The simplest way to test hearing is called pure tone audiometry; it is considered the gold standard for hearing screening programs involving school-age children (Krueger and Ferguson, 2002). This involves listening to a range of beeps and whistles called pure tones, and indicating when you can hear them. The softest sounds you can hear are marked on the audiogram. Pure tone audiometry (PTA) tests the hearing of both ears. Other hearing test types include: bone conduction test, tuning fork test and whispered voice test.

Hearing screening especially at an early age provides the opportunity to detect a child's hearing loss or previously unrecognized hearing loss and intervene to limit further loss and improve learning (AAP, 2004). According to the American Academy of Pediatrics (2007), hearing screening should be conducted for children several times throughout their schooling. School age hearing screenings are an integral tool in identifying children with hearing loss who were not identified at birth, lost to follow-up, or who developed hearing loss later. This is beneficial because early detection and management improve outcomes in terms of speech, language and education (Pimperton and Kennedy, 2012).

1.2 Problem statement

Hearing loss is a pervasive disability affecting nearly 250 million people around the globe, and 75% of the sufferers live in developing countries. It is estimated that 30 school children per 1,000 have a hearing loss. The Hearing Profile of Nigerian School Children (2000) observes that as many as 13.9% of the school pupils suffer from hearing loss in Lagos. Yet, in just 2% of the cases did parents or teachers observe signs of hearing loss. Northern and

Downs (2001) report that between 10% and 15% of children who receive hearing screenings at public school fail the test.

Hearing loss is a major public health issue that is the third most common physical condition after arthritis and heart disease (HLAA, 2013). Hearing loss in children can be a silent handicap; it is such a gradual, slow, invisible and painless health condition that most people do not realize it occurring. Those affected by this impairment do not look any different from those with normal hearing. Despite the high prevalence and incidence rate of hearing loss, developing countries like Nigeria have carried out little audiological assessment of school age children which could be as a result of lack of awareness of hearing screening, poverty, shortage of audiologist, insufficient trained personnel and unavailable audiological equipment such as audiometer.

The general awareness of hearing impairment is low; people are not well informed about the problems associated with hearing loss and need to carryout audiological assessment- this poses a serious problem. Thus, hearing assessment (audiometry) is important in the evaluation of a person's ability to hear in order to detect those with or at risk of developing hearing loss.

1.3 Justification

A study on the prevalence and pattern of hearing loss in children in a house-held National survey in Egypt clarified that audiological evaluation is crucial for the diagnosis of hearing loss in school children which will improve markedly with the early management of the hearing loss. Also, an investigation of hearing loss among school age children through audiological assessment to determine children with or having potential of hearing loss is justified considering the impact of hearing loss on speech, language acquisition, cognitive

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achievement and social/ emotional development. This is because reduced hearing during these periods interferes with the development of speech and language skills, and thus, a child will not receive adequate auditory, linguistic and social stimulation required for speech and language learning, social and emotional development and the family functioning will inevitably suffer (NIH, 1993).

The lack of access to quality health facilities and services is a key barrier to improving the health and wellbeing of rural communities. School health program provides a cost-effective measure to identify individuals with possible hearing deficits at the earliest possible stage. Hence, this study intends to investigate hearing loss of school age children in Obafemi Owode LGA using audiological assessment procedures.

1.4 Research questions

1. What is the prevalence of hearing loss among school age children in primary schools?
2. What are the common types of hearing loss among school age children?
3. What are the factors influencing hearing loss among school age children?

1.5 Objectives of the study

1.5.1 Broad objective:

To investigate hearing loss among school-age children in Obafemi Owode Local Government Area, Ogun State.

1.5.2 Specific objectives:

1. To determine the prevalence of hearing impairment among school-age children

2. To describe the types of hearing loss among school-age children.

3. To assess the factors influencing hearing loss in school-age children.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview of Hearing Loss

Literature has shown that hearing loss in children influences the development of communication and behavioral skills that affect educational experience and relationships with other people, but few studies have used pure-tone audiometry to derive hearing loss prevalence estimates for children (Niskar et al, 2001). Literature has also shown that impacted cerumen, a foreign body, edema of the auditory canal, and otitis media are just a few of many possible causes of conductive hearing loss among children while noise, medications, meningitis and congenital syphilis are among the many possible causes of sensorineural hearing loss among children(Behrman et al, 1992; Gulya, 1995). Studies have found that unilateral hearing loss (hearing loss in one ear) is more prevalent among children than bilateral hearing loss (hearing loss in both ears) (Brookhouser et al, 1992); and that obesity in childhood is associated with higher hearing thresholds at all frequencies and an almost 2-fold increase in the odds of unilateral low frequency hearing loss (Anil et al, 2013). It has been shown that early identification of hearing loss, particularly when it may be due to factors such as noise exposure, education and counseling may help prevent educational difficulties and further potentially handicapping hearing loss from developing, and may help maintain residual hearing (Anderson, 1992; Behrman et al, 1992).

2.2 Anatomy of the ear

The ear is made up of 3 parts namely- external ear, middle ear and the inner ear.

1. External (outer) ear: It consists of the pinna or auricle which is the outside part of the ear; external auditory canal or tube that connects the outer ear to the inside or middle ear; and the tympanic membrane (eardrum) which divides the external ear from the middle ear.
2. Middle ear (tympanic cavity): It consists of ossicles- three small bones that are connected and transmit the sound waves to the inner ear. The bones are called malleus, incus and stapes; and the Eustachian tube- a canal that links the middle ear with the throat area. It helps to equalize the pressure between the outer ear and the middle ear. Having the same pressure allows for the proper transfer of sound waves. The Eustachian tube is lined with mucous.
3. Inner ear: It consists of cochlea which contains the nerves for hearing; vestibule which contains receptors for balance; and the semicircular canals which contains receptors for balance (Ramalingam et al, 2007).

2.3 Physiology of the ear

The main functions of the ear are for:

1. Hearing: The auditory functions of the ear consist of conduction of sound waves through the external ear, middle ear and cranial bones with perception of these sounds by cochlear nerve to the brain.
2. Equilibrium function (balancing): The equilibrium of the body is maintained by co-ordination of three systems- vestibular apparatus, proprioceptors and vision (eye). Loss of functions of two leads to severe problems with posture and balance (Ramalingam et al, 2007).

2.4 Definition of terms

• **Hearing impairment or loss-** This is a general term used to describe any deviation from normal hearing, whether permanent or fluctuating, and ranging from mild hearing loss to

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• **Hearing impairment or loss-** This is a general term used to describe any deviation from normal hearing, whether permanent or fluctuating, and ranging from mild hearing loss to

profound deafness. WHO classifies hearing impairment based on the pure tone average of the better hearing ear ranging from "no impairment" to "profound impairment" according to the threshold level. The hearing threshold using audiometry is to be taken as the better ear average for four frequencies 0.5, 1, 2 and 4 KHz (WHO, 1991).

i. No impairment: Sounds can be heard with the better ear at 25dB or less. There is no or very slight hearing problems. Able to hear whispers.

ii. Mild hearing loss: On average, the quietest sounds that people can hear with their better ear are between 25 and 40dB. People who suffer from mild hearing loss have some difficulties keeping up with conversations, especially in noisy surroundings.

iii. Moderate hearing loss: On average, the quietest sounds heard by people with their better ear are between 40 and 70dB. People who suffer from moderate hearing loss have difficulty keeping up with conversations when not using a hearing aid.

iv. Severe hearing loss: On average, the quietest sounds heard by people with their better ear are between 70 and 95dB. People who suffer from severe hearing loss will benefit from powerful hearing aids, but often they rely heavily on lip-reading even when they are using hearing aids. Some also use sign language.

v. Profound hearing loss: On average, the quietest sounds heard by people with their better ear are from 95dB or more. People who suffer from profound hearing loss are very hard of hearing and rely mostly on lip-reading, and/or sign language (Martini, 1996).

Hearing impairment is a broad term that refers to hearing losses of varying degrees, ranging from hard-of-hearing to total deafness (Shemesh, 2010).

• **Hard of hearing-** This refers to people with hearing loss ranging from mild to severe. They usually communicate through spoken language and can benefit from hearing aids, captioning and assistive listening devices (WHO, 2014). It could also be defined as having some hearing, the ability to use it for communication purposes, and ability to comfortably communicate with this level of hearing (Ann, 2014).

• **Deafness-** This implies very little or no hearing. Deaf people mostly have profound hearing loss. They often use sign language for communication (WHO, 2014). Also, it is a degree of impairment such that a person is unable to understand speech even in the presence of amplification (Elzouki et al, 2012).

Pre-lingual deafness: This is hearing impairment that is sustained before the acquisition of language, which can occur due to a congenital condition or through hearing loss in early infancy. Pre-lingual deafness impairs an individual's ability to acquire a spoken language. Most pre-lingual hearing impairment is acquired via either disease or trauma rather than genetically inherited. Cochlear implants allow prelingually deaf children to acquire an oral language with remarkable success if implantation is performed within the first 2-4 years (Kral and O'Donoghue, 2010).

Post-lingual deafness: This is hearing impairment that is sustained after the acquisition of language, which can occur due to disease, trauma, or a side effect of a medicine. Typically, hearing loss is gradual and often detected by family and friends of affected individuals long before the patients themselves will acknowledge the disability. Common treatments include hearing aids, cochlear implants and learning lip reading. Post-lingual deafness is far more common than pre-lingual deafness.

Residual hearing- This refers to the hearing that remains after a person has experienced a hearing loss. It is suggested that greater the hearing loss, the lesser the residual hearing.

2.5 Types of hearing impairments

There are three main types of hearing impairments namely:

1. Conductive hearing loss: This is caused by problems in the outer or middle ear which prevent the sound from being 'conducted' to the inner ear and hearing nerves. Conductive hearing loss is usually mild or moderate in degree, ranging from 25 to 65 decibels. The hearing may fluctuate and may affect one or both ears to varying degrees. Thus, conductive hearing loss occurs when the sound is not reaching the inner ear, the cochlea. The common causes in the external ear include: cerumen (ear wax), otitis externa (ear infection) while the uncommon causes are foreign body in the external auditory canal, exotosis (abnormal bone growth within the ear canal), tumour of the ear canal and congenital or choanal atresia (Health Central, 2013). Common causes in the middle ear are fluid accumulation (especially in children) (Ruben, 2007), ear infections (otitis media) or conditions that block the Eustachian tube, such as allergies or tumors- major cause (Ruben, 2007). Blocking of the Eustachian tube leads to increased pressure in the middle ear relative to the external ear, and this causes decreased motion of both the ossicles (malleus, incus and stapes) and the tympanic membrane (Rex, 2004). Conductive problems generally affect the quantity (loudness only) of the sound that is heard. A common cause of conductive loss in children is middle ear infections (AH, 2010). Conductive hearing loss is usually medically or surgically treatable.

A US study has shown that children with conductive hearing loss may have difficulty hearing low frequencies such as human speech; this shows that majority of conductive hearing loss affects low frequencies (Gulya, 1995).

2. Sensorineural hearing loss: This is a type of hearing loss in which the root cause lies in the vestibulocochlear nerve (cranial nerve VIII), the inner ear, or the central processing centers of the brain. It is due to a problem in the cochlea (the sensory part of the ear) or the hearing nerve (the neural part). It can be acquired or be present at birth (congenital). There is usually loss of clarity as well as loudness, that is, the quality and the quantity of the sound is affected (AH, 2010). Sensorineural hearing loss can be mild, moderate or severe, including total deafness. The majority of sensorineural hearing loss affects the high frequencies (Gulya, 1995).

The great majority of human sensorineural hearing loss is caused by abnormalities in the hair cells of the organ of Corti in the cochlea. There are also very unusual sensorineural hearing impairments that involve the eighth cranial nerve (the vestibulocochlear nerve) or the auditory portions of the brain. In the rarest of these sorts of hearing loss, only the auditory centers of the brain are affected. In this situation, cortical deafness, sounds may be heard at normal thresholds, but the quality of the sound perceived is so poor that speech cannot be understood.

Most sensory hearing loss is due to poor hair cell function. The hair cells may be abnormal at birth, or damaged during the lifetime of an individual. There are both external causes of damage, like noise trauma and infection, and intrinsic abnormalities, like deafness genes. Sensory hearing loss that results from abnormalities of the central auditory system in the brain is called central hearing impairment. Since the auditory pathways cross back and forth on both

sides of the brain, deafness from a central cause is unusual. This type of hearing loss can also be caused by prolonged exposure to very loud noise, for example, being in a loud workplace without hearing protection, or having headphones set to high volumes for a long period (Health Central, 2013). In some cases, the cause is unknown. Sensorineural hearing loss in young children can occur with certain infections before birth, from lack of oxygen during birth, or from genetic causes.

In 2006, approximately 60% of children with a hearing loss of 40 decibels or more unaided in the better ear had a sensorineural loss (CDC, 2014). A US study reported that children with sensorineural hearing loss may have difficulty hearing high frequencies such as doorbells, telephones, or a high-pitched voice (Gulya, 1995). A study on the "prevalence, educational performance, and functional status of children with minimal sensorineural hearing loss" found that hearing loss almost doubles when children with minimal sensorineural hearing loss (MSHL) are included. This large, education-based study shows clinically important associations between MSHL and school behavior and performance. Children with MSHL experienced more difficulty than normally hearing children on a series of educational and functional test measures (Bess et al, 1998).

3. Mixed hearing loss: This is a combination of conductive and sensorineural hearing loss, which means there is damage in both the outer or middle ear and in the inner ear. This type of hearing loss ranges in severity from mild to profound. For people with mixed hearing loss, sounds can be both softer in volume and more difficult to understand.

Mixed hearing loss is caused by a combination of conductive damage in the outer or middle ear and sensorineural damage in the inner ear (cochlea) or hearing/auditory nerve. Birth

defects, diseases, infections, tumors or masses and head injuries are all possible causes of both conductive and sensorineural hearing loss. If the hearing loss is mostly conductive, speech tends to sound understandable, but only if it's loud enough and there isn't too much background noise but if the hearing loss is mostly sensorineural, there may be difficulty understanding speech, even when it seems loud enough. Children with sensorineural hearing loss also can have middle ear problems (such as fluid in the middle ear). This can make hearing loss worse.

Depending on the degree and make-up of mixed hearing loss, it may be treated with medications, surgery, hearing aids or an implantable bone conduction hearing system. A BahaR bone conduction implant is an effective treatment for mixed hearing loss because it totally bypasses the conductive element of the hearing loss and needs only to address the sensorineural element. Studies also suggest that Baha improves speech understanding in mixed hearing loss (Snik et al, 2005 and de Wolf et al, 2011).

2.6 Causes of hearing impairments

On the average, only half of all children diagnosed with a hearing loss actually have a known risk factor for hearing loss. This means that the cause is never known in about half of children with hearing loss. According to the World Health Organization, the causes of hearing loss can be divided into congenital causes and acquired causes.

- Congenital causes: This leads to hearing loss being present at or acquired soon after birth. Hearing loss can be caused by hereditary and non-hereditary genetic factors or by certain complications during pregnancy and childbirth, including:

  - Maternal rubella, syphilis or certain other infections during pregnancy.

- Low birth weight;
- Birth asphyxia (a lack of oxygen at the time of birth);
- Inappropriate use of ototoxic drugs (such as aminoglycosides, cytotoxic drugs, antimalarial drugs and diuretics) during pregnancy; and
- Severe jaundice in the neonatal period, which can damage the hearing nerve in a newborn infant (WHO, 2014).

➢ Acquired causes: This can lead to hearing loss at any age (WHO, 2014).

The following are some of the major causes of hearing loss

1. Aging – This is the most common cause of hearing loss. 1 out of 3 people aged 65-74 has some level of hearing loss. After age 75, that ratio goes up to 1 out of every 2 people. There is a progressive loss of ability to hear high frequencies with increasing age known as presbycusis. This begins in early adulthood, but does not usually interfere with ability to understand conversation until much later. Although genetically variable it is a normal concomitant of aging and is distinct from hearing losses caused by noise exposure, toxins or disease agents (Robinson and Sutton, 1979).

Hearing loss is estimated to affect 30% to 35% of adults aged 65-75 years in the United States, yet little is known about the etiology of this disorder (NSRP, 1996). Whereas hearing loss may be an inevitable consequence of aging, representing the cumulative damage from products of normal cellular metabolic processes, some studies of rural African tribes have failed to find a decline in hearing sensitivity with age (Rosen et al, 1962; Jarvis and van Heerden, 1967). This may suggest that genetic, environmental, and lifestyle factors play a role

in the development of presbycusis, age-related hearing loss. An association between cigarette smoking and hearing loss among adults has been found in some clinical studies (Siegelaub et al, 1974). It has been found that men who smoked more than 1 pack per day had worse hearing thresholds at 250 to 1000Hz than nonsmokers or light smokers, but there was no difference at higher frequencies (Weiss, 1970). This suggests that modification of smoking habits may prevent or delay age-related declines in hearing sensitivity. The Baltimore Longitudinal Study of Aging found no association between cigarette smoking and the development of a hearing loss in 531 white, upper-middle-class men but that hearing loss is linked to accelerated brain tissue loss (Brant et al, 1996; Susan, 2014). Also, in the Framingham Study which tested hearing with audiometry, there was no association between cigarette smoking and hearing loss (Gates et al, 1993).

2. Noise – It is a cause of approximately half of all cases of hearing loss, causing some degree of problems in 5% of the population globally (Oishi and Schacht, 2011). Noise is a major avoidable cause of hearing loss and is a cause for concern for both, developed and developing countries. In many countries, excessive noise has become the most compensated occupational hazard. The risk of social noise, such as, music and entertainment devices, is increasing globally among young persons (WHO, 2014). Noise-induced hearing loss (NIHL) is hearing decrease caused by loud sound. Evidences of NIHL include a history of exposure to loud sound and a hearing loss in a narrow range of frequencies, such as those from gun fire, power tools, explosions and night club music. The best, first option for protecting hearing is lowering the volume at the source of the sound (Mestayer, 2014).

Many people are unaware of the presence of environmental sound at damaging levels, or of the level at which sound becomes harmful. In USA, 12.5% of children aged 6-19 years have

permanent hearing damage from excessive noise exposure (CDC, 2009). A report from a large-scale American national health survey indicated that 12% to 15% of school-aged children have some hearing deficits attributable to noise exposure (Niskar et al, 2001). Also, a French audiometric survey of 1364 young subjects found evidence of hearing problems in 12% of the general population, and in a subgroup that often attended rock concerts or used 'personal cassette players' (more than 7 hours per week), 66% had hearing loss (Meyer-Bisch, 1996).

Worldwide, noise-induced hearing impairment is the most prevalent irreversible occupational hazard. In the developing countries, not only occupational noise, but also environmental noise is an increasing risk factor for hearing impairment. In 1995, at the World Health Assembly, it was estimated that there are 120 million persons with disabling hearing difficulties worldwide (Smith, 1998). It has been shown that men and women are equally at risk of noise-induced hearing impairment (Berglund and Lindvall, 1995). Studies suggest that children seem to be more vulnerable than adults to noise-induced hearing impairment (Berglund and Lindvall, 1995); and that high-frequency hearing loss from noise exposure during childhood can lead to further hearing loss from acute or chronic noise exposure at older ages (Brookhouser, 1994).

The National Institute on Deafness and Other Communication Disorders reports approximately 28 million Americans have lost some or all of their hearing, including 17 in 1000 children under age 18. Noise exposure is increasingly common in the age of iPods and other personal music players. Overexposure to noise can cause both temporary and permanent hearing loss. Although 10 million Americans suffer irreversible noise-induced hearing loss, with 30 million more exposed to dangerous noise levels each day, very little has been reported on the risk of such hearing loss in children. An estimated 12.5% of children and adolescents

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aged 6-19 years (approximately 5.2 million) and 17% of adults aged 20-69 years (approximately 26 million) have suffered permanent damage to their hearing from excessive exposure to noise (Niskar et al, 2001; NIDCD, 2008).

Children and adolescents are considered high risk group to the effect of noise (Bistrup et al, 2001). Noise has particular harmful effects on children as noise in the classroom or at home interferes with communication and therefore learning processes (Evans et al, 2001). Reading and memory have been shown to be impaired in school children who were exposed to high levels of aircraft and traffic noise (Meiss et al, 2000; Hygge et al, 2002). Some studies have shown higher stress hormone levels and higher mean blood pressure readings in children exposed to high levels of community noise (Babisch, 2000; Passchier-Varmeer, 2000).

Research has also documented that children in a noisy environment have problems filtering out background noise and interpreting speech. A study for the European Commission (known as RANCH) investigated road traffic and aircraft noise exposure and children's cognition and health. It was found that children exposed to noise levels over 55dB (A) achieved lower scores in reading tests (Stansfeld et al, 2005). Affected children will be disadvantaged in their development of speech and reading abilities as well as more general communication skills (Karchmer and Allen, 1999).

Majority of noise studies conducted in Nigeria tend to focus more on noise effects in occupational settings with little attention paid to schools (Olusanya et al, 2000). A Nigerian study carried out in Ibadan showed that school children are suffering from the health effects of noise including hearing impairment which is as a result of the hazardous noise they are exposed to daily in their schooling environments. This affects their overall academic

performances thus preventing them from maximizing their individual potentials (Geneva, 2009).

3. Genetic – Genetic factors are thought to cause more than 50% of all incidents of congenital hearing loss in children (Canalis and Lambert, 2000). Hearing loss can be inherited. Around 75-80% of all cases are inherited by recessive genes, 20-25% is inherited by dominant genes, 1-2% is inherited by X-linked patterns, and less than 1% is inherited by mitochondrial inheritance (Rehm, 2003).

There are 2 different forms of genetics of deafness: syndromic and nonsyndromic. Syndromic deafness occurs when there are other medical problems aside from deafness in an individual. This accounts for around 30% of deaf individuals who are deaf from a genetic standpoint. Nonsyndromic deafness occurs when there are no other problems associated with an individual other than deafness. From a genetic standpoint, these accounts for the other 70% of cases, which attributes to the vast majority of hereditary hearing loss (Rehm, 2003).

An estimated 30,000 infants are born with sensorineural hearing loss each year in China, which has a population of about 1.3 billion, but the percentage of these hearing losses attributable to hereditary is not known (Ouyang et al, 2009). Saunders et al demonstrated a prevalence of significant hearing loss of 18% in a group of school-aged children in rural Nicaragua with a familial history of hearing loss in 24% of the children with hearing loss (Saunders et al, 2007).

4. Illness – Many conditions can cause hearing problems in young children, including the following illnesses:

- Otosclerosis is a disease of the middle ear which affects the movement of tiny bones in the middle ear. It can cause a conductive type of hearing loss. This condition is often surgically treatable (ASHA, 2014).

- Meniere's disease is an inner ear disorder that affects balance and hearing. The cause is unknown. Meniere's disease rarely occurs in children. In most cases, it begins in both men and women between the ages of 30 and 50. A person with Meniere's disease will often have a combination of sensorineural hearing loss, dizziness (vertigo), ringing in the ear (tinnitus), and sensitivity to loud sounds. Some people with Meniere's disease report mild symptoms but for others the symptoms are much worse. The hearing loss comes and goes, but overtime some loss becomes permanent (ASHA, 2014).

- Autoimmune inner ear disease: This sudden-onset hearing loss is fast, dramatic, and should be medically treated as soon as possible. With swift medical treatment, the hearing loss from this disease can be reduced (ASHA, 2014). Autoimmune disease has only recently been recognized as a potential cause for cochlear damage. Although probably rare, it is possible for autoimmune processes to target the cochlea specifically, without symptoms affecting other organs. Wegener's granulomatosis is one of the autoimmune conditions that may precipitate hearing loss. It requires long-term immunosuppression (Seo and Stone, 2004). It has been estimated that autoimmune diseases are among the ten leading causes of death among women in all age groups up to 65 years (Noel and Ian, 2013). A substantial minority of the population suffers from these diseases, which are often chronic, debilitating, and life threatening. There are more than eighty illnesses caused by autoimmunity e.g. Grave's disease, type 1 diabetes, Addison's disease, reactive arthritis etc (Kono et al, 2012).

- Infectious diseases such as meningitis, measles, chicken pox and mumps can lead to hearing loss, mostly in childhood, but also later in life (WHO, 2014).

- Chronic ear infections are the most common cause of hearing loss in Nigerian children, according to two recent studies from Africa's most populous country. Infection of the middle ear was found to be the most prevalent ear affliction among Nigerian children in a study published in 2007. One child in three at an otology clinic in the town of Ife was diagnosed with infection of the middle ear, and among those, one in four suffered from hearing loss. Also, a hearing clinic in Abuja reported that middle ear infections were the cause of one case in four of hearing loss in child-patients, according to a study published in 2008. An example of such a condition is otitis media

Otitis media is an inflammation in the middle ear (the area behind the ear drum) that is usually associated with the build up of fluid. The fluid may or may not be infected. Symptoms, severity, frequency and length of the condition vary. At one extreme is a single short period of thin, clear, non infected fluid without any pain or fever but with a slight decrease in hearing ability. At the other extreme are repeated bouts with infection, thick "glue-like" fluid and possible complications such as permanent hearing loss. Fluctuating conductive hearing loss nearly always occurs with all types of otitis media. Among children, chronic otitis media is the leading cause of hearing loss (WHO, 2014).

Otitis media is the most frequently diagnosed disease in infants and young children (Dhooge, 2003). 75% of children experience at least one episode of otitis media by their third birthday. Almost one-half of these children will have 3 or more ear infections during their first 3 years of life (NIDCC, 2002). The global prevalence of chronic otitis media (COM) ranges from 1 to

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46% in developed and developing countries. COM leads to hearing loss and can cause life threatening complications and mortality. COM is largely preventable (WHO, 2014).

Otitis media is more common in children because the Eustachian tube, a passage between the middle ear and the back of the throat, is smaller and more nearly horizontal in children than in adults. Therefore, it can be more easily blocked by conditions such as large adenoids and infections. Until the Eustachian tube changes in size and angle as the child grows, children are more susceptible to otitis media. Three tiny bones in the middle ear carry sound vibrations from the ear drum to the inner ear. When fluid is present, the vibrations are not transmitted efficiently and sound energy is lost. The result may be mild or even moderate hearing loss. Therefore, speech sounds are muffled or inaudible. Generally, this type of hearing loss is conductive and is temporary. However when otitis media occurs over and over again, damage to the eardrum, the bones of the ear, or even the hearing nerve can occur and cause a permanent, sensorineural hearing loss. Signs and symptoms of otitis media include: inattentiveness, wanting the TV or radio louder than usual, misunderstanding directions, unexplained irritability, pulling or scratching at the ears.

High rates of chronic otitis media have been attributed to overcrowding, inadequate housing, and poor hygiene (these factors through transmission of the pathogens by physical contact with a contaminated individual, inhalation of infected droplets, or contact with an infected surface), lack of breastfeeding, poor nutrition, passive smoking, anecdotally to wood-burning smoke, high rates of naso-pharyngeal colonization with potentially pathogenic bacteria, and inadequate or unavailable health care. Poverty is a major risk factor in developing countries and certain neglected populations (WHO, 1998).

A study on "high frequency hearing loss associated with otitis media" found that high frequency (HF) hearing loss was associated with otitis media (OM) after middle ear disease resolved and after middle ear dysfunction was excluded. Relatively poorer HF hearing thresholds found for older children with OM histories appeared to be attributable to time spent with ear disease (Hunter et al, 1996).

- Premature birth causes sensorineural hearing loss approximately 5% of the time.

5. Medications – Some medications (ototoxic drugs) cause irreversible damage to the ear, and are limited in their use for this reason. The most important group is the aminoglycosides. Some medications may reversibly affect hearing. This includes some diuretics, aspirin and Non Steroidal Anti-inflammatory Drugs (NSAIDs). According to a study by researchers at Brigham and Woman's Hospital in Boston, the link between NSAIDs, such as ibuprofen and hearing loss tends to be greater in women, especially those who take ibuprofen six or more times a week (Curhan, 2012). Others may cause permanent hearing loss (Cone et al, 2013). On October 18, 2007, the U.S. Food and Drug Administration announced that a warning about a possible sudden hearing loss would be added to drug labels of PDE5 inhibitors, which are used for erectile dysfunction.

6. Chemicals – Hearing loss can also result from specific drugs; metals such as lead; solvents such as toluene (found in crude oil, gasoline and automobile exhaust) (Tox, 2010), and asphyxiants (Morata, 2008). Combined with noise, these ototoxic chemicals have an additive effect on a person's hearing loss (Morata, 2008). Hearing losses due to chemicals start in the high frequency range and is irreversible. It damages the cochlea with lesions and degrades the central portions of the auditory system. Controlling noise and using hearing protectors are

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insufficient for preventing hearing loss from these chemicals. However, taking antioxidants helps prevent ototoxic hearing loss, at least to a degree (Johnson, 2008). Ototoxic chemicals include:

- Drugs- antimalarial, antibiotics, anti-inflammatory (non-steroidal), antineoplastic, diuretics.
- Solvents- toluene, styrene, xylene, fuels, carbon disulphide etc
- Asphyxiants- carbon monoxide, hydrogen cyanide
- Metals- lead, mercury etc
- Pesticides/herbicides- paraquat, organophosphates.

7. Physical trauma- head injury or injury to the ear can cause hearing loss (WHO, 2014).
8. Neurobiological factors- there are simply two reasons that could cause a person to be deaf from a neurobiological perspective: either there is something wrong with the mechanical portion of the process, meaning the ear, or there is something wrong with the neural portion of the process, meaning the brain.

2.7 Signs and symptoms of hearing loss in children

The signs and symptoms of hearing loss are different for each child (CDC, 2014). Some early signs of a hearing problem include:

- Delayed speech.
- Unclear speech.

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- Delayed speech.
- Unclear speech.

- Inability to follow directions. This sometimes is mistaken for not paying attention or just ignoring, but could be the result of a partial or complete hearing loss.
- Often says, "Huh?"
- Turns the TV or radio volume up too high.
- Not reacting to loud noises.
- Pull, rub or scratch an ear.
- Have a fever.
- Have ear pain.

2.8 Epidemiology

Hearing loss is by far the most prevalent inner ear disorder; the World Health Organization estimates that 500 million people worldwide have a mild to moderate to severe or greater hearing loss (WHO, 2014). At ages above 85, almost everyone is affected to some extent. Estimates are that the number of people in the world with age-related hearing loss is expected to increase to 900 million by 2050. However, the incidence is rising rapidly among younger people as well, due to frequent exposure to excessive noise.

Globally, hearing loss affects about 10% of the population to some degree (Oishi and Schacht, 2011). In 2004, it caused moderate to severe disability in 124 million people (108 million of whom are in low and middle income countries) (WHO, 2008). Of these 65 million developed the condition during childhood (Elzouki et al, 2012). The reported prevalence rate of hearing impairment among children regardless of frequency or severity has varied from 1.5% to

14.9% (Lee et al, 1996). At birth , approximately 3 per 1000 in developed countries and more than 6 per 1000 in developing countries have hearing problems (Elzouki et al, 2012). Hearing loss increases with age. In those between 20 and 35, rates of hearing loss are 3% while in those 44 to 55, it is 11%; and in those 65 to 85, it is 43% (Lasak et al, 2014).

Over 5% of the world's population – 360 million people- has disabling hearing loss (328 million adults and 32 million children). Disabling hearing loss refers to hearing loss greater than 40dB in the better hearing ear in adults and a hearing loss greater than 30dB in the better hearing ear in children. The majority of these people live in low- and middle-income countries (WHO, 2014). The last MarkeTrak survey (2004) estimated that 3 in 1,000 infants are born with serious to profound hearing loss; and at least 1.4 million children (18 or younger) have hearing problems.

2.9 Impact of hearing loss

Functional impact: One of the main impacts of hearing loss is on the individual's ability to communicate with others. Spoken language development is often delayed in children with deafness. Hearing loss and ear diseases such as otitis media can have a significantly adverse effect on the academic performance of children. However, when opportunities are provided for people with hearing loss to communicate they can participate on an equal basis with others. The communication may be through spoken/ written language or through sign language.

Studies indicate that children with minimal sensorineural hearing loss experienced more difficulty than normally hearing children on a series of educational and functional test measures; so without proper intervention, children with mild to moderate hearing loss, on

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average, do not perform as well in school as children with no hearing loss. This gap in academic achievement widens as students progress through school (Bess et al, 1998). Studies have found that school-age children with unilateral hearing loss appear to have increased rates of grade failures, need for additional educational assistance, and perceived behavioral issues in the classroom. Speech and language delays may occur in some children with UHL, but it is unclear if children "catch up" as they grow older (Lieu, 2004).

Social and emotional impact: Limited access to services and exclusion from communication can have a significant impact on everyday life, causing feelings of loneliness, isolation and frustration, particularly among older people with hearing loss. If a person with congenital deafness has not been given the opportunity to learn sign language as a child, they may feel excluded from social interaction. It has been shown that the impact of hearing loss on the early development of a child's language, cognition and social-emotional competence can be pervasive. When a child has a hearing impairment of early onset, even of a relatively mild degree, the development of these skills is often delayed. Such delays adversely affect communicative and social success, which at a later age limit vocational choices (Ross et al, 1991). The negative outcome resulting from poor verbal communication skills is social isolation. The culmination of experiences with repeated failure can have a lifelong impact by contributing to low self esteem and limiting vocational choices (ACSD, 1993).

Economic impact: In developing countries, children with hearing loss and deafness rarely receive any schooling. Adults with hearing loss also have a much higher unemployment rate. Among those who are employed, a higher percentage of people with hearing loss are in the lower grades of employment compared with the general workforce. Improving access to

education and vocational rehabilitation services, and raising awareness especially among employers, would decrease unemployment rates among adults with loss.

In addition to the economic impact of hearing loss at an individual level, hearing loss substantially affects social and economic development in communities and countries (WHO, 2014).

2.10 The role of poverty

Living in poverty makes children more vulnerable to hearing loss and associated disabilities, as they often face inadequate medical care (Capps, 2003; Elster et al, 2003; Thompson et al, 2003), higher rates of recurrent serous otitis media, lead poisoning and poor nutrition (Mendola et al, 1994).

Many cases of hearing loss in Nigerian children are the result of untreated or late diagnosed middle ear infections. Early and timely treatment would prevent many middle ear infection related cases of hearing loss, according to the scientists behind Ife study. But often poverty was found to be a difficult barrier, particularly for the diagnosis and treatment of children from rural areas, wrote the researchers. Children living in rural poverty often come to the hospital when their ear infections have brought complications (Hear it, 2008).

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2.11 Prevention

According to the World Health Organization, half of all cases of deafness and hearing impairment (that is, 50% of cases) are avoidable through prevention; early diagnosis and management. Some simple strategies for prevention include:

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

Hearing loss due to otitis media can be prevented by healthy ear and hearing care practices (WHO, 2014).

2.12 Identification and management

A large percentage of people living with hearing loss can benefit from early identification and intervention, and appropriate management. Early detection and intervention is the most important factor in minimizing the impact of hearing loss on a child's development and educational achievements. In infants and young children with hearing loss, early identification and management through infant hearing screening programmes can improve the linguistic and educational outcomes for the child. Pre-school, school and occupational screening for ear diseases and hearing loss can also be effective for early identification and management of hearing loss (WHO, 2014).

There are a number of devices that can improve hearing in those who are hearing impaired or deaf or allow people with these conditions to manage better in their lives. These include:

- **Hearing aids**

Hearing aids, which amplify the incoming sound, will improve hearing ability. About 20% of people with hearing loss need hearing aids in developing countries. This suggests that there are an estimated 56 million hearing aid users worldwide. It is estimated that current hearing aid production meets only 3% of the need in developing countries (WHO, 2014).

A study on "to aid or not aid: children with unilateral hearing loss" by Sarah McKay in 2002 reported that most children fit with hearing aid showed improvements in areas in which auditory abilities were questioned. In areas in which confidence and frustration level were questioned, many remained the same, but most parents reported that confidence was not a problem prior to their hearing aid fitting.

- **Assistive devices**

Many hearing impaired individuals use assistive devices in their daily lives:

- Individuals can communicate by telephone using telecommunications device for the deaf (TDD) which transmits typed text over regular telephone lines.

- There are several new telecommunications relay service technologies including IP Relay and captioned telephone technologies. A deaf or hard of hearing person can communicate over the phone with a hearing person via a human translator.

- Real-time text technologies, involving streaming text that is continuously transmitted as it is typed or otherwise composed. This allows conversational use of text. Software programs are now available that automatically generate a closed-captioning of conversations. Examples include discussions in conference rooms, classroom lectures, and/or religious services. One such example of an available product is Auditory Sciences' Interact- AS product suite.

- Videophones and similar video technologies can be used for distance communication using sign language. Video conferencing technologies permit signed conversations as well as permitting a sign language-English interpreter to voice and sign conversations between a hearing impaired person and that person's hearing party, negating the use of a (teleprinter) TTY device or computer keyboard.

- Video relay service and video remote interpreting (VRI) services also use a third-party telecommunication service to allow a deaf or hard-of-hearing person to communicate quickly and conveniently with a hearing person, through a sign language interpreter.

- Phone captioning is a service in which a hearing person's speech is captioned by a third party, enabling a hearing impaired person to conduct a conversation with a hearing person over the phone.

- For mobile phones, software apps are available to provide 2-way communications.

- Other assistive devices include those that use flashing lights to signal events such as a ringing telephone, a doorbell, or a fire alarm.

- **Wireless devices**

A wireless device has two main components: a transmitter and a receiver. The transmitter broadcasts the captured sound, and the receiver detects the broadcast audio and enables incoming audio stream to be connected to accommodations such as hearing aids or captioning systems. Three types of wireless systems are commonly used: Frequency Modulation (FM), audio induction loop, and Infrared. Each system has advantages and benefits for particular uses (Ken, 2005).

- **Cochlear implants**

Cochlear implants improve outcomes in people with hearing loss in either one or both ears (James et al. 2013). They work by artificial stimulation of the cochlear nerve by providing an electric impulse substitution for the firing of hair cells. They are expensive; require programming along with extensive training for effectiveness. Cochlear implants are at higher risk for bacterial meningitis. Thus, meningitis vaccination is recommended (FDA, 2008). People who have hearing impairments, especially those who develop a hearing problem in childhood or old age, may need support and technical adaptations as part of the rehabilitation

process. Recent research shows variations in efficacy but some studies show that if implanted at a very young age, some profoundly impaired children can acquire effective hearing and speech, particularly if supported by appropriate rehabilitation (Tait et al, 2007).

Studies have demonstrated that on average, children continue to improve in oral communication skills and quality of peer relationships even years after implantation, especially those with initial poorer skills. While oral communication ability and quality of peer relationships are strongly associated at each time point, gains in these two variables are associated only for some of the children (Bat-Chava et al, 2013).

- **Classroom**

For a classroom setting, children with hearing impairments often benefits from interventions. One simple example is providing favorable seating for the child. Having the student sit as close to the teacher as possible improves the student's ability to hear the teacher's voice and to more easily read the teacher's lips. When lecturing, teachers should try to look at the student as much as possible and limit unnecessary noise in the classroom. In particular, the teacher should avoid talking when their back is turned to the classroom, such as while writing on a whiteboard.

Some other approaches for classroom accommodations include pairing hearing impaired students with hearing students. This allows the hearing impaired student to ask the hearing student questions about concept that they have not understood. The use of CART (Communication Access Real Time) systems, where an individual types a captioning of what the teacher is saying, is also beneficial (Jamie, 2014). The student views this captioning on their computer.

For those students who are completely deaf, one of the most common interventions is having the child communicate with others through an interpreter using sign language.

CHAPTER 3

METHODOLOGY

3.1 Study area

Obafemi Owode is a local Government Area in Ogun State. It came into existence through Edict No. 9 of 1976, resulting from the 1976 Local Government reforms, and prior to this period; the administration of the area was carried out by Oba Provincial Authority, Owode District Council and Obafemi District Council. Obafemi Owode Local Government has its headquarters at Owode Egba.

Obafemi Owode Local Government share common boundaries with the following Local and State Governments: North- Odeda Local Government and Oyo State; East- Sagamu and Ikenna Local Governments; South- Ifo Local Government and Lagos State. It has an estimated population of 230,000 and is made up of 1,204 towns and villages with a land mass of 104,787.07 hectares of largely agricultural land.

This Local Government is made up of people residing in Adigbe, Oba Kobape, Obafemi, Ogunmakin, Ajebo, Owode, Ibafo, Iro and Mokoloko towns and they are mostly Egba. Therefore, the common language being spoken is the Yoruba with the Egba dialect. It has some motorable (graded) roads which are linked by State and Federal road network for inter and intra city connections. In the area of health services, Obafemi Owode Local Government is blessed with competent staff and facilities (22 health clinics and 12 health posts). The people are predominantly farmers but in recent times, however, the people of the area engage themselves in Quarry business, artisan works and handcrafts, such as dye making and pottery. Also, for administrative convenience, Obafemi Owode Local Government is politically

CHAPTER 3

METHODOLOGY

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divided into 12 wards, viz: Mokoloki, Oba, Ofada, Egbeda, Owode, Kajola, Ajura, Obafemi, Moloko Asipa, Ajebo, Onidundu and Alapako-Oni wards.

The Obafemi zone which will be selected for the study has a functional rural health facility managed by the Department of Epidemiology and Medical Statistics of the University of Ibadan which is a referral and co-ordinating centre of the proposed school health programme.

3.2 Study design

This is a descriptive cross-sectional study.

3.3 Study population

The study population is school-age children from primary 3-6 in Obafemi Owode Local Government Area, Ogun State.

Inclusion criteria

- Pupils from primary 3-6 in the selected schools.
- The respondents who gave assent.
- Children whose parents gave consent for their participation.

Exclusion criteria

- Children that were too ill to participate in the study.

3.4 Sample size determination

The desired sample size was obtained using the statistical formula for estimating single proportion, that is, $n = \frac{Z^2_{\alpha}pq}{d^2}$

Where $Z\alpha$ = standard normal deviation of 1.96 which corresponds to 95% confidence interval

P = 13.9% or 0.139

q = 1-p = 86.1% or 0.861

d = degree of accuracy set at 0.05

D = design effect for cluster sampling = 1.5

Applying the formula:

$$n = \frac{1.96^2 \times 0.139 \times 0.861}{0.05^2} = 183.9 \times 1.5 = 275.9 \approx 276$$

In order to take care of non-response, the formula below will be used to increase the sample size

$$n = \frac{100 \times \text{number of subjects}}{100 - \%\text{ of dropout}} = \frac{100 \times 276}{(100-10)} = 306.7 \approx 307$$

Thus, the total number of samples will then be 307.

3.5 Sampling procedures

A multistage cluster sampling technique was used for the study as follows:

Stage 1- The Obafemi Owode Local Government is very extensive hence it was divided into three major zones of Oba, Obafemi and Owode. Obafemi zone was purposively selected because of the proximity and presence of a functional rural health facility managed by the Department of Epidemiology and Medical Statistics of the University of Ibadan which is a referral and co-ordinating centre of the proposed School Health Programme.

Stage 2- Two out of the four educational zones in Obafemi (Ajebo and Ogunmakin) were selected by purposive sampling technique.

Stage 3- All the schools in each of the educational zones selected were listed in alphabetical order; and the schools to be studied were then randomly selected from the list by balloting. 6 schools were selected.

Stage 4- All consenting students from 3-6 were recruited for the study.

3.6 Data collection instruments

The following instruments were used in collecting data for the study:

- A calibrated Amplivox 240 diagnostic audiometer
- A semi-structured questionnaire (interviewer administered)

3.7 Procedure for data collection

3.7.1 Audiometric assessment procedure

The researcher and a trained research assistant collected the data for this study. Each child was assessed using an electricity-powered screening audiometer (Amplivox 240) and their threshold recorded in the audiogram accordingly. Sound-excluding headphones were used with the audiometer. Electricity was provided by a generator that was placed at a distance from the room the test was done. The first part of the test focused on the five speech frequencies (500Hz, 1000Hz, 2000Hz, 4000Hz and 8000Hz) using only air conduction test, to identify those with or at risk of hearing loss. The air conduction test was performed by presenting a pure tone to the ear through an ear phone at specific frequencies (500-8000Hz) and the lowest intensity at which the tone was perceived was recorded for each ear. The pure tone average (PTA) was calculated as the arithmetic mean for the air conduction thresholds at the four frequencies between 500 and 4000Hz. Children with a PTA greater than 25dB hearing level in either ear after audiometric testing were said to have hearing loss.

3.7.2 Questionnaire procedure

The second part of the programme focused on the administration of questionnaire designed based on the study objectives.

3.8 Variables

Dependent variable: hearing loss (mild, moderate, severe and profound).

Independent variables: Socio-demographic characteristics (age, gender, religion, family type, ethnicity, religion, parental marital status, parent's occupation and parent's educational level).

noise, family history, ear diseases, infectious diseases (measles, meningitis and mumps) and non-infectious conditions (injury to the ear and head injury).

3.9 Variable definition

- Low frequency hearing loss: This is hearing loss caused by damaged inner ear hair cells. People with low frequency hearing loss cannot hear sounds in frequencies 2000Hz and below. It is also known as a "reverse slope audiogram" because someone with low frequency hearing loss may still hear sounds in higher frequencies.

- High frequency hearing loss: People with high frequency hearing loss can't hear sounds in higher frequencies (ranging from 2000Hz to 8000Hz), such as s, h and f. On the audiogram, the frequencies go from low to high frequencies.

- Unilateral hearing loss: This is the type of hearing loss where the hearing impairment affects either the right or left ears. It is also referred to as single sided deafness.

- Bilateral hearing loss: this is the type of hearing loss where the hearing impairment affects both the ears.

3.10 Data management and analysis

The project data was collected in a consistent systematic manner. The researcher checked for missing data and inconsistencies in the questionnaires collected on a daily basis and a coding guide was developed to facilitate data entry. Each questionnaire was numbered, coded and entered into a computer (using SPSS package) facilitated by the developed coding guide. The questionnaires were stored in a safe place to avoid destruction, limit access to the data by

unauthorized persons and to allow future access to the data in order to re-create findings and augment subsequent research.

The data was analyzed using the SPSS software. Analysis was done using descriptive statistics (frequency, percentage, mean, and standard deviation), chi-square and multiple logistic regression tests were used for inferential statistical analysis; the findings were then summarized and presented in tables and charts.

3.11 Ethical consideration

- Ethical Review Committee

Ethical approval was sought from the UCH/UI Research Ethical Review Committee. Also, approval was obtained from the Ogun State Universal Basic Education Board.

- Confidentiality

Each respondent was assured of maximum confidentiality during and after data collection. There were no identifiers such as names and address of the participants, the data was stored in a computer protected by password to restrict access to it. Data obtained was used for research purpose ONLY.

- Voluntariness

The details of the study was explained in clear terms to the participants, only the parents who showed complete willingness and interest for their wards to participate signed the informed consent form which served as a confirmation of the participants' voluntary and willing participation in the study.

- Beneficence

This study provided benefits to the study participants as those with or at risk of hearing loss were identified and referred for appropriate management and treatment.

- Non-maleficence

The study was relatively risk free since no intervention procedures were done that could cause harm to the study participants.

- Right to decline

It was clearly stated to the respondents that they had the right to withdraw their participation at any time of the study period.

CHAPTER 4

RESULTS

4.1 Socio-demographic characteristics of respondents

There were 305 respondents, 172 (56.4%) males and 133 (43.6%) females. The respondents were aged between 6 and 15 years with a mean age of 10.95 (SD= ±1.98). Majority, 249 (81.6%) of the respondents were Yorubas, 25 (8.2%) were Ibos, 9 (3%) were Hausas and 22 (7.2%) were from Calabar and Igede. One hundred and eighty six (61%) of the respondents were from monogamous households while 119 (39%) were from polygamous households. One hundred and ninety seven (64.6%) were Christians and 108 (35.4%) were Muslims. Thirty one (10.2%) of respondents were from single parents, 250 (82%) of the parents were married and 24 (7.9%) were divorced. Twenty six (8.5%) of the respondents' fathers had no formal education, 105 (34.4%) had primary school education, 141 (46.2%) had secondary school education and 33 (10.8%) had post-secondary school education. Also, 32 (10.5%) of their mothers had no formal education, 121 (39.7%) had primary school education, 123 (40.3%) had secondary school education and 29 (9.5%) had post-secondary school education.

Table 1: Socio-demographic characteristics of respondents

Characteristics	Frequency (n=305)	Percentages (%)
Gender		
Males	172	56.4
Females	133	43.6
Age groups (years)		
Less than 10	79	25.9
10-12	158	51.8
13-15	68	22.3
Ethnicity		
Yoruba	249	81.6
Ibo	25	8.2
Hausa	9	3.0
Other	22	7.2
Family type		
Monogamous	186	61.0
Polygamous	119	39.0
Religion		
Christianity	186	61.0
Islam	108	39.0
Parental marital status		
Single	31	10.1
Married	250	82.0
Divorced	24	7.9
Father's occupation		
Farmer	142	46.6
Trader	11	3.6
Artisan	80	26.2
Civil servant	13	4.3
Other	59	19.3

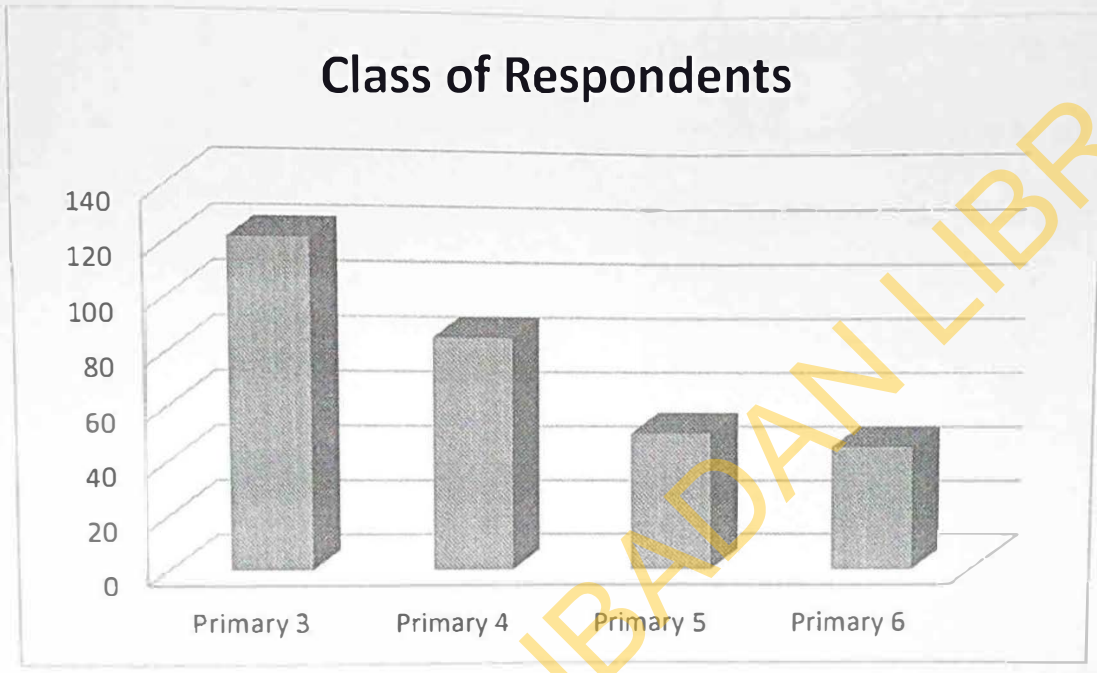
Table 1 (contd.): Socio-demographic characteristics of respondents

Characteristics	Frequency (n=305)	Percentages (%)
Mother's occupation		
Farmer	74	24.3
Trader	141	46.2
Artisan	45	14.8
Civil servant	13	4.3
Other	32	10.5
Father's educational level		
None	26	8.5
Primary	105	34.4
Secondary	141	46.2
Tertiary	33	10.8
Mother's educational level		
None	32	10.5
Primary	121	39.7
Secondary	123	40.3
Tertiary	29	9.5

4.2 Class of respondents

Figure 1 shows that 112 (40%) of the respondents were in primary 3, 86 (28.2%) were in primary 4, 51 (16.7%) were in primary 5 and 46 (15.1%) were in primary 6.

Figure 1: Class of Respondents



4.3 Prevalence of hearing loss

Table 2 shows that majority of the students examined had normal hearing function (64.9% in the right ear and 66.2% in the left ear) while a very negligible proportion had moderate hearing loss in the left ear (0.3%). About one-third of the study population had mild hearing loss 84 (27.5%) in the right ear, 96 (31.5%) in the left ear and 60 (19.7%) in both ears (bilateral hearing loss). Those at-risk of hearing loss were 23 pupils (7.5%) in the right ear 6 pupils (2%) in the left ear.

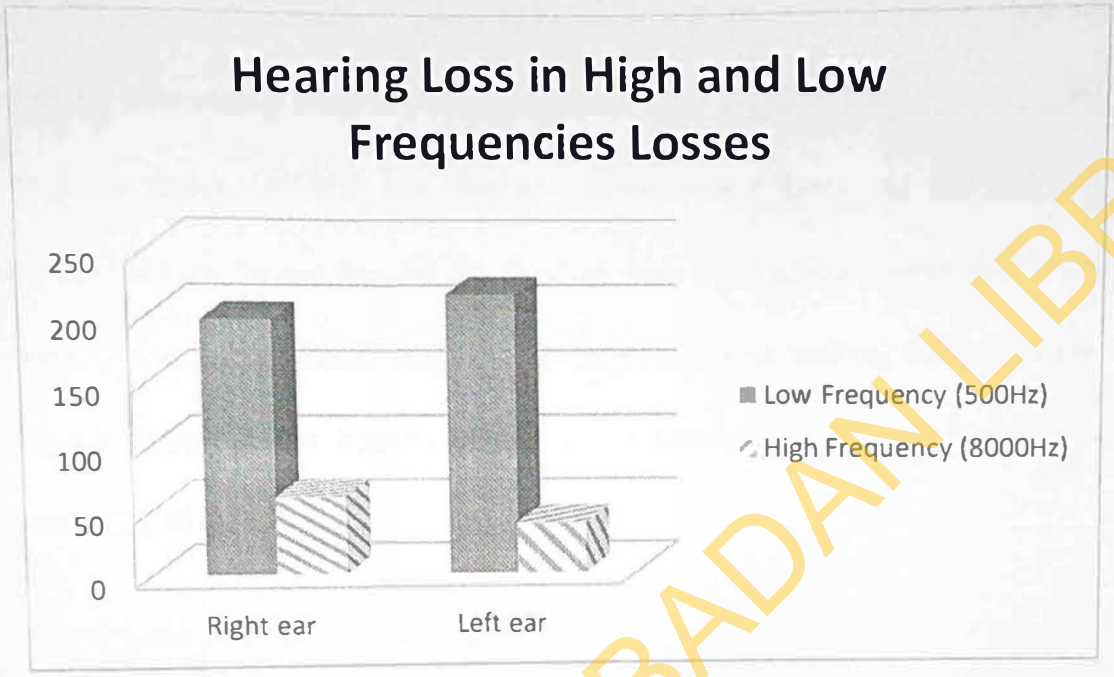
Table 2: Categories of hearing ability

Hearing loss categories	Right ear		Left ear		Both ears	
	(f)	%	(f)	%	(f)	%
Normal hearing (-10 to 24dB)	198	64.9	202	66.2	170	55.7
Borderline/at risk (25dB)	23	7.5	6	2.0	0	0
Mild hearing loss (26 to 40dB)	84	27.5	96	31.5	60	19.7
Moderate hearing loss (41 to 70dB)	-	0.0	1	0.3	-	0.0
Severe hearing loss (71 to 95dB)	-	0.0	-	0.0	-	0.0
Profound hearing loss (>95dB)	-	0.0	-	0.0	-	0.0
Total	**305**	**100**	**305**	**100**		

4.4 Prevalence of hearing loss in high and low frequencies losses

Figure 2 shows the type of hearing loss in terms of high and low frequency. One hundred and ninety eight (64.9%) and 217 (71.1%) of those with hearing loss have low frequency losses on their right and left ears while 61 (20%) and 40 (13.1%) have high frequency hearing loss on their right and left ears respectively.

Figure 2: Categories of hearing loss (HL) in high and low frequencies losses



4.5 Hearing loss related to age and sex

Table 3 and 4 shows the distribution of hearing loss in relation to age and sex of respondents. A total of 305 children were screened aging between 6 and 15 years. For the right ear, hearing loss was found to be decreasing with increasing age with the highest proportion in children less than 10 years in both males (27.9%) and females (44.4%). Similarly, on the left ear, hearing loss decreased with increase in age among the females with the highest proportion in respondents less than 10 years (44.4%). However, there was a different trend among the males on their left ear. Children 13-15 years had the highest proportion of hearing loss (35.0%) and those 10-12 years had the lowest (23.6%).

Table 3: Hearing loss (HL) related to age and sex for the right ear

	Males			Females			Total		
	N	fail	%	n	fail	%	n	fail	%
Age (years)									
Less than 10	43	12	27.9	36	16	44.4	79	28	35.4
10-12	89	19	21.3	69	30	43.5	158	49	31.0
13-15	40	7	17.5	28	2	7.1	68	9	13.2

*n represents the number of respondents in each age category
*fail represents the number of respondents with hearing loss

Table 4: Hearing loss (HL) related to age and sex for the left ear

	Males			Females			Total		
	n	fail	%	n	fail	%	n	fail	%
Age (years)									
Less than 10	43	12	27.9	36	16	44.4	79	28	35.4
10-12	89	21	23.6	69	26	37.7	158	47	29.8
13-15	40	14	35.0	28	8	28.6	68	22	32.4

*n represents the number of respondents in each age category
*fail represents the number of respondents with hearing loss

4.6 Association between socio-demographic characteristics and hearing loss

Table 5 and 6 shows the cross tabulation of hearing loss against certain explanatory variables. There was a significant association of age with hearing loss in the right ear (p=0.001). Pupils aged 10 and above had a significantly high proportion of hearing loss (31.5%) compared with those in the lower age group (17.6%).

There was a slight association between sex and hearing loss on the left ear (p=0.056). Females had a high proportion of hearing loss (37.6%) compared to males (27.3%).

Based on parental marital status, the prevalence of hearing loss on the left ear was highest among married parents (35.2%), lowest among single parents (16.7%), and those who were divorced had a prevalence of 16.7%. This relationship is statistically significant (p=0.025).

Table 5: Association between socio-demographic factors and hearing loss on the right ear

Risk factors	Categories	Yes (%)	No (%)	Total (100%)	X^2	P-value
Sex	Male	40 (23.3)	132 (76.7)	172	3.629	0.057
	Female	44 (33.1)	89 (66.9)	133		
Age	Less than 10	23 (17.6)	108 (82.4)	131	11.469	0.001
	>=10	61 (31.5)	113 (64.9)	174		
Ethnicity	Yoruba	72 (28.9)	177 (71.1)	249	3.813	0.149
	Ibo	8 (32.0)	17 (68.0)	25		
	Hausa	4 (12.9)	27 (87.1)	31		
Family type	Monogamous	46 (24.7)	140 (75.3)	186	1.886	0.170
	Polygamous	38 (31.9)	81 (68.1)	119		
Religion	Christianity	59 (29.9)	138 (70.1)	197	1.617	0.204
	Islam	25 (23.1)	83 (76.9)	108		
Parental marital status	Single	4 (12.9)	27 (87.1)	31	4.614	0.100
	Married	71 (28.4)	179 (71.6)	250		
	Divorced	9 (37.5)	15 (62.5)	24		
Father's occupation	Farmer	32 (22.5)	110 (77.5)	142	5.300	0.071
	Trader	33 (36.5)	58 (63.7)	91		
	Artisan	19 (26.4)	53 (73.6)	72		
Mother's occupation	Farmer	26 (35.1)	48 (64.9)	74	2.836	0.242
	Trader	47 (25.3)	139 (74.7)	186		
	Artisan	11 (24.4)	34 (75.6)	45		
Father's educational level	None	5 (19.2)	21 (80.8)	26	1.075	0.783
	Primary	29 (27.6)	76 (72.4)	105		
	Secondary	40 (28.4)	101 (71.6)	141		
	Tertiary	10 (30.3)	23 (69.7)	33		
Mother's educational level	None	7 (21.9)	25 (78.1)	32	3.459	0.326
	Primary	28 (23.1)	93 (76.9)	121		
	Secondary	39 (31.7)	84 (68.3)	123		
	Tertiary	10 (34.5)	19 (65.5)	29		

Table 5: Association between socio-demographic factors and hearing loss on the right ear

Risk factors	Categories	Yes (%)	No (%)	Total (100%)	X^2	P-value
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	Artisan	19 (26.4)	53 (73.6)	72		
Mother's occupation	Farmer	26 (35.1)	48 (64.9)	74	2.836	0.242
	Trader	47 (25.3)	139 (74.7)	186		
	Artisan	11 (24.4)	34 (75.6)	45		
Father's educational level	None	5 (19.2)	21 (80.8)	26	1.075	0.783
	Primary	29 (27.6)	76 (72.4)	105		
	Secondary	40 (28.4)	101 (71.6)	141		
	Tertiary	10 (30.3)	23 (69.7)	33		
Mother's educational level	None	7 (21.9)	25 (78.1)	32	3.459	0.326
	Primary	28 (23.1)	93 (76.9)	121		
	Secondary	39 (31.7)	84 (68.3)	123		
	Tertiary	10 (34.5)	19 (65.5)	29		

Table 6: Association between socio-demographic factors and hearing loss on the left ear

Risk factors	Categories	Yes (%)	No (%)	Total (100%)	X^2	P-value
Sex	Males	47 (27.3)	125 (72.7)	172	3.646	0.056
	Females	50 (37.6)	83 (62.4)	133		
Age	Less than 10	40 (30.5)	91 (69.5)	131	0.170	0.680
	>=10	57 (32.8)	117 (67.2)	174		
Ethnicity	Yoruba	83 (33.3)	166 (66.7)	249	1.651	0.438
	Ibo	7 (28.0)	18 (72.0)	25		
	Hausa	7 (22.6)	24 (77.4)	9		
Family type	Monogamous	59 (31.7)	127 (68.3)	186	0.002	0.969
	Polygamous	38 (31.9)	81 (68.1)	119		
Religion	Christianity	64 (32.5)	133 (67.5)	197	0.120	0.729
	Islam	33 (30.6)	75 (69.4)	108		
Parental marital status	Single	5 (16.1)	26 (83.9)	31	7.377	0.025
	Married	88 (35.2)	162 (64.8)	250		
	Divorced	4 (16.7)	20 (83.3)	24		
Father's occupation	Farmer	38 (26.8)	104 (73.2)	142	4.190	0.123
	Trader	36 (39.6)	55 (60.4)	91		
	Artisan	23 (31.9)	49 (68.1)	72		
Mother's occupation	Farmer	29 (39.2)	45 (60.8)	74	2.655	0.265
	Trader	56 (30.1)	130 (69.9)	186		
	Artisan	12 (26.7)	33 (73.3)	45		
Father's educational level	None	9 (34.6)	17 (65.4)	26	4.479	0.214
	Primary	91 (39.0)	64 (61.0)	105		
	Secondary	38 (27.0)	103 (73.0)	141		
	Tertiary	9 (27.3)	24 (72.7)	33		
Mother's educational level	None	11 (34.4)	21 (65.6)	32	1.865	0.601
	Primary	43 (35.5)	78 (64.5)	121		
	Secondary	34 (27.6)	89 (72.4)	123		
	Tertiary	9 (31.0)	20 (69.0)	29		

Table 6: Association between socio-demographic factors and hearing loss on the left ear

Risk factors	Categories	Yes (%)	No (%)	Total (100%)	X^2	P-value
Sex	Males	47 (27.3)	125 (72.7)	172	3.646	0.056
	Females	50 (37.6)	83 (62.4)	133		
Age	Less than 10	40 (30.5)	91 (69.5)	131	0.170	0.680
	>=10	57 (32.8)	117 (67.2)	174		
Ethnicity	Yoruba	83 (33.3)	166 (66.7)	249	1.651	0.438
	Ibo	7 (28.0)	18 (72.0)	25		
	Hausa	7 (22.6)	24 (77.4)	9		
Family type	Monogamous	59 (31.7)	127 (68.3)	186	0.002	0.969
	Polygamous	38 (31.9)	81 (68.1)	119		
Religion	Christianity	64 (32.5)	133 (67.5)	197	0.120	0.729
	Islam	33 (30.6)	75 (69.4)	108		
Parental marital status	Single	5 (16.1)	26 (83.9)	31	7.377	0.025
	Married	88 (35.2)	162 (64.8)	250		
	Divorced	4 (16.7)	20 (83.3)	24		
Father's occupation	Farmer	38 (26.8)	104 (73.2)	142	4.190	0.123
	Trader	36 (39.6)	55 (60.4)	91		
	Artisan	23 (31.9)	49 (68.1)	72		
Mother's occupation	Farmer	29 (39.2)	45 (60.8)	74	2.655	0.265
	Trader	56 (30.1)	130 (69.9)	186		
	Artisan	12 (26.7)	33 (73.3)	45		
Father's educational level	None	9 (34.6)	17 (65.4)	26	4.479	0.214
	Primary	91 (39.0)	64 (61.0)	105		
	Secondary	38 (27.0)	103 (73.0)	141		
	Tertiary	9 (27.3)	24 (72.7)	33		
Mother's educational level	None	11 (34.4)	21 (65.6)	32	1.865	0.601
	Primary	43 (35.5)	78 (64.5)	121		
	Secondary	34 (27.6)	89 (72.4)	123		
	Tertiary	9 (31.0)	20 (69.0)	29		

4.7 Association between ear infection and hearing loss

Table 7 and 8 shows the relationship between hearing loss and the history of ear infection. A statistically significant relationship was found in the association between respondents who had current ear discharge and hearing loss (p=0.001) in the right ear. About three-quarter (72.7%) of those with current ear discharge had hearing loss compared with those without ear discharge (25.9%). Similarly, previous history of ear discharge also had a statistical significant relationship with having hearing loss on either the right (<0.001) or left ear (p=0.001). Among respondents who have ever experienced ear discharge, 45.2% had hearing loss on their right ear as against 22% with no history. Also, 47.9% had hearing loss on their left ear compared to 26.7% with no history.

Table 7: Association between ear infection and hearing loss on the left ear

Risk factors	Categories	Yes (%)	No (%)	Total (100%)	X^2	P-value
Current ear discharge	Yes	8 (72.7)	3 (27.3)	11	11.676	0.001
	No	76 (25.9)	218 (74.1)	294		
Ever had ear discharge	Yes	33 (45.2)	40 (54.8)	73	15.006	<0.001
	No	51 (22.0)	18 (78.0)	232		

Table 8: Association between ear infection and hearing loss on the left ear

Risk factors	Categories	Yes (%)	No (%)	Total (100%)	X^2	P-value
Current ear discharge	Yes	5 (45.5)	6 (54.5)	11	0.981	0.322
	No	92 (31.3)	202 (68.7)	294		
Ever had ear discharge	Yes	35 (47.9)	38 (52.1)	73	11.529	0.001
	No	62 (26.7)	170 (73.3)	232		

Table 7: Association between ear infection and hearing loss on the left ear

Risk factors	Categories	Yes (%)	No (%)	Total (100%)	X^2	P-value
Current ear discharge	Yes	8 (72.7)	3 (27.3)	11	11.676	0.001
	No	76 (25.9)	218 (74.1)	294		
Ever had ear discharge	Yes	33 (45.2)	40 (54.8)	73	15.006	<0.001
	No	51 (22.0)	18 (78.0)	232		

Table 8: Association between ear infection and hearing loss on the left ear

Risk factors	Categories	Yes (%)	No (%)	Total (100%)	X^2	P-value
Current ear discharge	Yes	5 (45.5)	6 (54.5)	11	0.981	0.322
	No	92 (31.3)	202 (68.7)	294		
Ever had ear discharge	Yes	35 (47.9)	38 (52.1)	73	11.529	0.001
	No	62 (26.7)	170 (73.3)	232		

4.8 Association between physical trauma and hearing loss

The relationship between history of ear injury and hearing loss was statistically significant ($p<0.001$) for either ear. A higher proportion of individuals with history of injury to the ear developed hearing loss (58% on the right ear and 61% on the left ear) as against respondents with no history of ear injury (12.7% on the right and 17.6% on the left ear). In a similar finding, previous history of head injury also had a statistical significant association with developing hearing loss ($p<0.001$) on both ears. Among respondents with history of head injury, 52.8% had hearing loss on their right ears as against 10.4% who have never had head injury. Also, 56.1% developed hearing loss on their left ears as against 15.4% with no history.

Table 9: Result of bivariate analysis of physical trauma and hearing loss (right ear)

Risk factors	Categories	Yes (%)	No (%)	Total (100%)	X^2	P-value
Ear injury	Yes	58 (58.0)	42 (42.0)	100	69.168	<0.001
	No	26 (12.7)	179 (87.3)	205		
Head injury	Yes	65 (52.8)	58 (47.2)	123	66.139	<0.001
	No	19 (10.4)	163 (89.6)	182		

Table 10: Result of bivariate analysis of physical trauma and hearing loss (left ear)

Risk factors	Categories	Yes (%)	No (%)	Total (100%)	X^2	P-value
Ear injury	Yes	61 (61.0)	39 (39.0)	100	58.476	<0.001
	No	36 (17.6)	169 (82.4)	205		
Head injury	Yes	69 (56.1)	54 (43.9)	123	56.093	<0.001
	No	28 (15.4)	154 (84.6)	182		

4.9 Hearing loss and medical history

Hearing loss was examined against the respondents past medical history. A past history of measles ($p<0.001$) and meningitis ($p<0.001$) were significantly associated with hearing loss on either ear. 52.9% (right ear) and 51.4% (left ear) of the respondents with hearing loss reported a history of measles compared to 6.6% (right ear) and 15.6% (left ear) with no history. 46.3% (right ear) and 59.9% (left ear) of respondents with hearing loss had history of meningitis compared to 10.2% (right ear) and 5.7% (left ear) with no history. Mumps also had a statistical significant relationship with hearing loss on the right ear ($p=0.005$). 39.3% of respondents with mumps developed hearing loss as against 23.1% with no history.

Table 11: Bivariate analysis of hearing loss and medical history (right ear)

Risk factors	Categories	Yes (%)	No (%)	Total (100%)	X^2	P-value
Eye problem	Yes	3 (13.0)	20 (87.0)	23	2.620	0.106
	No	81 (28.7)	201 (71.3)	282		
Drugs	Antibiotics	10 (55.6)	8 (44.4)	18	3.535	0.060
	Pain relieve	17 (30.9)	38 (69.1)	55		
Measles	Yes	73 (52.9)	65 (47.1)	138	81.209	<0.001
	No	11 (6.6)	156 (93.4)	167		
Meningitis	Yes	68 (46.3)	79 (53.7)	147	49.388	<0.001
	No	16 (10.2)	141 (89.8)	157		
Mumps	Yes	33 (39.3)	51 (60.7)	84	8.013	0.005
	No	51 (23.1)	170 (76.9)	221		

Table 12: Bivariate analysis of hearing loss and medical history (left ear)

Risk factors	Categories	Yes (%)	No (%)	Total (100%)	X^2	P-value
Eye problem	Yes	6 (26.1)	17 (73.9)	282	0.375	0.540
	No	91 (32.3)	191 (67.7)	23		
Drugs	Antibiotics	10 (55.6)	8 (44.4)	18	1.333	0.248
	Pain relieve	22 (40.0)	33 (60.0)	55		
Measles	Yes	71 (51.4)	67 (48.6)	138	44.851	<0.001
	No	26 (15.6)	141 (94.3)	167		
Meningitis	Yes	88 (59.9)	59 (40.1)	147	102.388	<0.001
	No	9 (5.7)	148 (94.3)	157		
Mumps	Yes	30 (35.7)	54 (64.3)	84	0.818	0.366
	No	67 (30.3)	154 (69.7)	221		

4.10 Family history and hearing loss

There was no statistical significant relationship between family history of hearing loss and developing the problem on either ear.

Table 13: Result of bivariate analysis of family history and hearing loss (right ear)

Risk factors	Categories	Yes (%)	No (%)	Total (100%)	X^2	P-value
Family history	Parent	3 (27.3)	8 (72.7)	11	0.236	0.889
	Sibling	13 (35.1)	24 (64.9)	37		
	Uncle/Aunt	5 (33.3)	10 (66.7)	15		

Table 14: Result of bivariate analysis of family history and hearing loss (left ear)

Risk factors	Categories	Yes (%)	No (%)	Total (100%)	X^2	P-value
Family history	Parent	4 (36.4)	7 (63.6)	11	0.195	0.907
	Sibling	11 (29.7)	26 (70.3)	37		
	Uncle/Aunt	5 (33.3)	10 (66.7)	15		

4.11 Association between noise exposure and hearing loss

Noise was a statistically significant factor in the occurrence of hearing loss on either ear ($p<0.001$). 62.2% of individuals with hearing loss on the right ear were exposed to noise as against 11.1% with no noise exposure. Also, 59.2% of respondents with hearing loss on their left ears were exposed to noise as against 18.8% with no noise exposure.

4.11 Association between noise exposure and hearing loss

Noise was a statistically significant factor in the occurrence of hearing loss on either ear ($p<0.001$). 62.2% of individuals with hearing loss on the right ear were exposed to noise as against 11.1% with no noise exposure. Also, 59.2% of respondents with hearing loss on their left ears were exposed to noise as against 18.8% with no noise exposure.

Table 15: Bivariate analysis between noise exposure and hearing loss (right ear)

Risk factor	Categories	Yes (%)	No (%)	Total (100%)	X^2	P-value
Noise	Yes	61 (62.2)	37 (37.8)	98	87.145	<0.001
	No	23 (11.1)	184 (88.9)	207		

Table 16: Bivariate analysis between noise exposure and hearing loss (left ear)

Risk factor	Categories	Yes (%)	No (%)	Total (100%)	X^2	P-value
Noise	Yes	58 (59.2)	40 (40.8)	98	49.911	<0.001
	No	39 (18.8)	168 (81.2)	207		

4.12 Multivariate analysis for the right ear

The variables in the bivariate analysis were further analyzed using the multiple logistic regression model. The result of the multivariate analysis for the right ear is presented in table 17 below.

Age, history of ear discharge, head injury, measles and noise had independent effects on hearing loss. Individuals aged less than 10 years are 3 times less likely to have hearing loss compared to those 10 years and above (OR=0.39, 95% CI=0.23-0.68). Also, individuals who have ever had ear discharge are about 3 times more likely than those who never had ear discharge to develop hearing loss (OR=2.80, 95% CI=1.23-6.38). The relationship is statistically significant (p=0.014).

Head injury(p<0.001) is a risk factor as individuals in this category are 5 times more likely to have hearing loss than those without history of head injury (OR=4.54, 95% CI=1.97-10.44).

Individuals who had measles are 11 times more likely to have hearing loss than those who have never had measles (OR=11.26, 95% CI=4.79-26.49). The relationship is statistically significant (p<0.001).

Noise is a risk factor as individuals who were exposed to noise are 8 times more likely to have hearing loss than those without noise exposure (OR=8.32, 95% CI=3.99-17.38). This association is statistically significant (p<0.001).

Table 17: Results of multiple logistic regression in respondents with hearing loss on their right ear

Variables	Categories	OR	95% CI	P-value
Age (years)	Less than 10	0.395	0.228-0.682	0.001
	>=10 (Ref)	1		
Ear discharge now	Yes	3.788	0.582-24.655	0.163
	No (Ref)	1		
Ever had ear discharge	Yes	2.800	1.230-6.376	0.014
	No (Ref)	1		
Ear injury	Yes	1.612	0.705-3.682	0.258
	No (Ref)	1		
Head injury	Yes	4.540	1.973-10.443	<0.001
	No (Ref)	1		
Measles	Yes	11.259	4.785-26.493	<0.001
	No (Ref)	1		
Meningitis	Yes	1.746	0.780-3.911	0.175
	No (Ref)	1		
Mumps	Yes	1.374	0.656-2.880	0.399
	No (Ref)	1		
Noise	Yes	8.322	3.985-17.376	<0.001
	No (Ref)	1		

4.13 Multivariate analysis for the left ear

History of ear discharge, ear injury, head injury, meningitis and noise had independent effects on hearing loss. Individuals who have ever had ear discharge are about 3 times more likely to develop hearing loss than those who have never had ear discharge (OR=2.72, 95% CI=1.33-5.56). The relationship is statistically significant (p=0.006).

Individuals who have ever had ear injury are 2 times more likely than those with no history to develop hearing loss (p=0.028). Also, history of head injury and developing hearing loss is statistically significant (p<0.001). Individuals with history of head injury are about 4 times more likely to have hearing loss than those without history (OR=3.62, 95% CI=1.79-7.32).

Individuals who have had meningitis are 27 times more likely than those without history of meningitis to develop hearing loss (p<0.001).

Individuals who were exposed to noise are 3 times more likely to develop hearing loss than those without noise exposure (OR=2.74, 95% CI=1.45-5.17). This association is statistically significant (p=0.002). Noise is a risk factor for developing hearing loss.

Table 18: Results of multiple logistic regression in respondents with hearing loss on the left ear

Variables	Categories	OR	95% CI	P-value
Parental marital status	Divorced	2.716	0.900-8.196	0.076
	Married	0.962	0.228-4.051	0.957
	Single (Ref)	1		
Ever had ear discharge	Yes	2.724	1.334-5.562	0.006
	No (Ref)	1		
Ear injury	Yes	2.277	1.094-4.742	0.028
	No (Ref)	1		
Head injury	Yes	3.621	1.790-7.324	<0.001
	No (Ref)	1		
Measles	Yes	0.893	0.410-1.944	0.775
	No (Ref)	1		
Meningitis	Yes	26.521	10.521-66.855	<0.001
	No (Ref)	1		
Noise	Yes	2.739	1.450-5.172	0.002
	No (Ref)	1		

CHAPTER 5

DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1 DISCUSSION

Hearing loss is the inability to hear as well as someone with normal hearing – hearing thresholds of 25dB or better in both ears (WHO, 2014). Of all the school health programs, audiometric assessment of school-aged children are rarely carried out which could be due to lack of awareness among parents, school authorities and health care providers (Ossama et al, 2010).

In the current study, the hearing assessment of 305 primary school pupils was carried out using pure tone audiometry. Low frequency hearing loss was the commonest type of hearing loss among the school age children. The predisposing factors for hearing loss in this study include age, ear infection, history of measles and meningitis, ear injury, head injury and noise. The study findings are discussed in line with the study objectives.

5.1.1 Prevalence

The prevalence of hearing loss in this study is 13.9% in males and 16.1% in females. Similarly, Olusanya et al (2004) and Ossama et al (2010) found a prevalence of 13.9% and 13.8% respectively in males. The findings of this study are however higher than that of Mourad et al (1993) with a prevalence of 7.65% and Aqeel et al (2013) with a prevalence of 8.8%. Multiple testing (screening test and a diagnostic workup) by this researchers to rule out the false positives may have accounted for this difference. Even though a higher estimate of hearing loss was found in females compared with males, gender was not found to be

significant in the occurrence of hearing loss. There has been inconsistency in the report of gender as a risk factor for hearing loss in the literature (Lasisi et al, 2010). For example, while some have found females to be at elevated risk (Uchida et al, 2000, Bazargan et al, 2001), other researchers found males to be at a high risk (Wallhagen et al, 1997, Sixt and Rosenhall, 1997).

The study reveals that 27.5% (about 1 out of 4 pupils) and 31.8% (about 1 out of 3 pupils) have conductive unilateral hearing loss in their right and left ears respectively at not more than moderate hearing loss level. This is in consonance with other studies from Africa (Ossama et al, 2010; Aqeel et al, 2013; Olusanya et al, 2004). Sixty (19.7%) of the pupils have mild hearing loss on both ears (bilateral hearing loss). The majority of hearing impaired children in this study had mild degree of hearing loss. Mild hearing loss may not be noticed and even moderate losses may not impose a problem for people with excellent perceptual abilities and good coping skills. However, it will cause communication defects of most of those children that will be manifested in lower scholastic achievement (Ossama et al, 2010).

5.1.2 Types of hearing loss

Whilst many studies have reported conductive, sensorineural and mixed hearing losses as the types of hearing loss (Aqeel et al, 2013, Ossama et al, 2010, Ashoor et al, 2006), low frequency hearing loss was the commonest type of hearing loss among the school-aged children in this study with a prevalence of 64.9% and 71.1% in the right and left ears respectively. The finding of this research is similar to that of Olusanya et al (2004). The Kresge Hearing Research Institute in the United States reported Wolfram Syndrome 1 resulting from the mutation in the Wolfram Syndrome gene (WFS1 gene) as a cause of low

frequency hearing loss. Other reported causes include sudden hearing loss, Mondini dysplasia and Meniere's disease. However, the specific cause was not ascertained in this study.

5.1.3 Risk factors

Age has been found to have independent effect on hearing loss. This impairment occurred more often with increasing age. Children 10 years and older had significantly increased odds of developing hearing loss compared with those less than 10. This is in agreement with the findings of Josef et al (2010) who reported that there is higher prevalence of hearing loss among teenagers aged 12-19 years. The explanation may be that children 10 years and older are likely to be exposed to a high level of noise compared with those in the lower age group.

Noise exposure is a well recognized and probably the most studied environmental factor causing hearing loss (Thurston F., 2013). This study found that children exposed to noise had statistically significant increased odds of developing hearing loss. This is in line with a WHO report in 2002 which states that 7% to 21% of hearing loss is attributed to noise exposure. Geneva B. (2009) also reported that school children are suffering from the health effects of noise including hearing impairment which is as a result of the hazardous noise they are exposed to daily in their schooling environments. An explanation as to why this is so may be that high noise levels over time can cause damage to the tiny hair cells in the cochlea, which then can't transmit sounds effectively as they did before. The prevalence of hearing loss due to noise exposure in this study is approximately 60%. This is in line with the work of Smith et al (2000) who found that the numbers of young people with social noise exposure had tripled since the early 1980s. This increase of risk is consistent with a study by Niskar et al (2001)

who estimated the prevalence of noise-induced hearing threshold shift among children aged 6-19 years in the USA.

This study found that ear discharge (otorrhea) which is a clinical feature of middle ear infection is a statistically significant risk factor for developing hearing loss. This is similar to the findings of Selly and co-workers (1995) and WHO data (2003) who reported that otitis media (inflammation of the middle ear) is considered the commonest cause of childhood hearing loss in developing countries. This generally occurs because the infection blocks sound from passing through the ear canal or middle ear to the inner ear. The association between ear discharge and hearing loss has been reported by several authors (Olusyana et al, 2000; Zakzouk S., 2000; Maharjan et al, 2009). This association may be due to the fact that persistent ear discharge deteriorates hearing level with passage of time. This shows that the duration of ear discharge has a significant effect on the magnitude of hearing loss in that the longer the duration of ear discharge, the more the hearing loss.

Individuals in this study with ear injury had significantly increased odds of developing hearing loss compared with those who reported no injury to the ear. This association was found to be significant and in agreement with the WHO report in 2014 that injury to the ear leads to hearing loss. Hearing loss can be a sequel of previous head injuries. Hearing loss from head (which includes brain) injuries may be due to a disruption of the membranous portion, disturbance in the microcirculation, or hemorrhage into the fluids of the cochlea (Fransen et al, 2003). Rasmussen (1947) stated that direct head trauma, particularly trauma severe enough to cause unconsciousness can cause ossicular chain discontinuity and ear drum perforation, and subsequently conductive hearing loss. In 2010, Munjal et al observed a higher prevalence of hearing impairment in the group of patients with closed head injury compared

with control group, and also an association between the extent of auditory dysfunction and severity of traumatic brain injury. Segal et al (2002) concluded that fluctuation in hearing occurs after head trauma within the first year after trauma, after which the associated hearing loss should be considered to be stabilized.

In this study, individuals who reported history of measles had significantly increased odds of developing hearing loss. The association is statistically significant and in line with other studies (Asatryan et al, 2008 and Dunmade et al, 2006) which reported that hearing loss is a known complication of measles viral infection. This is due to blockage of the Eustachian tubes which causes a collapse in the walls of the middle ear and no air can be pumped up from the throat. A study conducted in the western area of Sierra Leone in 1991 showed that measles was responsible for 45% of cases of hearing loss. A higher prevalence of 52.9% was seen in the current study.

Meningitis is a significant risk factor for developing hearing loss in the current study. This is expected and in line with the findings of several studies (Kutz et al, 2006; Tasaduq and Lubna, 2011; Benson et al, 2013; Dunmade et al, 2002). It is thought that over 30% of bacterial meningitis cases result in some degree of hearing loss from mild impairment to profound deafness. This is seen in this study with a prevalence of 59.9%. In a 2006 study, the Gallaudet Research Institute reported that 3.2% of American youth with hearing loss had suffered meningitis, making the infection the second most common cause of hearing loss. Kutz et al, 2006; Benson et al, 2013; Tasaduq and Lubna, 2011 reported that hearing loss is prevalent in children treated for bacterial meningitis. The prevalence of 59.9% in this study was greater than findings in previous studies (Kutz et al, 2006 reported an incidence of 14%;

Tasaduq and Lubna, 2011 reported a prevalence of 43.4%). The reason may be that current pathogens are more virulent owing to continued drug resistance.

5.2 Conclusion

This study has revealed that there are children with hearing loss and those at-risk of having hearing loss in public primary schools in Obafemi Owode Local Government Area, Ogun State. Hearing loss occurred more often with increasing age and was considerably more common in females than in males, especially at higher age. The prevalence of this hearing loss reveals that about 1 out of 4 and about 1 out of 3 pupils have mild to moderate hearing loss at their right and left ears respectively. Findings from this study show that the commonest type of hearing loss is low frequency hearing loss, followed by conductive unilateral hearing loss, and then the high frequency hearing loss on either ear.

The predisposing factors to developing hearing loss was found to be ear discharge, physical trauma (ear and head injury), infectious diseases (measles and meningitis), and noise exposure which is similar to findings from both developed and developing countries. This study clarified the need for audiological assessment in school children which will improve markedly with early detection and management of hearing loss.

5.3 Recommendations

1. Hearing loss and its consequences can be detected and treated through appropriate hearing screening programs in schools, thus, it is recommended that annual hearing screening programs should be carried out in every educational setting in Nigeria so as to identify children with and those at-risk of hearing loss for early intervention to limit further loss and improve learning.

2. There is need for education and awareness programs for the general public through the media to update their knowledge on the adverse effect of undetected hearing loss, especially in school-age children.

3. Parents and teachers should be informed about the increased risk of hearing loss in children for prompt diagnostic assessment and early treatment of those with the problem.

5.4 Limitation

1. Audiological assessment is best done in a sound proof environment to minimize every noise levels for appropriate test results, but this study was carried out in schools where background noise could not be eliminated completely, thereby leading to the inability to conduct the bone conduction test.

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APPENDIX ONE

QUESTIONNAIRE ON THE INVESTIGATION OF HEARING LOSS AMONG SCHOOL-AGE CHILDREN IN OBAFEMI OWODE LOCAL GOVERNMENT AREA, OGUN STATE

Dear Respondent,

I am a postgraduate student of the department of Epidemiology and Medical Statistics, College of Medicine, University of Ibadan. I am presently carrying out a study whose objective is to determine the prevalence and factors influencing hearing loss among school-age children in Obafemi Owode LGA. Findings from this study will help to identify individuals with or at risk of developing hearing loss.

Your sincere response is encouraged as the information provided will be used for research purposes only and strict confidentiality would be ensured. Please be informed that participation is voluntary and there is no right or wrong answers.

If you have accepted to participate, please indicate your interest by signing. Thank you

Respondent's signature ----------

INSTRUCTION: PLEASE TICK (√) ANSWERS WHERE APPROPRIATE

SECTION A – SOCIO-DEMOGRAPHIC INFORMATION

STUDY ID NUMBER: ---------- DATE: ----------

S/N	QUESTIONS	OPTIONS		CODE
1.	Sex	1. Male 2. Female		
2.	Date of birth			
3.	Age (years)			
4.	Ethnicity	1. Yoruba 2. Ibo 3. Hausa 4. Other (specify)		
5.	Class of respondent	1. Primary 3 2. Primary 4 3. Primary 5 4. Primary 6		
6.	Family type	1. Monogamous 2. Polygamous		
7.	Religion	1. Christianity 2. Islam 3. Traditional		

8.	Parental marital status	1. Single 2. Married 3. Divorced		
9.	What is your father's occupation?	1. Farmer 2. Trader 3. Artisan 4. Civil servant 5. Other (specify)		
10.	What is your mother's occupation?	1. Farmer 2. Trader 3. Artisan 4. Civil servant 5. Other (specify)		
11.	What is your father's educational level?	1. None 2. Primary 3. Secondary 4. Tertiary 5. Post tertiary		
12.	What is your mother's educational level?	1. None 2. Primary 3. Secondary 4. Tertiary 5. Post tertiary		

SECTION B – HEARING EXAMINATION

13. Hearing thresholds: **Air conduction test**

SECTION C – BASIC EAR ASSESSMENT

		YES (1)	NO (2)	DON'T KNOW (3)
14.	Do you feel you have difficulty hearing?			

15.	Do you experience constant ringing in one or both ears?			
16.	Do you have difficulty with hearing in a noisy environment?			
17.	Do you experience ear pain?			
18.	Do you have ear discharge now?			
19.	Have you had ear discharge in the past 6 months or 1 year?			
20.	Have you had injury to the ear in the past?			
21.	Have you ever been involved in an accident and sustained severe head injury?			
22.	Does one of your ears hear better than the other?			
23.	Do you have any problem with your sight?			

24. Compare your previous and present academic abilities in school. How would you describe your academic performance? (1) Poor [ ] (2) Fair [ ] (3) Good [ ] (4) Excellent [ ]

		YES	NO	SOMETIMES
25.	Do you find yourself asking people to repeat themselves?			
26.	Do you find it difficult to hear clearly when your teacher is teaching?			
27.	Do you find yourself knowingly or unknowingly reading lips when people talk to you?			
28.	Do people complain that you turn the TV volume up too high?			

MEDICAL HISTORY

29. Are you presently on any drug? (a) Yes [ ] (b) No [ ]

30. If "YES", is it (a) Anti-malarial drug [ ] (b) Antibiotics [ ] (c) Aspirin [ ]

31. Have you ever suffered from any of the following health conditions in the table below?

		YES	NO
A	Febrile rash		
B	Severe headache		
C	Neck stiffness		
D	Swelling around the jaw		
E	Fever		

FAMILY HISTORY

32. Do any of your relatives have difficulty hearing? (a) Yes [ ] (b) No [ ]

33. If "YES", what is your relationship with the person? (a) Parent [ ] (b) Sibling [ ] (c) Uncle [ ] (d) Aunty [ ] (e) grandparents [ ]

RESIDENTIAL ENVIRONMENT

		YES	NO	DON'T KNOW
34.	Is your residential area noisy?			
35.	Is your house close to any Religious Centre (church or mosque) that places loud speaker outside?			
36.	Is your house close to a motorable road?			
37.	Is your house close to a manufacturing industry?			
38.	Is your house close to a market?			
39.	Do you use generator in your house?			
40.	Do your neighbors usually use generator?			
41.	Do your neighbors frequently play loud music?			

RESIDENTIAL ENVIRONMENT

		YES	NO	DON'T KNOW
34.	Is your residential area noisy?			
35.	Is your house close to any Religious Centre (church or mosque) that places loud speaker outside?			
36.	Is your house close to a motorable road?			
37.	Is your house close to a manufacturing industry?			
38.	Is your house close to a market?			
39.	Do you use generator in your house?			
40.	Do your neighbors usually use generator?			
41.	Do your neighbors frequently play loud music?			

APPENDIX TWO

Audiometric assessment of pupils