

**PRE-SCHOOL HEARING SCREENING IN A SELECTED SCHOOL IN  
KORLE BU, GHANA**

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The crest of the University of Ghana is a shield-shaped emblem. It features three golden palm trees at the top, a central golden symbol resembling a stylized 'G' or a traditional Ghanaian motif, and a golden banner at the base. The shield itself is light blue.

**A DISSERTATION SUBMITTED TO THE DEPARTMENT OF  
AUDIOLOGY, SPEECH AND LANGUAGE TEHRAPY,  
SCHOOL OF BIOMEDICAL AND ALLIED HEALTH SCIENCES,  
UNIVERSITY OF GHANA  
IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE  
AWARD OF MASTER OF SCIENCE DEGREE IN AUDIOLOGY**

**JULY 2013**

## DECLARATION

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

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## **DEDICATION**

I dedicate this work to my beloved wife Rose Tumpi and my four lovely daughters especially the twins, Ruth and Ruthann Tumpi

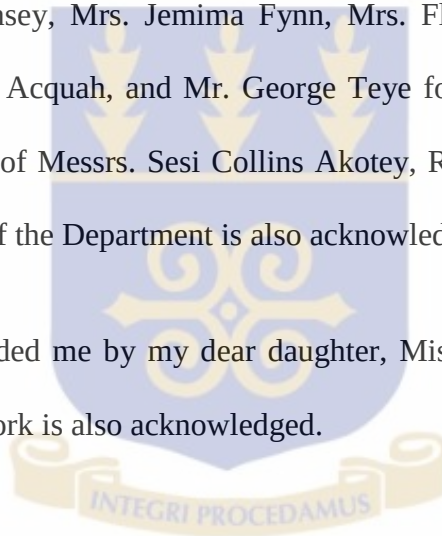


## ACKNOWLEDGEMENT

The pleasure is mine to express my profound gratitude to God almighty for giving me the strength, energy and grace to accomplish this work. I also wish to acknowledge the efforts of my supervisors Dr. Samuel Anim-Sampong and Prof. Emmanuel Dornu Kitcher for their valuable contributions to my work via suggestions, corrections, guidance and support.

I will also like to thank Dr. Neal Boafo, a Clinical Audiologist and Lecturer in the Department for his technical and professional support in realizing the goals of this research dissertation. I am indebted to my fellow colleagues of the Hearing Assessment Centre of Korle Bu Teaching Hospital - Mrs. Grace Ocansey, Mrs. Jemima Fynn, Mrs. Florence Mensah, Mrs. Josephine Decker Aryee, Mrs. Rejoice Acquah, and Mr. George Teye for their interest and support. The moral and technical support of Messrs. Sesi Collins Akotey, Ronald N. Adjekum and Anthony Azaglo, all former students of the Department is also acknowledged.

Finally, the assistance accorded me by my dear daughter, Miss Mary Tumpi (MSc Audiology candidate) throughout this work is also acknowledged.



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### **LIST OF ABBREVIATIONS**

|        |                                                  |
|--------|--------------------------------------------------|
| ABR    | Auditory Brain Response                          |
| AN     | Auditory Neuropathy                              |
| APD    | Auditory Processing Disorder                     |
| ASHA   | American Speech Language and Hearing Association |
| CORs   | Conditioned Oriented Responses                   |
| dB     | Decibels                                         |
| EOAE   | Evoked Otoacoustic Emissions                     |
| EPRC   | Ethics and Protocol Review Committee             |
| KBTH   | Korle Bu Teaching Hospital                       |
| LiNKS  | Lilliput Nursery and Kindergarten School         |
| NIH    | National Institute of Health                     |
| OAE    | Otoacoustic Emissions                            |
| OHC    | Outer Hair Cell                                  |
| OKAT   | Oklahoma Auditory Taskforce                      |
| OME    | Otitis Media                                     |
| SBAHS  | School of Allied Health Sciences                 |
| UNICEF | United Nations Children's Educational Fund       |
| VRA    | Visual Reinforced Audiometry                     |

## ABSTRACT

**Background:** Hearing impairment has detrimental effects on the linguistic and educational development of children. In developing countries routine screening programmes for hearing impairment is minimal.

**Aim:** The aim of the study was to screen pre-school pupils for hearing loss and related ear pathologies and determine the prevalence of hearing loss at test frequencies for purposes of early management and intervention.

**Methods:** Across sectional study design was adopted to purposively sample and screen 150 pre-school pupils aged 3 – 5 years of a nursery school via otoscopic examinations and pure tone screening audiometry. The audiological screening was conducted in a quiet environment with a 30dBHL and 25dBHL pass/refer criteria at 500 Hz and 1 kHz to 6 kHz respectively.

**Results:** The highest prevalence of hearing loss were registered at 500 Hz (14%) and 6000 Hz (9%), while a prevalence of 6% -7% was recorded for test frequencies of 1000 Hz – 4000 Hz. Statistical analysis via chi-square tests established no significant association between pure tone hearing screening and age and gender of the pre-school children for both ears at different test frequencies (500 Hz – 6000 Hz).

**Conclusions:** The results from the study affirmed that hearing screening was very necessary at the pre-school level and provides a baseline for building a more comprehensive pre-school hearing screening protocol for early identification and detection of hearing loss

**Keywords:** Pre-school pupils, pure tone audiometry, otoscopic examination, hearing loss, prevalence.

## CHAPTER ONE

### INTRODUCTION

#### 1.1 BACKGROUND

According to the British Association of Otolaryngology and British Society of Audiology (1983), hearing loss is defined as a loss in hearing sensitivity between test frequencies of 1000 Hz - 4000 Hz. Hearing loss is the most common developmental disorder identifiable at birth (White, 1997) and its prevalence increases throughout school-age due to additions of late-onset, late identification and acquired hearing loss. The primary justification for early identification of hearing impairment among pre-school children relates to its impact on speech and language acquisition, cognitive achievements and social and emotional development. Reduced hearing acuity during infancy and early childhood, most especially during pre-school stages interferes with the development of speech and language skills. This is due to the likelihood that the child may not receive adequate auditory and linguistic stimulation required for speech and language learning as well as social and emotional development (National Institute of Health, 1993).

Childhood hearing impairment has a detrimental effect on linguistic and educational development. Data on early childhood (0-5 years) hearing impairment in developing countries is scarce or of limited value due to the lack of infant hearing screening programs (Bolajoko, 2008). Available studies are predominantly among school-aged children in mainstream schools. In developed countries, the incidence of congenital hearing loss is 0.004% in live births (White, 2004). In another study, of the 133 million annual live births in developing countries, about 798,000 (0.6%) are likely to present with permanent congenital and early-onset hearing loss

(UNICEF, 2005). In most developing countries, routine screening programmes for hearing impairment is either non-existent or their practice is minimal. This could be due to problems involved in implementing screening programmes which underscores the need for consideration of some protocols or factors towards effective implementation. In particular, some of these protocols include the availability of qualified personnel to handle the exercise, societal knowledge and acceptance of hearing impairment as a condition to slowing down a child's speech and language development, and the availability of modern equipment. Early childhood screening will therefore help in identification of hearing problems in such children for early rehabilitation.

## **1.2 PROBLEM STATEMENT**

Hearing impairment is largely considered an 'invisible' disability, and studies have shown that without any hearing screening a significant number of pre-school aged children may have substantial hearing loss which could be unilateral or bilateral in nature, conductive or sensorineural or both. A World Health Organization (WHO) report stipulated that hearing impairment in children across the world constituted a particularly serious obstacle to their optimal development and education, including language acquisition (WHO, 2010). This problem is particularly disturbing since children are expected to develop competent language ability by age 2. Hearing impairment in such pre-school children presents significant challenges to child language or speech development.

In Ghana children are enrolled into pre-school at an early age without any official screening protocol to identify suspected disabilities. As a result, children could struggle with one or multiple disabilities, rendering academic work and general development very difficult. In view of

this, the current educational reforms in Ghana stipulates that children should be screened for hearing impairment at every entry point (starting level at each educational level) into formal education to identify children with hearing disability. On the contrary and rather unfortunately, this reform, though very laudable is not being done to achieve this goal. Another major problem is the limited data on early childhood and pre-school hearing screening in Ghana. This presents further challenges to implementing mediatory measures. In the light of all these setbacks, there is the need for a study on pre-school hearing screening to estimate what the hearing status of the pupils are and to also establish the prevalence of suspected hearing difficulties.

### **1.3 AIM**

This study was aimed at screening pre-school pupils for suspected hearing loss and related pathologies, and also determines the prevalence of hearing loss at various test frequencies for purposes of early management and intervention.

### **1.4 SPECIFIC OBJECTIVES**

The objectives of this study included:

- screening pre-school children for outer ear problems like wax impactation and suspected hearing loss using pure tone screening audiometry and otoscopic examination
- determining the prevalence of hearing loss among the pre-school pupil
- investigating the existence of any significant associations between age, gender, and the outcomes of the hearing screenings at test frequencies and otoscopic examinations respectively.
- determining the pass and referral rates for right and left ears

## **1.5 RESEARCH QUESTION**

The study was guided by the following research questions:

1. What is the prevalence of hearing loss among the pre-school pupil at each test frequency?
2. Is there any significant association between age, gender, and the outcomes of the hearing screenings at test frequencies and otoscopic examinations respectively?
3. What are the pass and referral rates for right and left ears?

## **1.6 SIGNIFICANCE OF THE STUDY**

This study was very relevant because it provided sufficient data on the hearing abilities of pre-school children. It also underscored the need for future screening of pre-school children for hearing difficulties or impairment at entry points into the school system.

## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **2.1 INTRODUCTION**

This Chapter reviews relevant literature on the topic under study, for easy reference and better understanding.

#### **2.2 PREVALENCE OF HEARING IMPAIRMENT IN GHANA**

Both children and adults in Ghana are often at high risk of undetected hearing impairment (Amedofu and Fuente, 2008). Current attempts to limit the problem of hearing impairment conditions through primary prevention are inadequate and sometimes ineffective although about 50% of the hearing impairment is believed to be preventable or avoidable (Smith, 2003). A current activity aimed at preventing hearing impairment in Ghana involves the promotion of immunization against known causes of hearing impairment such as measles, mumps and rubella; improved care of maternal health before and during child delivery (Amedofu and Fuente, 2008).

The health delivery system in Ghana involves educating expectant and nursing mothers on the dangers of hearing impairment and its consequences. Its aim of early identification, detection and application of appropriate intervention has however not been achieved. For this reason, it became necessary to identify cases of hearing impairment promptly through “secondary” prevention in order to minimize its consequences or execute prompt treatment. Screening is the best-known secondary prevention process for hearing impairment (Smith 2003).



### **2.3 PREVALENCE OF HEARING LOSS AMONG PRE-SCHOOL CHILDREN**

Hearing loss is considered to be the most prevalent congenital abnormality in newborns and is more than twice as prevalent as other conditions that are screened for at birth, such as sickle cell disease, hypothyroidism, phenylketonuria, and galactosaemia (Finitzo and Crumley, 1995). It is one of the most common sensory disorders and is the consequence of sensorineural and/or conductive malfunctions of the ear. The impairment may also occur during or shortly after birth and causes may be associated with genetic factors, trauma and disease. Hearing loss may be pre-lingual (i.e., occurring prior to speech and language acquisition) or post-lingual (i.e., occurring after the acquisition of speech and language). Since hearing loss in infants is silent and hidden, great emphasis is placed on the importance of early detection, reliable diagnosis, and timely intervention (Spivak et al., 2000). Even children presenting with mild or unilateral permanent hearing loss may experience difficulties with understanding speech, especially in noisy environments, and have problems with educational and psycho-social development (Bess et al., 1988; Culbertson and Gilbert 1996).

Children with hearing loss frequently experience speech-language deficits and exhibit lower academic achievement and poorer social-emotional development compared to their peers with normal hearing (Yoshinaga-Itano et al, 1998). The period from birth to 2 years is often considered as the "critical period" for the development of normal speech and language. Normal hearing in the first 6 months of life is also considered critical for normal speech and language skills. Hence, early identification and appropriate intervention within the first 6 months of life have been demonstrated to prevent or reduce many of the adverse consequences and to facilitate language acquisition (Yoshinaga-Itano et al, 1998). Consequently, in countries with a high

standard of health care, primary services include the early detection of congenital hearing loss and the initiation of auditory habilitation before 6 months of age.

The prevalence of hearing loss in children in most developed countries is estimated to range between 2-4 children with moderate-severe hearing loss in every 1000 births. In contrast, only limited information is available in developing countries, including the Middle East (especially in the Arab countries), where the prevalence is estimated to be markedly higher than in Israel or Europe and North America (Attias et al., 2006). In developing countries, more than 10 infants in every 1000 births are estimated to be affected by a severe-profound hearing loss (Smith, 2003).

Post-newborn hearing screening is necessary in order to assist in the identification of hearing loss that is late-onset or acquired, or not identified in early infancy. The American Academy of Audiology (1997) recommends that all children should receive screening for hearing loss at least once during their pre-school years. Additionally, the American Speech and Hearing Association (ASHA) recommends screening for outer and middle ear disorders for all children age 7 months through 6 years (ASHA, 1997). Several studies support the value of using aural acoustic immittance measures for the identification of middle ear effusion in children (De Chicchis et al, 2000). Formal audiologic screening programmes are therefore particularly important in assisting with the early identification and management of hearing and middle ear disorders during the formative pre-school and school-age years (Mundy, 2001).

Pre-school programmes that provide audiologic screening services are becoming increasingly available but lack universally accepted methods on administration. Such programmes may not follow protocols recommended by professional standards and may use inadequately trained

personnel to perform the screenings (Johnson, 2002). Therefore, the applied screening procedures and referral and follow-up criteria differ among programs and may not be specific to the professional guidelines for audiologic screening (ASHA, 1997). As such, varying screening outcomes have been reported in the literature (Allen et al., 2004).

A prevalence survey in pre-school children by Hatcher et al., (1992) in Kenya reported 6.0% failure with 8.7% prevalence of impacted wax in either. Another study conducted by Amedofu and Brobby (1999) to determine prevalence of hearing impairment among some pre-school children in Kumasi District of Ghana used a total of 960 pre-school children (566 males and 394 females) with an average age of 4.5 years. In this study, otoscopy and audiometric screenings were performed. Audiometric screening was carried out at 1000 Hz, 2000 Hz and 4000 Hz and for each ear a pass was defined as responding correctly to stimuli at 30 dBHL. The findings indicated that 91.2% ( $n=881$ ) passed and 8.2% ( $n=79$ ) failed. Otoscopic examinations also showed that 9.4% ( $n=89$ ) were found with either unilateral or bilateral impacted wax.

## **2.4 IMPLICATIONS OF HEARING LOSS IN CHILDREN**

Hearing loss can have an impact on language acquisition, speech, psycho-social well-being and learning. The critical time to learn and stimulate the auditory and brain pathways is during the first 6 months to 2 years. Children presenting with all degrees of hearing loss, and who receive appropriate intervention prior to 6 months of age, can obtain speech and language skills comparable to their hearing peers by age 3 years (Yoshinaga-Itano & Apuzzo, 1998). According to the American Academy of Pediatrics (2003), ongoing review of hearing and speech age-appropriate milestones, risk factors and routine hearing screening is critical. Unidentified hearing impairments in the pre-school population are associated with speech and language delays,

decreased attention span, and academic deficits (Roberts et al, 2002). Mild hearing loss can significantly interfere with the reception of spoken language and education performance.

#### **2.4.1 Audiologic Implications**

Studies indicate that children with unilateral hearing loss (in one ear) are ten times as likely to be held back at least one grade compared to children with normal hearing (Bess et al, 1998). Chronic otitis media affects 5-30% of children aged 6 months to 11 years, and can persist for 4 to 5 months with or without medical intervention (Daly et al, 1999). During this period, a child is at risk for a fluctuating hearing loss that can affect speech and language acquisition and auditory processing (Roberts et al, 2002). In school, children must be able to listen in a noisy environment, pay attention, concentrate, and interpret information. The linguistic skill of interpreting information affects the reading success of the child. Therefore, a child with a hearing loss is at a greater risk for academic deficits since hearing has an impact on the ability to learn and how to read.

#### **2.4.2 Communication Effects**

Children with hearing loss typically exhibit delays and difficulty with tasks involving language concepts, auditory attention and memory, and comprehension. They also have problems with receptive and expressive language as well as syntax, semantics, and vocabulary development. Speech perception and production is also a major problem (ASHA, 2011).

#### **2.4.3 Academic Effects**

Children with hearing loss may have problems in academic achievement, including language arts and vocabulary. They may also demonstrate delays in development, reading, spelling, math, and

problem solving; these can lower scores on achievement and verbal IQ tests and therefore greater need for enrollment in special education or support classes as well as increased need for organization support in the classroom (ASHA, 2011)

#### **2.4.4 Social Effects**

Children may have self-described feelings of isolation, exclusion, embarrassment, annoyance, confusion, and helplessness. They may refuse to participate in group activities and may act withdrawn or sullen. Such children also exhibit lower performance on measures of social maturity and have significant problems following directions (ASHA, 2011).

### **2.5 SIGNIFICANCE OF EARLY DETECTION**

Prior to the advent of objective hearing screening test in developed countries, the median age of identification varied from 10.4 months to 43.2 months depending on the degree of hearing loss (Harrison *et al.*, 2003). Parents were usually the first to suspect hearing impairment but confirmation was always considerably delayed, sometimes by the physicians. This is due to lack of knowledge and doubts about the possibility and efficacy of hearing screening in newborns and infants (Kittrel and Arjmand, 1997).

In developing countries, parental suspicion prompted by a child's inappropriate response, or lack of response to environmental sounds is still the predominant mode of detection and occurs usually at a mean age of 22 months (Gopal *et al.*, 2001). Two objective screening tests currently available for detecting infants with hearing loss are otoacoustic emission (OAE) and auditory brainstem response (ABR).

Screening with OAE is an electro- physiologic measure of the integrity of the outer hair cells in the cochlea. OAE, also known as cochlear echoes, are low intensity sounds originating from the outer hair cells and can be elicited in response to clicks presented to the ear through a light weight probe that houses both a transducer and microphone or receiver. The emission are recorded and displayed in a wave form for interpretation in diagnostic instruments or simply produce a “pass” or “refer” result in OAE screeners. The test is relatively quick, non-invasive and does not require sleep, can be done readily for babies and acceptable to parents. The recording often takes about one minute and can be administered without audiological expertise. The ABR measures the electro physiologic function of the eighth cranial nerve and its pathways in the brainstem. Response is significantly correlated with the degree of hearing impairment. In general, the click-evoked threshold predicts behavioral audiometric threshold in the 1,000 to 4000 Hz range within 10 to 15 dB HL (Watkins, 2001).

## **2.6 ELEMENTS OF AUDIOMETRY**

### **2.6.1 Test Environment**

Threshold measurement may be affected in any test environment if the ambient noise levels present at the time of the test is high. The evaluation should be conducted in a sound treated environments designed specifically for hearing thresholds measurements. In cases where such facilities are not available, every care should be taken to perform the evaluation in the quietest room available.

The intensity level of sound in the testing room should not exceed 40 dispel (ANSI S3.1-1991) as checked using a sound level meter. A room can receive sound treatment by using materials in the room, which absorb sound. Covering the floor with any available carpeting or matting is

helpful. Acoustic tiles on the walls or ceiling can be used if available, otherwise more readily accessible materials such as drapes on the walls can be used.

### **2.6.2 Controlling the Test Environment**

There are many ways to control the test environment. The optimal test environment is quiet and free of distractions. There should be no activity outside the test room that the listener can see or hear. A person with normal hearing may be able to follow a conversation outside the test room even if the ambient noise levels meet the level specified by ANSI S3.1-1991. While audible speech would not mask the test tones, it would distract the listener, making a difficult test more difficult yet. There is no such thing as a “soundproof” test room; i.e., a room which no outside sound can penetrate. It is important that rooms are designed to attenuate nominal outside noise to the point where it won’t mask the test signals, and it is just as important to not have unnecessary noise generating activities in the area of the test room (ANSI, 1996).

### **2.6.3 Testing Protocol**

Silverman et al., (1994) evaluated the sensitivity of pure tone survey of children with middle ear effusion. The study comprised of 82 ears of children with confirmed middle ear effusion. The results from the study indicated that the sensitivity to ASHA (1985) pure tone screening to middle ear effusion were 54% (500 Hz excluded), 85% (500 Hz included), and 89% (250 Hz included). The study recommended that 500 Hz as well as 1000 to 4000 Hz should be used in pure tone screening at 20 dBHL for detection of middle ear effusion. The study also questioned the assumption in the ASHA (1985) screening guidelines that passing a pure tone screening at 1000 Hz – 4000 Hz puts one at a low risk of hearing loss.

Walker et al., (2013) purported that in family practice, pure tone testing is typically done across 500 Hz – 4000 Hz to determine if a patient's hearing falls within normal limits. The results assist in patient referrals to an audiologist or ENT. This is done at 25 dB or 30 dB for adults, and 15 dB to 20 dB for children.

## **2.7 PHYSICAL EXAMINATION OF THE EARS**

A thorough physical examination is an essential part of evaluating a child for hearing loss. Findings on head and neck examination associated with hearing impairment include difference in coloration of the irises known as heterochromia, malformation of the auricle or ear canal, dimpling or skin tags around the auricle, cleft lip or palate, asymmetry or hypoplasia of the facial structures, and microcephaly (Grunfast et al, 1992). Abnormal increased distance between two organs or bodily parts known as hypertelorism and abnormal pigmentation of the skin, hair, or eyes also may be associated with hearing loss, as in Warrensburg syndrome.

Abnormalities of the eardrum should alert the physician to the possibility of hearing impairment. A leading cause of acquired hearing impairment is otitis media with effusion (OME). Temporary hearing loss has been demonstrated during episodes of acute otitis media. A child with repeated or chronic otitis media is at high risk of acquired hearing impairment and should undergo hearing evaluation (American Academy of Pediatrics, 1996). Pediatricians should be familiar with pneumatic otoscopy and tympanometry as useful diagnostic tools in the management of OME.



## **CHAPTER THREE**

### **METHODOLOGY**

#### **3.1 INTRODUCTION**

This Chapter describes the methods and procedure adopted in carrying out the study. The details consists of the research design, study site, sample population and size, samplings technique, audiological test procedure, research instruments, data collection and data analysis. Data management and ethical issues associated with the study are also included.

#### **3.2 RESEARCH DESIGN**

Cross sectional studies are particularly useful for studying prevalence of an illness and may also support inferences of causes and effects. Carson et al., (2001) identifies cross sectional survey as purely descriptive and used to assess the burden of a particular disease or disease prevalence in a defined population. For these reasons, a cross sectional study design was adopted for this research work.

#### **3.3 STUDY SITE**

Liliput Nursery and Kindergarten School (LiNKS) situated in the residential area of the Korle – Bu Teaching Hospital (KBTH) was chosen as study site because of its relative proximity to the Department of Audiology and Speech and Language Therapy of the School of Biomedical and Allied Health Sciences. Another reason was its economic advantage in terms of transportation of equipment and other logistics for the data collection.

### **3.4 STUDY POPULATION**

The study population consisted of 150 nursery and kindergarten pre-school LiNKS pupils aged 3- 5 years. This age limit was chosen in accordance with the educational policy in Ghana which defines pre-school pupils as children between ages 3 years to 5 years.

### **3.5 SAMPLE AND SAMPLING TECHNIQUES**

According to Cohen et al., (2007), purposive sampling requires that samples in a study are handpicked on the basis of their judgment of their typicality or possession of the particular characteristics being sought. A population of 150 pupils between the ages 3 to 5 years was purposively selected for the study.

### **3.6 INCLUSION AND EXCLUSION CRITERIA**

#### **3.6.1 Inclusion Criteria**

All LiNKS pupils aged 3 – 5 years were included in the study.

#### **3.6.2 Exclusion Criteria**

The following criteria were used to exclude participants:

- All LiNKS children aged outside the 3-5 years bracket
- All non-LiNKS pre-school pupils

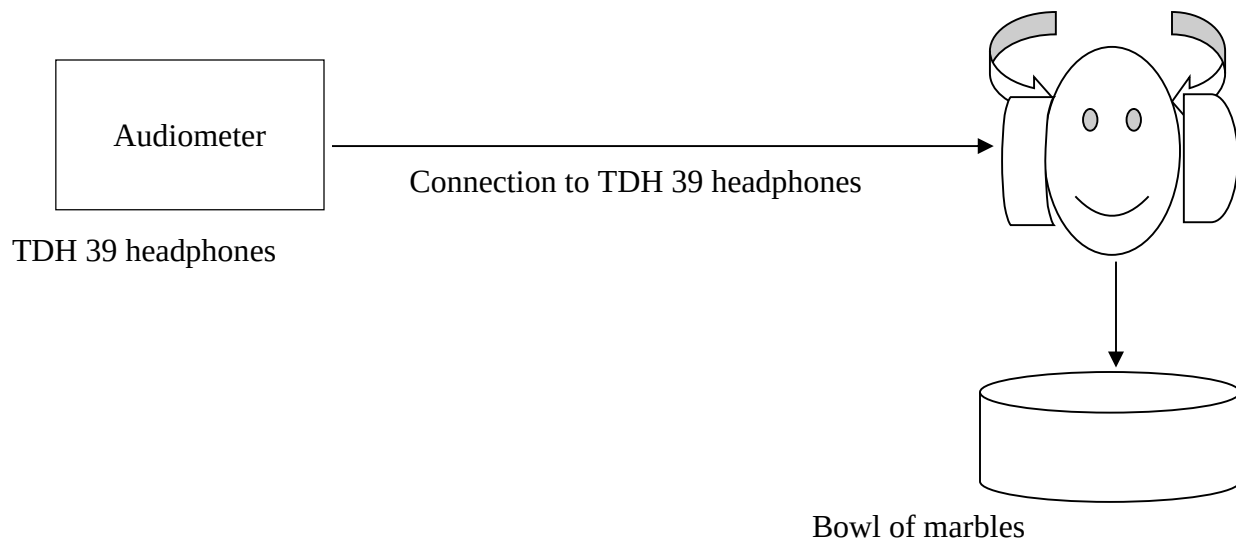
### **3.7 INSTRUMENTATION**

The instrumentation included an HS-OT10C otoscope and two Audiometers namely, an Interacoustics AD229e 2-channel audiometer and a Maico MA 40 audiometric screener

incorporating a built-in Rs 232 interface for data transfer to a computer. The audiometers were calibrated and connected to TDH 39 headphones (Table 3.1 and Fig. 3.1).

**Table 3.1: Technical specifications of audiometers**

|            | Type of audiometer                     |                                 |
|------------|----------------------------------------|---------------------------------|
|            | Interacoustics AD 229e                 | Maico MA40                      |
| Components | TDH 39 audiometer headset              | TDH 39 audiometer headset       |
|            | UP 5400 External power supply:100-240V | External power supply: 100-240V |



**Fig. 3.1: Schematic flowchart of pure tone audiometry**

The calibrated audiometers were used for behavioral measurements. Biologic calibration was done using an individual with known hearing thresholds in order to establish the consistency of the equipment on the day of testing.

### 3.8 AUDIOLOGICAL SCREENING TEST

Conditioned play audiometry presented by air conduction under headphones using warble tone was used to screen the pupils. To pass the screening, the child must respond to at least two out of three tone presentations at all frequencies in both ears. The screening was performed in the

headmistress office as it provided a relatively quiet environment conducive for the screening exercise. Initially, demographic information on pupils was recorded followed by an otoscopic examination. The outcomes of otoscopic examination were categorized as pass or refer: A pass means ear canal with a visible tympanic membrane where as a referral constituted an ear canal completely blocked with wax and/or any foreign material. Hearing screening was subsequently conducted with 30 dBHL and 25 dBHL at 500 Hz and 1000 Hz, 2000 Hz, 4000 Hz, 6000 Hz respectively using a warble test tone, initially conditioning with a 50dBHL warble tone. An average 31 dB ambient noise level was measured during the screening process.

Although ASHA (1997) recommends pure tone hearing screening to be conducted at 1000 Hz, 2000 Hz and 4000 Hz, the current study incorporated hearing screening at 500 Hz and 6000 Hz for the detection of middle ear effusion and also for experimental purposes as recommended by Silverman et al., (1994) and Walker et al., (2013)..

### **3.9 PROTOCOL FOR TESTING AND DATA COLLECTION**

The following test protocol was used for testing and data collation.

1. Perform otoscopic inspection of each ear canal. In the event of complete occlusion (impacted cerumen), foreign object, visible signs of ear disease.
2. Seat the child in a chair next to the table with the audiometer and condition the child to the test. This is done by asking the child to listen and pick small balls on a table into a basket any time sounds are heard in either ear, in this case sounds are made audible enough to be heard by child (e.g., 1000 Hz at 50 dBHL), and then the child is assisted with the desired response till they are able to respond independently.

3. Set the attenuator to 30 dBHL at 500 Hz and 25 dBHL at 1000 Hz, 2000 Hz, 4000 Hz and 6000 Hz and present the tone to obtain responses from tone presentations for pass or refer.
4. Interpret and record screening results. To pass the screening, the child must respond to at least two out of three tone presentations at all frequencies in both ears (ASHA, 1997).
5. Arrange for referral or follow-up as needed.

### **3.10 ETHICAL CONSIDERATIONS**

Ethical clearance was obtained from the Ethics and Protocol Review Committee of the School of Allied Health Sciences before the commencement of the data collection. Permission to commence the data collection was sought from the Head of the School serving at the study site. Participation of subjects conformed to the required ethical guidelines regarding the use of human subjects. Written informed consent was sought from parents of each participant before data collection with the objectives, methods of the study, and the testing process duly explained. Additionally, participants were assured of strict confidentiality with regards to their bio-data and any data generated by the study.

### **3.11 DATA ANALYSIS**

Descriptive and inferential statistics was used to present, describe, and interpret the data in light of the research questions set for the study. Cohen et al., (2007) explained that descriptive statistics do exactly what they say; that is, they describe and present data.

## CHAPTER FOUR

### RESULTS

#### 4.1 INTRODUCTION

The results of the study are presented in this Chapter. Described via descriptive and inferential statistics in respect of demographics, otoscopic examinations, pure tone audiometric screening, the results show the prevalence of hearing loss at defined test frequencies, the existence of any significant associations between age, gender, and the outcomes of the hearing screenings at test frequencies and otoscopic examinations respectively.

#### 4.2 DESCRIPTIVE STATISTICS

##### 4.2.1 Demographic Characteristics

The age and gender demographics of the pre-school children are presented in Table 4.1.

**Table 4.1: Age and gender distributions**

| Age (years)                         | Number | Percent (%) |
|-------------------------------------|--------|-------------|
| Age distribution                    |        |             |
| 3                                   | 92     | 61.3        |
| 4                                   | 19     | 12.7        |
| 5                                   | 39     | 26.0        |
| Total                               | 150    | 100.0       |
| Average age = $3.00 \pm 0.27$ years |        |             |
| Gender distribution                 |        |             |
| Males                               | 79     | 52.7        |
| Females                             | 71     | 47.3        |
| Total                               | 150    | 100.0       |

The largest population was constituted by the 3 year olds ( $n=92$ , 61.3%) while the 4 year olds constituted the least population of 19 (12.7%). The mean age of the children was  $3.00 \pm 0.27$  years. The breakdown for gender indicated more males ( $n=79$ , 52.7%) than females ( $n=71$ , 47.3%).

#### 4.2.2 Otoscopic Examination and Hearing Screening Results

Otosopic examination was conducted in both ears of the 150 children to establish a pass/refer. Subsequently, pure tone audiometric screening tests were conducted across six test frequencies: 500 Hz at 30dB, and 1000 Hz, 2000 Hz, 4000 Hz, 6000 Hz at 25dB. The results were categorized as either “pass” or “refer” for both genders. The distribution of hearing screening results at test frequencies for both ears is presented in Tables 4.2.

**Table 4.2: Distribution of hearing screening results at test frequencies**

| Ear      | Results | Test Frequencies (Hz) |      |      |      |      | Total |
|----------|---------|-----------------------|------|------|------|------|-------|
|          |         | 500                   | 1000 | 2000 | 4000 | 6000 |       |
| Right    | Pass    | 131                   | 141  | 144  | 141  | 136  | 693   |
|          | Refer   | 19                    | 9    | 6    | 9    | 14   | 57    |
| Left     | Pass    | 128                   | 138  | 139  | 137  | 136  | 678   |
|          | Refer   | 22                    | 12   | 11   | 13   | 14   | 72    |
| Combined | Pass    | 259                   | 279  | 283  | 278  | 272  | 1371  |
|          | Refer   | 41                    | 21   | 17   | 22   | 28   | 259   |

Most of the “pass” results were recorded in the 1000 Hz- 4000Hz range in both ears, with the least observed at 500 Hz. The opposite trend was registered for the “refer” test results. The number of passes in the right ear ( $n=693$ , 46.2%) marginally exceeded that in the left ear ( $n=678$ , 45.2). Overall there were more “passes” ( $n=1371$ , 91.4%) compared to “refers” ( $n=129$ , 8.6%).

The prevalence of hearing loss estimated at the test frequencies for both ears is shown in Table 4.3.

**Table 4.3: Prevalence of hearing loss at test frequencies for right and left ears**

| Test frequency (Hz) | Prevalence of hearing loss (%) |
|---------------------|--------------------------------|
| 500                 | 14.0                           |
| 1000                | 7.0                            |
| 2000                | 6.0                            |
| 4000                | 7.0                            |
| 6000                | 9.0                            |

From Table 4.3, the highest prevalence of hearing loss were registered at 500 Hz (14%) and 6000 Hz (9.0%), while a prevalence of 6.0% - 7.0% was recorded for test frequencies of 1000 Hz – 4000 Hz.

### 4.3 INFERENCE STATISTICS

Inferential statistics was applied to analyze the otoscopic examinations and pure tone audiometry results for purposes of establishing any associations with age and gender.

#### 4.3.1 Association between Otoscopy and Age

The detailed otoscopy results presented in Table 4.4 revealed no significant association between the outcome of otoscopic examination for both right and left ears and the age of participants [ $\chi^2$  ((2,  $n= 150$ ) = 3.80,  $p> 0.05$ ]. Among the 3 year olds, 88 (95.7%) and 85 (92.4%) passed the otoscopic examinations in the right and left ears, while 4 (4.3%) and 7 (7.6%) failed respectively.



**Table 4.4: Association between otoscopy and age for right and left ears**

| Age (years) | Pass | Refer | Total | $\chi^2$ | $p$ -value |
|-------------|------|-------|-------|----------|------------|
| Right ear   |      |       |       |          |            |
| 3           | 88   | 4     | 92    | 1.20     | 0.67       |
| 4           | 17   | 2     | 19    |          |            |
| 5           | 37   | 2     | 39    |          |            |
| Total       | 142  | 8     | 150   |          |            |
| Left ear    |      |       |       |          |            |
| 3           | 85   | 7     | 92    | 0.19     | 1.00       |
| 4           | 17   | 2     | 19    |          |            |
| 5           | 36   | 3     | 39    |          |            |
| Total       | 138  | 12    | 150   |          |            |

\*Significant at 0.05

Equal “pass” and “refer” rates were observed for the 4 year olds in both ears (Pass:  $n=17$ , 89.5%, Refer:  $n=2$ , 10.5%). For the 5 year olds, a similar trend was recorded involving 37 (94.9%) and 36 (92.3%) passes in the right and left ears, and 2 (5.1%) and 3 (7.7%) were referred respectively.

#### 4.3.2 Association between Pure Tone Audiometry and Age

Pure tone audiometric screening test was conducted on each participant at an intensity level of 30 dBHL across the spectrum of test frequencies. The results which were analyzed to investigate any statistical significance between pure tone audiometric screening and age in both ears for each test frequency are shown Tables 4.5 – 4.9.

**Table 4.5: Association between pure tone audiometry and age for both ears at 500Hz**

| Age (years)      | Pass | Refer | Total | $\chi^2$ | <i>p</i> -value |
|------------------|------|-------|-------|----------|-----------------|
| <b>Right ear</b> |      |       |       |          |                 |
| 3                | 78   | 14    | 92    | 3.30     | 0.21            |
| 4                | 19   | 0     | 19    |          |                 |
| 5                | 34   | 5     | 39    |          |                 |
| Total            | 131  | 19    | 150   |          |                 |
| <b>Left ear</b>  |      |       |       |          |                 |
| 3                | 77   | 15    | 92    | 3.80     | 0.15            |
| 4                | 19   | 0     | 19    |          |                 |
| 5                | 32   | 7     | 39    |          |                 |
| Total            | 128  | 22    | 150   |          |                 |

\*Significant at 0.05

The chi-square estimates of Table 4.5  $\{\chi^2 [(2, n = 150) = 3.30, p = 0.21 > 0.05]\}$ , and  $\{\chi^2 [(2, n = 150) = 3.80, p = 0.15 > 0.05]\}$  showed no significant association between the outcome of the pure tone hearing screening and age of pre-school children for both ears at 500Hz. The number of passes for the 3 year olds were highest (right ear:  $n=78$ , 84.8%; left ear:  $n=77$ , 83.7%) compared to the 4 year olds (right ear:  $n=19$ , 100%; left ear:  $n=19$ , 100%) and 5 year olds (right ear:  $n=34$ , 87.2%; left ear:  $n=32$ , 82.0%) respectively. More children were referred among the 3 year olds (right ear:  $n=14$ ; 15.2%; left ear:  $n=15$ , 16.3%) than the 5 year olds ( $n=5$ , 12.8%; left ear:  $n=7$ , 18.0%). No “refer” cases were recorded for the 4 year olds.

**Table 4.6: Association between pure tone audiometry and age for both ears at 1000Hz**

| Age (years)      | Pass | Refer | Total | $\chi^2$ | <i>p</i> -value |
|------------------|------|-------|-------|----------|-----------------|
| <b>Right ear</b> |      |       |       |          |                 |
| 3                | 87   | 5     | 92    | 2.52     | 0.31            |
| 4                | 19   | 0     | 19    |          |                 |
| 5                | 35   | 4     | 39    |          |                 |
| Total            | 141  | 9     | 150   |          |                 |
| <b>Left ear</b>  |      |       |       |          |                 |
| 3                | 86   | 6     | 92    | 1.70     | 0.55            |
| 4                | 18   | 1     | 19    |          |                 |
| 5                | 34   | 5     | 39    |          |                 |
| Total            | 138  | 12    | 150   |          |                 |

\*Significant at 0.05

At 1000 Hz frequency, no significant association between pure tone hearing screening and age was established among the pre-school children in both ears as suggested by the inferential statistics (right ear:  $\chi^2 [(2, n= 150) = 2.52, p=0.31 > 0.05]$ ; left ear:  $\chi^2 [(2, n= 150) = 1.70, p=0.55 > 0.05]$ ). Table 4.6 shows higher number of passes among the 3 year olds ( $n=87, 94.6\%$ ; left ear:  $n=86, 93.5\%$ ). The number of “refers” were fewer ( $n=9$ ) in the right ear compared to the left ear ( $n=12$ ). The referred cases among the 5 year olds were fractionally lower ( $n=9$ ) than the 3 year olds ( $n=11$ ) for both ears. A single (5.3%) “refer” case was recorded for the 4 year olds.

Table 4.7 depicts a non-significant association between the hearing screening outcome and the children’s age at 2000 Hz for both right ( $\chi^2 =0.95, p\text{-value}= 0.73 > 0.05$ ) and left ( $\chi^2 =2.34, p\text{-value}= 0.35 > 0.05$ ) ears.

**Table 4.7: Association between pure tone audiometry and age for both ears at 2000Hz**

| Age       | Pass | Refer | Total | $\chi^2$ | <i>p</i> -value |
|-----------|------|-------|-------|----------|-----------------|
| Right ear |      |       |       |          |                 |
| 3         | 88   | 4     | 92    | 0.95     | 0.73            |
| 4         | 19   | 0     | 19    |          |                 |
| 5         | 37   | 2     | 39    |          |                 |
| Total     | 144  | 6     | 150   |          |                 |
| Left ear  |      |       |       |          |                 |
| 3         | 87   | 5     | 92    | 2.34     | 0.35            |
| 4         | 18   | 1     | 19    |          |                 |
| 5         | 34   | 5     | 39    |          |                 |
| Total     | 139  | 11    | 150   |          |                 |

\*Significant at 0.05

The total pass rates for the different age groups for the right ear were higher ( $n=144$ , 96.0%) than in the left ear ( $n=139$ , 92.7%). The “refer” rates were however higher in the left ear ( $n=11$ , 7.3%) than in the right ear ( $n=6$ , 4.0%).

The statistics of Table 4.8 showed non-significant associations between the hearing screening outcome for both right ears ( $\chi^2 [(2, N= 150) = 1.69, p=0.43 > 0.05]$ ) and left ears ( $\chi^2 [(2, N= 150) = 0.40, p=0.85 > 0.05]$ ) at 4000Hz respectively while the largest number of “passes” were recorded for the 3 year olds (right ear:  $n=85$ , 92.4%; left ear:  $n=84$ , 91.3%). As observed, the “refer” rates were higher for left ear ( $n=13$ , 8.7%) than right ears ( $n=9$ , 6.0%).

**Table 4.8: Association between pure tone audiometry and age for both ears at 4000Hz**

| Age       | Pass | Refer | Total | $\chi^2$ | <i>p</i> -value |
|-----------|------|-------|-------|----------|-----------------|
| Right ear |      |       |       |          |                 |
| 3         | 85   | 7     | 92    | 1.69     | 0.43            |
| 4         | 19   | 0     | 19    |          |                 |
| 5         | 37   | 2     | 39    |          |                 |
| Total     | 141  | 9     | 150   |          |                 |
| Left ear  |      |       |       |          |                 |
| 3         | 84   | 8     | 92    | 0.40     | 0.85            |
| 4         | 18   | 1     | 19    |          |                 |
| 5         | 35   | 4     | 39    |          |                 |
| Total     | 137  | 13    | 150   |          |                 |

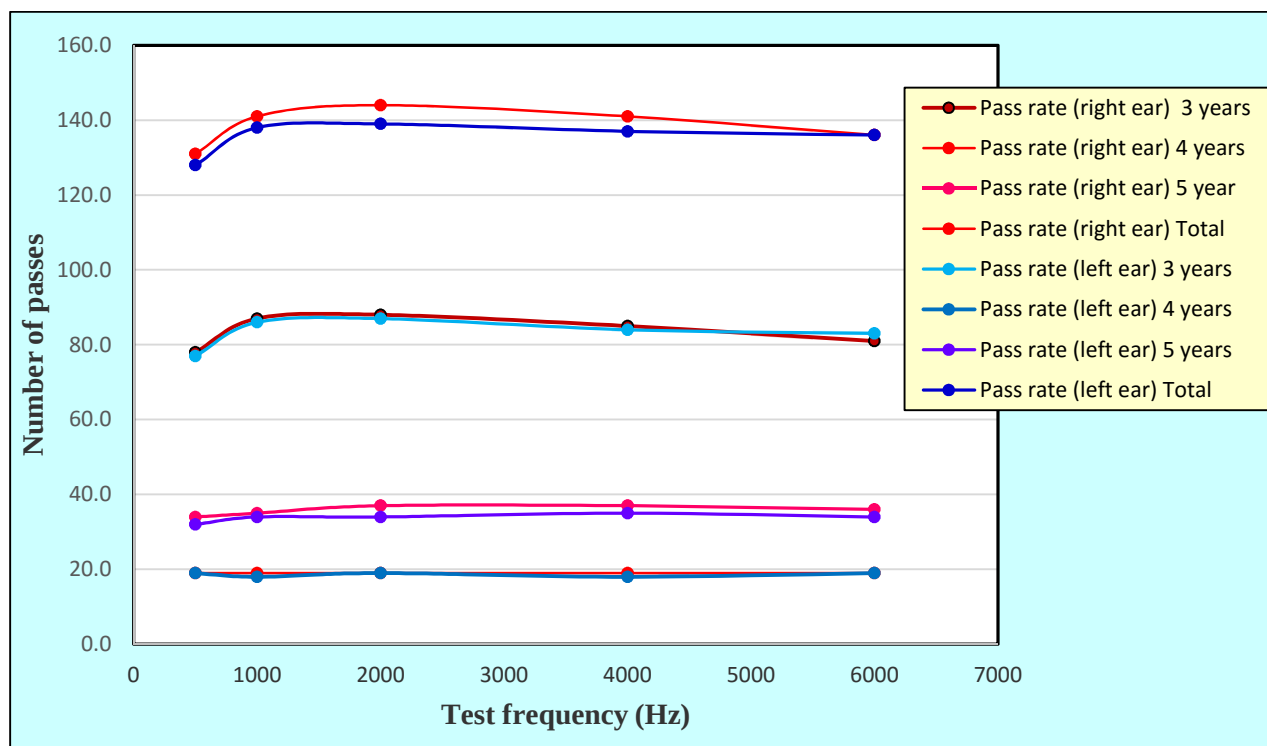
**Table 4.9: Association between pure tone audiometry and age for both ears at 6000Hz**

| Age       | Pass | Refer | Total | $\chi^2$ | <i>p</i> -value |
|-----------|------|-------|-------|----------|-----------------|
| Right ear |      |       |       |          |                 |
| 3         | 81   | 11    | 92    | 2.82     | 0.25            |
| 4         | 19   | 0     | 19    |          |                 |
| 5         | 36   | 3     | 39    |          |                 |
| Total     | 136  | 14    | 150   |          |                 |
| Left ear  |      |       |       |          |                 |
| 3         | 83   | 9     | 92    | 2.54     | 0.30            |
| 4         | 19   | 0     | 19    |          |                 |
| 5         | 34   | 5     | 39    |          |                 |
| Total     | 136  | 14    | 150   |          |                 |

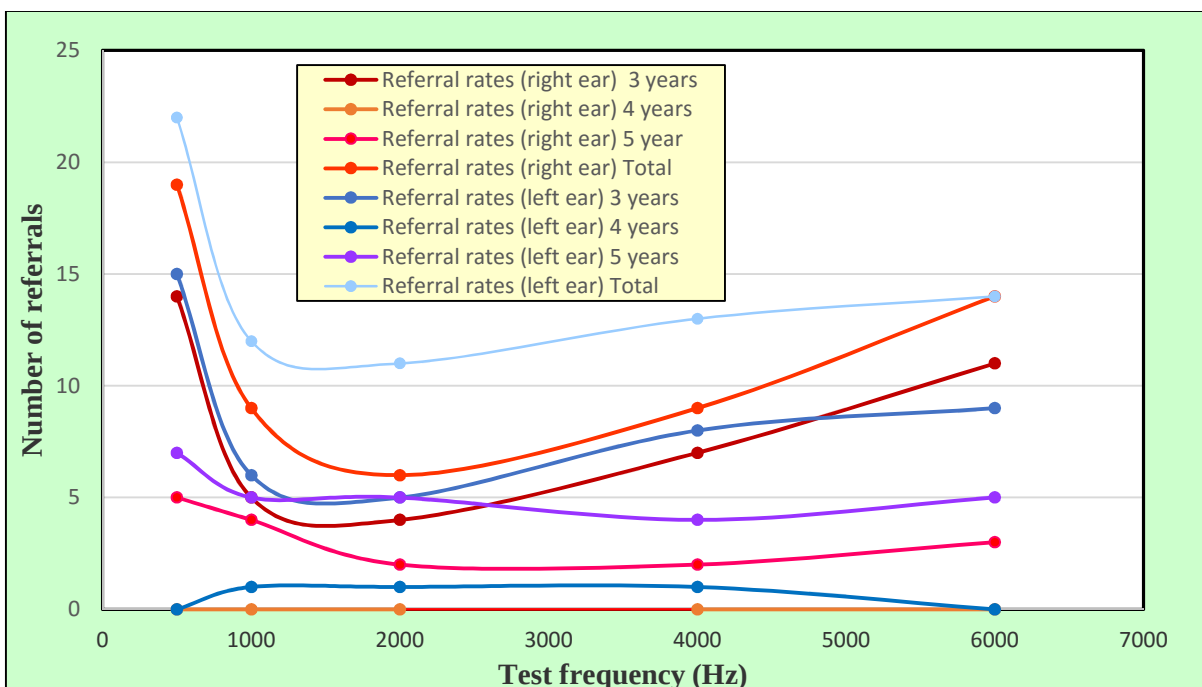
\*Significant at 0.05

At 6000 Hz (Table 4.9), no significant association between the hearing screening outcome and age was found for both ears as indicated by the statistics (right ear:  $\chi^2 [(2, N= 150) = 2.82, p=0.25 > 0.05]$ ; left ear:  $\chi^2 [(2, N= 150) = 2.54, p=0.30 > 0.05]$ . The total number of passes and referrals recorded for all the age categories in both ears were equal (pass:  $n=136, 90.7\%$ ; refer:  $n=14, 9.3\%$ ). No case of referrals was recorded for the 4 year old children.

The variations of test frequency with pass and referral rates for the different age groups of the pre-school children are shown in Figs. 4.1 and 4.2 respectively.



**Fig. 4.1: Frequency variation with pass rate for different age groups**



**Fig. 4.2: Frequency variation with referral rate for different age groups**

#### 4.3.3 Association between Pure Tone Audiometry and Gender

The association between pure tone audiometric hearing screening and gender in both ears for each test frequency was also investigated. The results are shown Tables 4.10 – 4.15.

**Table 4.10: Association between pure tone audiometry and gender for both ears at 500Hz**

| Frequency<br>=500Hz | Male |       |       | Female |       |       | Combined |       |       | $\chi^2$ | $p$ -<br>value |
|---------------------|------|-------|-------|--------|-------|-------|----------|-------|-------|----------|----------------|
|                     | Pass | Refer | Total | Pass   | Refer | Total | Pass     | Refer | Total |          |                |
| Right ear           |      |       |       |        |       |       |          |       |       |          |                |
| Number              | 69   | 10    | 79    | 62     | 9     | 71    | 131      | 19    | 150   | 0.00     | 1.00           |
| Percent             | 87.3 | 12.7  | 100.0 | 87.3   | 12.7  | 100.0 | 87.3     | 12.7  | 100.0 |          |                |
| Left ear            |      |       |       |        |       |       |          |       |       |          |                |
| Number              | 69   | 10    | 79    | 59     | 12    | 71    | 128      | 22    | 150   | 0.54     | 0.460          |
| Percent             | 87.3 | 12.7  | 100.0 | 83.0   | 17.0  | 100.0 | 85.3     | 14.7  | 100.0 |          |                |

\*Significant at 0.05

The statistics showed no significant association between pure tone audiometric hearing screening and gender for both right ( $\chi^2 [(1, N= 150) = 0.00, p=1.00 > 0.05]$ ) and left ears ( $\chi^2 [(1, N= 150) = 0.54, p =0.46 > 0.05]$ ) at 500Hz was established. Sixty nine (87.3%) males passed in both ears while 62 (87.3%) and 59 (83.1%) females passed in the right and left ears respectively. There were less referrals for both gender in both ears (male:  $n=20, 25.3\%$ ; females:  $n=21, 29.6\%$ ).

**Table 4.11: Association between pure tone audiometry and gender for both ears at 1000Hz**

| Frequency<br>=1000Hz | Male      |       |       | Female |       |       | Combined |       |       | $\chi^2$ | $p$ -<br>value |  |
|----------------------|-----------|-------|-------|--------|-------|-------|----------|-------|-------|----------|----------------|--|
|                      | Pass      | Refer | Total | Pass   | Refer | Total | Pass     | Refer | Total |          |                |  |
|                      | Right ear |       |       |        |       |       |          |       |       |          |                |  |
| Number               | 72        | 7     | 79    | 69     | 2     | 71    | 141      | 9     | 150   | 2.42     | 0.12           |  |
| Percent              | 91.1      | 9.9   | 100.0 | 97.2   | 2.8   | 100.0 | 94.0     | 6.0   | 100.0 |          |                |  |
|                      | Left ear  |       |       |        |       |       |          |       |       |          |                |  |
| Number               | 73        | 6     | 79    | 65     | 6     | 71    | 138      | 12    | 150   | 0.04     | 0.85           |  |
| Percent              | 92.4      | 7.6   | 100.0 | 91.5   | 8.5   | 100.0 | 92.0     | 8.0   | 100.0 |          |                |  |

\*Significant at 0.05

At 1000 Hz, 72 (91.1%2.8%) males and 69 (97.2%) females passed while 7 (8.9%) males and 2 (2.8%) females referred respectively in the right ear. Similarly, 73 males (92.4%) and 65 (91.6%) females passed in the left ear, while 6 each of both gender were referred. The statistics showed no significant association between the hearing screening outcome for both ears (right ear:  $\chi^2 [(1, N= 150) = 2.42, p= 0.12 > 0.05]$ ; left ear:  $\chi^2 [(1, N= 150) = 0.04, p=0.85 > 0.05]$ ).

Table 4.12 also revealed a non-significant association between the hearing screening outcome and gender for both right ears (right ear:  $\chi^2 = 0.49, p=0.48 > 0.05$ ; left ear:  $\chi^2 = 0.25, p=0.62 > 0.05$ ).



**Table 4.12: Association between pure tone audiometry and gender for both ears at 2000Hz**

| Frequency | Male      |       |       | Female |       |       | Combined |       |       | $\chi^2$ | $p$ -value |
|-----------|-----------|-------|-------|--------|-------|-------|----------|-------|-------|----------|------------|
| =2000Hz   | Pass      | Refer | Total | Pass   | Refer | Total | Pass     | Refer | Total |          |            |
|           | Right ear |       |       |        |       |       |          |       |       |          |            |
| Number    | 75        | 4     | 79    | 69     | 2     | 71    | 144      | 6     | 150   | 0.49     | 0.48       |
| Percent   | 94.9      | 5.1   | 100.0 | 97.2   | 2.8   | 100.0 | 96.0     | 4.0   | 100.0 |          |            |
|           | Left ear  |       |       |        |       |       |          |       |       |          |            |
| Number    | 74        | 5     | 79    | 65     | 6     | 71    | 139      | 11    | 150   | 0.25     | 0.62       |
| Percent   | 94.7      | 6.3   | 100.0 | 91.5   | 8.5   | 100.0 | 92.7     | 7.3   | 100.0 |          |            |

Out of 79 males, 75 (94.9%) and 74 (93.7%) passed respectively in right and left ears, while 4 (5.1%) and 5 (6.3%) failed in the right and left ears. The pass and refer rates among the 71 females were 69 (97.2%) and 2(2.8%) for right ears and 65(91.4%) and 6 (8.5%) for left ears.

**Table 4.13: Association between pure tone audiometry and gender for both ears at 4000Hz**

| Frequency<br>= 4000Hz | Male      |       |       | Female |       |       | Combined |       |       | $\chi^2$ | p-value |
|-----------------------|-----------|-------|-------|--------|-------|-------|----------|-------|-------|----------|---------|
|                       | Pass      | Refer | Total | Pass   | Refer | Total | Pass     | Refer | Total |          |         |
|                       | Right ear |       |       |        |       |       |          |       |       |          |         |
| Number                | 74        | 5     | 79    | 67     | 4     | 71    | 141      | 9     | 150   | 0.03     | 0.86    |
| Percent               | 94.7      | 6.3   | 100.0 | 94.4   | 5.6   | 100.0 | 94.0     | 6.0   | 100.0 |          |         |
|                       | Left ear  |       |       |        |       |       |          |       |       |          |         |
| Number                | 74        | 5     | 79    | 63     | 8     | 71    | 137      | 13    | 150   | 1.15     | 0.28    |
| Percent               | 94.7      | 6.3   | 100.0 | 88.7   | 11.3  | 100.0 | 91.3     | 8.7   | 100.0 |          |         |

\*Significant at 0.05

The results of Table 4.13 showed no significant association between the hearing screening outcome and gender for both right ears (right ear:  $\chi^2 = 0.03$ ,  $p=0.86 > 0.05$ ; left ear:  $\chi^2 = 1.15$ ,  $p=0.28 > 0.05$ ). Seventy four 74 (93.7%) and 5 (6.3%) males passed and failed in both right and

left ears respectively. The pass and refer rates among the females were 67(94.4%) and 4 (5.6%) for right ears and 63 (88.7%) and 8 (11.3%) for left ears.

At 6000 Hz, the statistical estimates (Table 4.14) also showed no significant association between the hearing screening outcome and gender for both right ears (right ear:  $\chi^2 = 0.12$ ,  $p = 0.73 > 0.05$ ; left ear:  $\chi^2 = 0.04$ ,  $p = 0.28 > 0.05$ ).

**Table 4.14: Association between pure tone audiometry and gender for both ears at 6000Hz**

| Frequency | Male      |       |       | Female |       |       | Combined |       |       | $\chi^2$ | $p$ -value |  |
|-----------|-----------|-------|-------|--------|-------|-------|----------|-------|-------|----------|------------|--|
| =6000Hz   | Pass      | Refer | Total | Pass   | Refer | Total | Pass     | Refer | Total |          |            |  |
|           | Right ear |       |       |        |       |       |          |       |       |          |            |  |
| Number    | 71        | 8     | 79    | 65     | 6     | 71    | 136      | 14    | 150   | 0.12     | 0.73       |  |
| Percent   | 89.9      | 10.1  | 100.0 | 94.4   | 5.6   | 100.0 | 90.7     | 9.3   | 100.0 |          |            |  |
|           | Left ear  |       |       |        |       |       |          |       |       |          |            |  |
| Number    | 72        | 7     | 79    | 64     | 7     | 71    | 136      | 14    | 150   | 0.04     | 0.28       |  |
| Percent   | 91.1      | 8.9   | 100.0 | 90.1   | 9.9   | 100.0 | 90.7     | 9.3   | 100.0 |          |            |  |

\*Significant at 0.05

Among the 79 males, 71 (89.9%) and 72 (91.1%) passed in the right and left ears, while 8 (10.1%) and 7 (8.9%) failed in the respective ears. For the female children, 65(94.4%) and 64 (90.1%) passed in the right and left ears, while 6 (5.6%) and 7 (9.9%) failed respectively. The number of total passes ( $n=136$ , 90.7%) and refers ( $n=14$ , 9.3%) were the same for both ears

## **CHAPTER FIVE**

### **DISCUSSION**

#### **5.1 INTRODUCTION**

The results of the pre-school hearing screening study conducted at LiNKS School in the Korle Bu Metropolis are discussed in this Chapter. The discussions are guided by the research questions set for the study.

#### **5.2 DEMOGRAPHICS**

A population of 150 pre-school children aged between 3 and 5 years distributed in three classes were screened via otoscopy and pure tone audiometry for hearing loss. The calculated average age of  $3.00 \pm 0.27$  years was closer to the 3 year olds because this group constituted the largest population ( $n=92$ , 61.3%) of the pre-schoolers. The gender distribution indicated a relatively larger population of males ( $n=79$ , 52.7%) than females ( $n=71$ , 47.3%).

#### **5.3 AUDITORY SCREENING**

##### **5.3.1 Outcome of Otoscopic Examination**

From the outcome of the otoscopic examinations conducted in both ears of the 150 children, there was a general observation of more “passes” compared to “refers” and this is suggestive that most of the children had normal ear canal.

From the inferential statistics, the study revealed no significant association between the outcome of otoscopic examination for both right and left ears and the pre-school children’s age as indicated via the estimated  $p$ -values of 0.67 (right ear) and 1.00 (left ear) respectively. A

common trend of more passes (right ear:  $n=142$ , 94.7%, left ear:  $n=138$ , 92.0%) than referrals (right ear:  $n=8$ , 5.3%; left ear:  $n=12$ , 0.8.0%) was observed for all the age groups

### 5.3.2 Pure tone Screening Audiometry

The highest prevalence of hearing loss were registered at 500 Hz (14.0%) and 6000 Hz (9.0%) where the least numbers of “passes” and most numbers of “refers” were recorded. The lowest prevalence rates of 6.0% - 7.0% were estimated in the 1000 Hz – 4000 Hz range. This observation agrees with earlier findings of the work by Al-Kandari and Alshuaib (2010) that majority of children were referred at lowest frequency of 500Hz and attributed the cause to possible wax impaction in the ear canal of most children. The high prevalence of hearing loss registered in the current study may also be due to the occurrence of middle ear effusion and or wax impaction.

Inferential statistics were applied to analyze the pure tone audiometry screening results across the spectrum of test frequencies. This was done to establish any associations with age and gender. The chi-square and  $p$ -values estimated at different test frequencies (500 Hz – 6000 Hz) showed a common and consistent trend of no significant association between the outcome of the pure tone hearing screening and age of pre-school children for both ears. According to the literature, hearing loss tends to increase with age (Amedofu, 2006). Hence it was anticipated that the 5 year olds would have presented with higher prevalence of “refers”. However, due to the relatively larger population of the 3 year old group, the number of “passes” and “refers” were highest among this group of children compared to the 4 year old and 5 year old children respectively.

In general, the total pass rates were higher in the right ear than in the left ear for each age group and for each test frequency. The highest pass rates were recorded at 2000 Hz. The inter-frequency variations in the pass rates for the three categories of ages were minimal. The relative changes were almost constant across the test frequency spectrum for the 4 year and 5 year olds. Conversely, the number of “refers” was higher in the left ear than in the right ear. No consistent trend was observed in the inter-frequency variation of referral rates with age. As noted for the pass rate, the least referrals were recorded at 2000 Hz for both the 3 year olds, 5 year olds and combined age for right ear.

The data gathered from the 150 pupils screened via pure tone audiometry also showed that 91.4% passed in either one ear or both for the initial screening. This is consistent with the pass rate of 91.8% observed by Amedofu and Brobby (1999). The 8.6 % referral rate in either one or both ears obtained in this study is also consistent with the observations of Amedofu and Brobby (1999) but higher than the rate reported by Bal and Hatcher (1992). This failure could be attributed to a variety of reasons ranging from environmental influence such as background noise and some disturbances from their colleagues, poor conditioning, inattention on the part of the testee, foreign body in the ear, impacted cerumen, a middle ear pathology, problems with the sensory and neural portion of the auditory system, and errors arising from the tester. This is supported by the findings of McCarter et al, (2007) who observed that cerumen is a naturally occurring, normally extruded product of the external auditory canal. It is usually asymptomatic, but can cause complications such as hearing loss pain, or dizziness when it becomes impacted, as well as interfering with examination of the tympanic membrane. As noted by McCarter et al., (2007) that wax and/or any other condition in the ear could cause hearing loss, the implications of this failure rate are therefore very critical.

Roland et al., (2008) posted that cerumen impaction is a common problem encountered by the general physician, the family physician and the otolaryngologist almost every day. They noted that some 2–6% of the general population in the United Kingdom suffers from cerumen impaction at any given time, suggesting a prevalence of 6–18 million individuals.

With respect to gender, the same statistical observations were made. In particular, the  $\chi^2$  tests of association at different test frequencies (500 Hz – 6000 Hz) showed a common and consistent trend of no significant association between the outcome of the pure tone hearing screening and gender of pre-school children for both ears. The findings of the study are consistent with the published work of Lu et al (2011) which also established no significant correlation between hearing loss and gender among pre-school children. On the contrary, a study conducted in Iran showed hearing loss was significantly more common in boys (Sarafraz & Ahmadi, 2009).

In general, the outcome of association between age and gender, and hearing loss in the current study may be due to the fact that there is no significant difference in the physical and physiological activities of 3, 4 and 5 years old children, and also regardless of gender. The fact that more number of males and females “passed” the screening tests in both ears, and fewer numbers of children had “refers” regardless of age and gender is suggestive that prevalence of hearing loss is less at younger ages for both males and females as further confirmed by Rose et al., (2003).

## **CHAPTER SIX**

### **CONCLUSIONS AND RECOMMENDATIONS**

#### **6.1 INTRODUCTION**

A study on pre-school hearing screening in a selected nursery school in Korle Bu, Accra, Ghana has been done. This Chapter presents the summary of the research findings, conclusion and some recommendations.

#### **6.2 SUMMARY OF THE STUDY**

The study was aimed at screening pre-school pupils for suspected hearing loss and related pathologies and to determine the prevalence of hearing loss at test frequencies for purposes of early management and intervention. Additionally to these, the study:

- Ascertained the existence of any significant associations between age, gender, and the outcomes of the hearing screenings at test frequencies and otoscopic examinations respectively, and
- Determined the pass and referral rates for right and left ears for both gender and at different ages.

Out of the 150 pre-school children screened via otoscopy and pure tone audiometry, 91.4 % passed in either one ear or both for the hearing screening and 8.6% referred in either one or both ears. The referral rate or percentages could be attributed to several factors ranging from the presence of middle ear pathology, wax impaction, failure to comprehend test instruction and

environmental factors. More so, the test of association at different test frequencies (500 Hz – 6000 Hz) showed a common and consistent trend of no significant association between the outcome of the pure tone hearing screening and age/gender of pre-school children for both ears

### **6.3 CONCLUSION**

The results from the study affirmed that hearing screening was very necessary at the pre-school level and provides a baseline for building a more comprehensive pre-school hearing screening protocol for early identification and detection of hearing loss.

### **6.4 RECOMMENDATION**

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

- Hearing screening in pre-school children should be encouraged in all nursery and kindergarten schools across the country.
- Awareness should be made to parents and guardians about the importance of early childhood screening
- Children identified with hearing problems should be referred to audiology centers for further assessment and for rehabilitation
- Hearing screening protocols for preschool children in Ghana should include 500 Hz.

### **6.5 LIMITATION OF STUDY**

Pre-school hearing screening is very important for detection of early childhood hearing loss and therefore the study should have provided room to cover a number of schools. However, the lack of competent audiological staff and equipment limited the study to only one selected school.



Generally, audiometric hearing assessment including hearing screening is carried out in a sound proof booth. However the hearing screening at LiNKS was done in the head teacher's office which could be termed an unsuitable environment for testing hearing. The nursery school where the study was done has accommodation problems in terms of class rooms and that compelled authorities to combine nursery and kindergarten thereby making it impossible to separate and compare results of nursery and kindergarten children.

## REFERENCES

- Al-Kandari, J. M., & Alshuaib, W.B. (2010). Hearing evaluation of school children in Kuwait. *Electromyoclin Nerophysiology*.50 (6); 309-318.
- Allen, R. L., Stuart A., Everett, D, & Elangovan, S (2004). Preschool hearing screening: Pass/refer rates for children enrolled in a Head Start program in eastern North Carolina. *American Journal of Audiology*.13; 29–38.
- Amedofu, G.K., Ocansey, G., & Barbara, B.A. (2006). Characteristics of hearing-impairment among patients in Ghana. *African Journal of Health Sciences*. 13; 110-116.
- Amedofu, G.K., & Brobby, G.W (1999). Patterns of pre-school hearing impairment among kindergarten school children in Kumasi District, Ghana. *Ghana Journal of Science*. 36,127-131.
- Amedofu, G.K., & Fuente, A. (2008). Occupational hearing loss in developing countries. *Audiology for developing countries*. 121-125
- Amedofu, G.K., Brobby, G.W., & Ocansey, G. (1997). The causes and prevalence of preschool deafness in Ghana. *African Journal of Health Sciences*.4:29-32.
- Amedofu, G.K., & Fuente. A. (2008). In Occupational Hearing Loss in Developing Countries New York: Nova Science Publishers Inc.
- American Academy of Audiology (1997). Identification of middle ear dysfunction in pre-school and school age children. Available at <http://www.audiology.org/resources/documentlibrary/pages/hearinglosschildren.aspx>.199

- American Academy of Audiology (2011). Childhood Hearing Screening Guidelines. Available at [http://www.infanthearing.org/resource/home/positionstatements/docs/ps/AAA Guidelines 2011.pdf](http://www.infanthearing.org/resource/home/positionstatements/docs/ps/AAA_Guidelines_2011.pdf).
- American Academy of Pediatrics (1996). Recommendations for preventative pediatric health care. *Pediatrics*.105, 645–646.
- American Academy of Pediatrics (2003). Prevention of Pediatric Overweight and obesity. *Pediatrics*, 112 (2), 424-430
- American-Speech-Language-Hearing Association (1972). Guidelines for Identification Audiometry.21, 98-102.
- American-Speech-Language-Hearing Association (1985). Guidelines for Identification Audiometry. ASHA 27, 49- 52.
- American-Speech-Language-Hearing Association (1997). Guidelines for Hearing Screening.17, 94-99.
- American-Speech-Language-Hearing Association (2011). Guidelines for Hearing Screening.17, 94-99.
- American-Speech-Language-Hearing Association (2012). *Guidelines for audiometric symbols*. Rockville, MD: Author.
- Anderson, K.L. (2011). Hearing screening in early childhood: What, Why, How. <http://successforkidswithhearingloss.com/wp-content/uploads/2011/12/Handout-Hearing-Screening-in-Early-Childhood.pdf>.2011.
- Anna, F.B.S., Heidi, R., & Margaret, K.M.D (2004). Causes of hearing loss for parents and families. Harvard Medical School Center for Hereditary Deafness.

- American National Standards Institute (1991). Draft Standard for the Evaluation of Hearing Conservation Program. ANSI S12.13.
- American National Standards Institute (ANSI) (1996). Specifications for audiometers. ANSI S3.6.
- Attias, J., Al-Masri, M., Abukader, I., Cohen, G., Merlov, P., & Pratt, H, et al. (2006). The prevalence of congenital and early-onset hearing loss in Jordanian and Israeli infants. *International Journal of Audiology*.45, 528-536.
- Bess, F.H., Dodd-Murphy, J., & Parker, R.A (1988). Children with minimal sensorineural hearing loss: Prevalence, educational performance, and functional status. *Ear and Hearing*. 19(5), 39-54.
- Bolajoko, O.O. (2008). The need for standardization of methods for worldwide infant hearing screening. *The Laryngoscope*, 118(10), 1830-1836.
- British Association of Otolaryngology and British Society of Audiology (1983).Method for assessment of hearing disability. *British Journal of Audiology*.17, 203-212.
- Carney, A.E., & Moeller, M.P (1997). Treatment Efficacy: Hearing Loss in Children. *Journal of Speech, Language, and Hearing Research* **41**, 61-84.
- Clark, J.G. (1981).Uses and abuses of hearing loss classification. *ASHA* 23:493-500
- Carson, D., Gilmore, A., Gronhaug, K. & Perry (2001). *Qualitative Research in Marketing* Sage, London.
- Cohen, J.Y., Pouget, P., Woodman, G.F., Subraveti, C.R., Schall, J.D., & Rossi, A.F. (2007). Difficulty of visual search modulates neuronal interactions and response variability in the frontal eye field. *J. Neurophysiol.* 98, 2580–2587

- Daly K., Hunter L., & Giebink, G (1999). Chronic otitis media with effusion. *Pediatrics in Review*, 20(3), 85-93.
- De Chicchis, A.R., Todd, N.W., & Nozza, R.J (2000). Developmental changes in aural acoustic admittance measurements. *American Journal of Audiology*, 11, 97–102.
- Finitzo, T., & Crumley, W.G (1995). The role of the pediatrician in hearing loss from detection to connection. *Pediatric Clinics of North America*.
- Gopal, R., Hugo, S.R., & Louw, B. (2001). Identification and follow up of children with hearing loss in Mauritius. *International Journal Pediatric Otorhinolaryngology*, 57, 99-113.
- Grunfast, K.M., & Lalwani, A.K. (1992). Practical approach to diagnosis and management of hereditary hearing impairment (HHI). *Ear Nose Throat J* 71 (10):479–493.
- Harrison, M., & Roush, J.W. (2003). Trends in Age of Identification and Intervention in Infants with Hearing Loss. *Ear and Hearing*. 24, 89-95.
- Hatcher, J., Smith, A., Mackenzie, I., Thompson, S., Bal, I., Macharia, I., Mugwe, P., Okoth-Olende, C., Oburra, H., & Wanjohi, Z., et al (1992). A prevalence study of ear problems in school children in Kiambudistrict. *Int J Pediatr Otorhinolaryngol*. 33(3):197-205
- Johnson, C.D. (2002). Hearing and immittance screening. In J. Katz (Ed.), *Handbook of clinical audiology* (5th Ed., 481–493). Baltimore: Williams and Wilkins.
- Kennedy, C.R., McCann, D.C., & Campbell, M.J. (2006). Language Ability after Early Detection of Permanent Childhood Hearing Impairment. *New England Journal of Medicine*, 354, 2131-2141.
- Kittrel. A.P., & Arjmand, E.M. (1997). The Age of Diagnosis of Sensorineural Hearing Impairment in Children. *Int. Journal of Pediatric Otorhinolaryngology*, 40, 97-106.

- Lü, J., Huang, Z., Yang, T., Li, Y., Mei, L., Xiang, M., Chai, Y., Li, X., Li, L., Yao, G., Wang, Y., Shen, X & Wu, H (2011). Screening for delayed-onset hearing loss in preschool children who previously passed the newborn hearing screening. *Int J Pediatr Otorhinolaryngol.* 75 (8):1045-9.
- Mccarter, D.F., Courtney, AU. & Pollart, S.M. (2007). University of Virginia Health System, Charlottesville, Virginia. *Am Fam Physician.* 75(10):1523-1528.
- Mundy, M.R. (2001). The Chapel Hill–Carrboro (NC) schools: Hearing and middle ear screening for preschool and school age children. In J. Roush (Ed.), *Screening for hearing loss and otitis media in children*. San Diego, CA: Singular Thomson Learning.
- National Institute of Health (1990). Noise and hearing loss. *NIH Consensus Statement*, 8(1), 1-24
- Noise: A review of human studies. In Axelsson (Ed), *Scientific Bases of Noise-Induced*
- Roberts, J., Burchinal, M., & Zeisel, S (2002). Otitis media in early childhood in relation to children's school-age language and academic skills. *Pediatrics.* 696-706.
- Roland, P.S., Smith, T.L., Schwartz, S.R., Rosenfeld, R.M., Ballachanda, B., Earll, J.M., Fayad, J., Harlor, A.D. Jr., Hirsch, B.E., Jones, S.S., Krouse, H.J., Magit, A., Nelson, C., Stutz, D.R., & Wetmore, S. (2008). Clinical practice guideline: cerumen impaction. *Otolaryngol. Head Neck Surg.* 139, S1–S21.
- Rose, L.A., Andrew, S., Deborah, E. & Saravana, E., (2003). Pre-school hearing screening. Pass/Refer rates for children enrolled in a head start program in Eastern North Carolina. *American Journal of Audiology.* 16(1), 4-12.
- Sarafraz, M. & Ahmadi, K.H. (2009). A practical screening model for hearing loss in Iranian school-aged children. *World J Pediatr.* 5(1): 64-72.

- Smith, A. (2003). Preventing deafness: An achievable challenge: The WHO perspective. International Congress Series. 1240, 183-191.
- Spivak, L. Datzell, L., Berg, A., Bradley, M., & Cacace, A (2000). The New York universal newborn hearing screening demonstration project: Inpatients outcome measures. *Ear and Hearing*.21, 92-103.
- Silverman, S. et al (1994).Puretone Assessment and Screening of Children with Middle Ear Effusion. *J. Am Academy Audiology*. 5(3) 173-82.
- United Nations Children's Funds (UNICEF) (2005).State of the world's children, New York. Oxford University Press.
- Walker, J. J. et al (2013). Hearing Test and Screening in Young Children. *American Family Physician*. 82 (1) 41 – 47.
- Watkins, P.M. (2001).Neonatal screening for hearing impairment. *Seminars in Neonatology*.6, 501-509.
- White, K.R. (1997). The scientific basis for newborn hearing screening. *Early Hearing Detection and Intervention (EHDI)*.Centers for Disease Control and Prevention. Atlanta, Georgia.
- White, K.P. (2004). Early Hearing Detection and Intervention Programs: Opportunities for Genetic Services. *America Journal of Medical Genetics*, 130(A), 29-36.
- World Health Organization (WHO) (1999).Health Promotion: milestone on the road to a global alliance .WHO fact sheet. No 171.Available at <http://www.Int/inffs/en/fact171.html>
- Yoshinaga-Itano, C, Sedey, A., Coulter, D., & Mehl, A. (1998). Language of early- and later-identified children with hearing loss.*Pediatrics*.102: 1161–1171.
- Yowhinaga-Itano, C & Apuzzo, A. (1998). Language of early- and later-identified children with hearing loss. *Pediatrics*.102 (5):1161-71.

**APPENDIX**

**SCHOOL OF ALLIED HEALTH SCIENCES  
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P O Box KB 143,  
Korle Bu

My Ref. No. SAHS/

Your Ref. No,

March 21, 2013

The Headmistress  
Liliput Nursery School, Korle Bu

Dear Madam,

**PERMISSION TO CARRY OUT PRE-SCHOOL HEARING SCREENING EXERCISE:  
MSc AUDIOLOGY RESEARCH PROJECT**

Mr. Daniel Avoyem Tumpi is a 2<sup>nd</sup> year MSc Audiology student in the Department of Audiology of the University of Ghana School of Allied health Sciences, Korle Bu.

He is conducting a research project in early childhood hearing in respect of his MSc Audiology research dissertation under the supervision of Dr. E.D. Kitcher (ENT Dept, Korle Bu Teaching Hospital) and Dr. N. Bofo (Clinical Audiologist). The Ethical and Protocols Review Committee of the School has reviewed and passed his work as meeting all ethical requirements.

Your school has been selected as a research site for the pre-school hearing screening. Following your earlier discussions on the subject with Mr. Tumpi, the Department and the School would be most grateful if you could kindly grant him permission to carry out the hearing screening activity in the first week of April, 2013. Thank you.

Yours faithfully,

  
Dr. S. ANIM-SAMPONG  
(Academic Coordinator)