PREVALENCE OF HEARING LOSS IN PRIMARY SCHOOL CHILDREN IN CENTRAL ZONE OF LUSAKA- ZAMBIA

BY

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2016
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A certify that this dissertation is my original work and has not been presented to any other university for a degree

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DEDICATION

I dedicate this work to my husband Edwin and my son Ethan. Your selfless act of allowing me to be absent all these years whilst I chased after my dream will always remain dear to my heart. Thank you for your patients, encouragement and support, I love you guys.
ACKNOWLEDGEMENT

I would like to acknowledge My God and My Savior as none of this would be possible without him. My family members who gave me the support in every way possible, thank you for your endless prayers. My supervisors who tirelessly worked with me through this project and my lecturers who continue to inspire me every day. Last but not least the team at Beit cure Trust Hospital-Zambia that lent me the technical support to carry out this project and my sponsor, Ministry of Health-Zambia, I will forever remain grateful to you all.
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### ACRONYMS & ABBREVIATIONS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>ABR</td>
<td>Auditory Brainstem Response</td>
</tr>
<tr>
<td>AOM</td>
<td>Acute Otitis Media</td>
</tr>
<tr>
<td>CHL</td>
<td>Conductive Hearing Loss</td>
</tr>
<tr>
<td>CMV</td>
<td>Cytomegalovirus</td>
</tr>
<tr>
<td>COM</td>
<td>Chronic Otitis Media</td>
</tr>
<tr>
<td>CSF</td>
<td>Cerebrospinal fluid</td>
</tr>
<tr>
<td>CSOM</td>
<td>Chronic Suppurative Otitis Media</td>
</tr>
<tr>
<td>DHL</td>
<td>Disabling Hearing Loss</td>
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<tr>
<td>ENT</td>
<td>Ear Nose and Throat</td>
</tr>
<tr>
<td>ETD</td>
<td>Eustachian Tube Dysfunction</td>
</tr>
<tr>
<td>GCS</td>
<td>Glasgow Coma Scale</td>
</tr>
<tr>
<td>HI</td>
<td>Hearing Impairment</td>
</tr>
<tr>
<td>HIV</td>
<td>Human Immunodeficiency Virus</td>
</tr>
<tr>
<td>HL</td>
<td>Hearing Loss</td>
</tr>
<tr>
<td>MHL</td>
<td>Mixed Hearing Loss</td>
</tr>
<tr>
<td>OAE</td>
<td>Otoacoustic emission</td>
</tr>
<tr>
<td>OME</td>
<td>Otitis Media with Effusion</td>
</tr>
<tr>
<td>PEHC</td>
<td>Primary Ear and Hearing Care</td>
</tr>
<tr>
<td>PTA</td>
<td>Pure Tone Audiometry</td>
</tr>
<tr>
<td>SNHL</td>
<td>Sensorineural Hearing Loss</td>
</tr>
<tr>
<td>TORCH</td>
<td>Toxoplasmosis, Rubella, Cytomegalovirus, and Herpes Simplex</td>
</tr>
<tr>
<td>TM</td>
<td>Tympanic Membrane</td>
</tr>
<tr>
<td>VRA</td>
<td>Visual reinforcement Audiometry</td>
</tr>
<tr>
<td>UHL</td>
<td>Unilateral Hearing loss</td>
</tr>
<tr>
<td>UON</td>
<td>University of Nairobi</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
</tbody>
</table>
ABSTRACT

**Background:** Disabling Hearing Loss (DHL) has serious implications in a child’s development as it reduces the intelligibility of speech thereby interfering with the learning process. As a result a child will end up having poor psychosocial development and low academic achievements, which will negatively impact on his/her vocational choices.

**Study objective:** To determine the prevalence of hearing loss in primary school children in the central zone of Lusaka district, Zambia.

**Study design:** Cross sectional school based survey

**Methodology:** 1277 children, aged 6 to 13 years, from public primary schools in the central zone of Lusaka district were randomly selected and examined. Clinical otologic assessment, tympanometry and audiometry screening were conducted on all participants. Children who failed the audiometry-screening test underwent a pure tone audiometry (PTA) to determine the extent and nature of their hearing impairment.

**Study area:** The study was carried out in primary schools in the central zone of Lusaka district, Zambia.

**Results:** The prevalence of hearing impairment was 11.5% consisting of conductive hearing loss (87.8%), sensorineural hearing loss (6.8%) and mixed hearing loss (5.4%). Hearing impairment was more common in male children (13.8%) compared to female children (9.3%) (P value= < 0.05). Thirty six point eight percent children had ear disease. The commonest ear disease was wax impaction (66%) found in children followed by otitis media with effusion (20%), foreign body ear (4%) and chronic suppurative otitis media (2%). The odds of developing hearing impairment in children with chronic suppurative otitis media was nine times greater than that of children without chronic suppurative otitis media OR = 9.9(95% CI, 2.33-47.43).

**Conclusions and recommendations:** The prevalence of hearing impairment in school children in central zone of Lusaka district is high. This study shows that CSOM has a statistical significant association with hearing loss and that the male children are at a higher risk of developing hearing impairment. There is urgent need for ear and hearing care awareness, and screening programs at the community level in central zone of Lusaka district.
INTRODUCTION

Eighty percent (80%) of deaf people live in low and middle-income countries. The World Health Organization (WHO) estimates 5% of the world’s population to have Disabling Hearing Loss (DHL) of which 32 (9%) million are children. DHL in children refers to hearing loss (HL) greater than 30dB in the better hearing ear. Sub-Saharan Africa records a 1.9% prevalence rate of DHL in children\textsuperscript{1}. Among congenital sensory birth defects, HL is the most common accounting for 4-6 per 1000 live births in the developing world\textsuperscript{2}. At some point in their first 10 years of life 95% of school children suffer from middle ear diseases, which will constitute a risk factor associated with hearing loss in the same age group \textsuperscript{(3, 4)}\textsuperscript{3, 4}. Many types of Hearing impairment (HI) are preventable and/or reversible with appropriate intervention and treatment.

Hearing impairment if left undiagnosed can have devastating developmental results in children. Hearing is critical to speech development, communication and learning. The retention rate (repeating a grade in school) among students with minimal unilateral sensorineural hearing loss (SNHL) has been estimated at 30\% and 37\%\textsuperscript{5}. Poor academic achievements as a consequence of learning problems have a significant impact on vocational choices. Children with hearing impairment also face difficulties interacting in a spontaneous way. They also tend to be labeled negatively and as a result end up being isolated from their peers and are left depressed. This is in contrast to blind children who are regarded with pity and understanding. The impacts of HL can be very costly on a country’s economy. In the United States of America the lifetime educational cost of DHL has been estimated at $115,600 per child\textsuperscript{6}. Once deafness is identified in a child, he/she will have to receive special education, which is very costly in developing countries. Income of individuals with HL in the third world is estimated to be 40-45\% less than the hearing population in developed countries\textsuperscript{7}.

The negative impacts of HI in children can be mitigated through early diagnosis and proper management of the HI through prevention and promotion, treatment and rehabilitation\textsuperscript{8}. Public health interventions are an ideal less costly approach of prevention of HI. Unfortunately, the real scale of HI in school children in developing
countries is not well known owing to lack of prevalence surveys. As such most of the figures used are estimates from a regional and global perspective and since the real magnitude of this problem is not fully known, political will to deal with the problem is lacking.

BACKGROUND

Anatomy and Physiology of Auditory System
The ear consists of three parts; the outer ear (auricle and external auditory canal (EAC)), the middle ear, and the inner ear. The outer and middle ear components are responsible for transmitting and transforming acoustic energy into mechanical energy whilst the inner ear converts this mechanical energy to neural energy that the brain interprets. The Eustachian tube (ET), which forms part of the middle ear cleft, equalizes middle ear pressure with the atmospheric pressure, which is a prerequisite for normal sound transmission. Blockage of the tube raises the hearing threshold by 30-40dB.

Types of Hearing Loss
The three types of HL are conductive hearing loss (CHL), sensorineural hearing loss (SNHL) and mixed hearing loss. CHL results from a reduction in the transmission of sound through the outer and middle ear. Audiometrically there is normal bone conduction threshold and an air bone gap equal or greater than 15dB. SNHL occurs as a result of failure of transduction of sound waves into electrical impulses in the cochlear or its transmission from the cochlear to the central pathways. Audiometrically, bone conduction threshold is > 25dB and air bone gap of less than 15dB whilst mixed hearing loss (MHL) refers to a combination of conductive and sensorineural hearing loss. It has a bone conduction threshold of at least 25dB and air bone gap equal to or greater than 15dB.

Etiology of Hearing Loss
Causes of hearing loss in children can be classified into 3 groups, which are prenatal, perinatal, or post natal and this is shown in table below.
### Table 1: Causes of Hearing Loss in Children

<table>
<thead>
<tr>
<th><strong>PRENATAL</strong> CHL</th>
<th>Genetic: Tunner’s syndrome, Melnick needle syndrome.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SNHL</strong></td>
<td>Intrauterine infections: Toxoplasmosis, Rubella, Cytomegalovirus, and Herpes Simplex (TORCH), Human Immunodeficiency Virus (HIV), Intrauterine teratogenic drugs: thalidomide, quinine and retinoic acid</td>
</tr>
<tr>
<td><strong>MHL</strong></td>
<td>Genetic: Di George Syndrome, Apert syndrome, Pierre Robbin syndrome</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>PERINATAL</strong> SNHL</th>
<th>Low birth weight, neonatal meningitis, anoxia, and hyperbilirubinaemia and incubator noise.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>POSTNATAL</strong> CHL</th>
<th>Cerumen impaction, otitis media with effusion (OME), acute otitis media (AOM), chronic otitis media (COM), temporal bone trauma and tumors.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SNHL</strong></td>
<td>Meningitis, syphilis, herpes zoster oticus, HIV and opportunistic infections (OI) such as toxoplasmosis &amp; cytomegalovirus, diabetes mellitus, hypertension, ototoxic drugs, noise, head injury, temporal bone tumor</td>
</tr>
</tbody>
</table>

Fifty percent of congenital causes of hearing loss are of a genetic origin, a third of which are of a syndromic nature whilst 2/3 are non syndromic\textsuperscript{11}. Deafness is one of the commonest sequela of bacterial meningitis in children. In first world countries about 10% survivors of bacterial meningitis are left with permanent SNHL\textsuperscript{12}. Cerumen impaction is the commonest cause of hearing impairment amongst school children, reporting a prevalence of 46.7% and significantly higher (42.4%) in the lower socioeconomic status in Nigeria\textsuperscript{13}. Otitis Media with Effusion (OME) is the most common cause of transient CHL in children between 1 and 5 years. Approximately 90% of children have OME at some time before their school age\textsuperscript{14}. In the first year of
life, >50% of children will experience OME, increasing to >60% by 2 years\textsuperscript{15}. Acute Otitis Media (AOM) is predominantly a childhood disease with the peak incidence seen at 3 months to 3 years\textsuperscript{16}. The WHO defines chronic suppurative otitis media (CSOM) as mucopurulent otorrea for a period of at least 2 weeks\textsuperscript{17}. CSOM is the most common cause of persistent mild to moderate HL among children and young population in developing countries\textsuperscript{18}. Amongst chronic diseases, diabetes mellitus has been associated with HL and the cause may be due to vasculature injury to the neural system of the inner ear\textsuperscript{19}. Systemic hypertension is an accelerating factor of degeneration of hearing organ\textsuperscript{20}. These two chronic illnesses cause progressive or sudden SNHL. Drugs such as aminoglycosides (gentamycin, streptomycin, kanamycin, neomycin, and amikacin), diuretics like furosemide and ethacrynic acid and cytotoxic drugs (bleomycin, cisplatin, vincristine, vinblastine and carboplatin) are known to cause HL. Other ototoxic drugs, which include aspirin, quinine, and some antiretroviral drugs (nucleoside reverse transcriptase inhibitors and non-nucleoside reverse transcriptase inhibitors) can cause HL.

### Table 2: Severity of Hearing Impairment

<table>
<thead>
<tr>
<th>Grade of impairment</th>
<th>Corresponding audiometric value</th>
<th>Performance</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - No impairment (better ear)</td>
<td>25 dB or better</td>
<td>No or very slight hearing problems. Able to hear whispers.</td>
<td></td>
</tr>
<tr>
<td>1 - Slight impairment (better ear)</td>
<td>26-40 dB</td>
<td>Able to hear and repeat words spoken in normal voice at 1 meter.</td>
<td>Counseling. Hearing aids may be needed.</td>
</tr>
<tr>
<td>2 - Moderate impairment (better ear)</td>
<td>41-60 dB</td>
<td>Able to hear and repeat words spoken in raised voice at 1 meter.</td>
<td>Hearing aids usually recommended.</td>
</tr>
<tr>
<td>3 - Severe impairment including deafness (better ear)</td>
<td>61-80 dB</td>
<td>Able to hear some words when shouted into better ear.</td>
<td>Hearing aids needed. If no hearing aids available, lip-reading and signing should be taught.</td>
</tr>
<tr>
<td>4 - Profound impairment (better ear)</td>
<td>81 dB or greater</td>
<td>Unable to hear and understand even a shouted voice.</td>
<td>Hearing aids may help understanding words. Additional rehabilitation needed. Lip-reading and sometimes signing essential.</td>
</tr>
</tbody>
</table>
Pediatric Hearing Assessment

HL assessment in children can be subjective or objective. Subjective hearing tests used in the pediatric population are behavioral observation audiometry, distraction test, visual reinforcement audiometry, cooperation test, performance test, play audiometry, pure tone audiometry (PTA) and speech audiometry.

PTA measures hearing threshold sensitivity across the range of audible frequencies useful for human communication. PTA thresholds are usually measured at sinusoidal frequencies over the range from 250 Hz to 8000 Hz. Air conduction assesses the entire auditory system from the periphery to the central portion. Bone conduction threshold reflects functions of the cochlea, regardless of the status of the outer and middle ear and it is considered to be a better reflection of sensory hearing. The audiogram is the chart on which hearing ability is recorded and shows the threshold hearing level against the frequency. PTA can be done in children 4 years and above. Speech audiometry test measures the ability of one to hear and understand speech.

Objective hearing tests include otoacoustic emission (OAE) and auditory brainstem response (ABR). OAE measures internally generated sounds produced by the cochlea whilst ABR measures electrical responses of the auditory system. Both tests are utilized in universal neonatal screening hearing programs to diagnose neonates with hearing loss.

Tympanometry assesses the middle ear condition by measuring the mobility of the tympanic membrane as a function of the TM when variable air pressures (between 200 to -200 dPa) are introduced into the ear canal. According to the Jerger classification system there are three types of tympanograms\textsuperscript{21}. These are A, B and C. Type A tympanogram has peak compliance between -100 and 100dPa. Type As is shallow, and Ad has a high compliance peak (off the chart). Type B tympanogram is a flat trace with no peak compliance while type C has its peak compliance in the negative pressure range beyond -100dPa. Type A represents normal middle ear function, type As represents tympanic membrane and ossicular chain stiffness whilst type Ad represents a flaccid tympanic membrane or a disarticulation of middle ear ossicles. Type B suggests OME if ear canal volume is normal, occluded EAC with
wax or debris if canal volume is small and a perforated tympanic membrane if the canal volume is large. Type C is seen in Eustachian tube dysfunction.

**Screening for Hearing Loss**

Screening school age groups is aimed at identifying children with hearing loss who were not identified at birth, lost to follow-up, or who developed hearing loss later. This exercise ensures that children with HL are identified and managed appropriately at the right time before severe consequences set in. This way the child is afforded an opportunity to attain his/her academic potential. Screening audiometry is used for children above the age of 4 years and it is conducted in a room where there is minimal external noise. PTA test is used at tones across frequencies 500 to 4,000 Hz at the upper limits of normal hearing (15 to 20 dB). Results are recorded as pass, if the patient's hearing levels are within normal limits. If a fail is recorded, a repeat screening test or a threshold search test is recommended.
LITERATURE REVIEW

Hearing loss is a disability that can have profound consequences on development of speech, language, and cognitive skills in children. Lack of data describing the prevalence of HI in most developing countries especially in children makes it difficult to quantify the magnitude of the problems it causes. Presently Zambia uses regional prevalence to estimate its own prevalence.

Stevens et al estimated regional and global hearing impairment prevalence from sparse data. Prevalence of hearing impairment was estimated by region, sex, and age and hearing level by using data from 42 studies. HL prevalence in children between ages 4 and 15 years in sub-Sahara African region was found to be 70.9%, 12.2%, 2.4%, 0.6%, 0.2% and 0.1% for mild, moderate, moderate-severe, severe, profound and complete hearing loss respectively. Classification of levels of hearing loss used by Stevens et al was different from the WHO classification of severity of HL. In this study mild HL was taken to be between 20 and 34dB (WHO mild HL ranges between 26 and 40dB). As a result of this the prevalence of HL in this study was much higher than what the WHO would suggest according to its classification.

Mugabo, for his MMED thesis at The University of Nairobi (UON) conducted a descriptive cross sectional survey on a total of 1073 children between ages 6-13 years old in Kigali, Rwanda and found that the overall prevalence of HI was 13.3% with CHL being the most common type of HL at 11.4%. The causes of CHL in decreasing order were cerumen impaction at 18%, OME at 6.7%, ETD at 4%, CSOM at 2.1%. HL in boys was found to be at 7.2% whilst in girls, it was at 6.2%. Mugabo reported that some parents removed wax and foreign bodies from their children’s ears prior to the examination, and this could have affected the prevalence rates of HL and prevalent causes of HL in these populations.

In a community-based, retrospective case-control study of school entrants in an inner city in Nigeria, Olusanya et al found that the prevalence of hearing loss was 13.9%. Middle ear abnormalities accounted for 20.9% of the population with hearing loss, of which 18.7% was as a result of OME. The high prevalence of HL in Olusanya’s study can be explained by the classification of HL taken from PTA average greater
than 15dB in the worse ear. Similar to Mugabo’s study some parents in this study removed impacted wax and foreign bodies from their children’s ears prior to the examination, and this too could have affected the outcome of the study. OME was the leading cause of HL in this study.

Tahir et al conducted a survey during 2008–2009 in 170 schools on Karachi’s school children between the ages of 5–15 years. The study revealed no significant difference in the prevalence of HI between males (14.1%) and females (13.0%). 12.0% had mild hearing loss (26–40 dB); 0.8% had moderate hearing loss (41–50) dB; 0.6% had moderately severe hearing loss (51–70 dB); and 0.2% children had severe hearing loss (71–90 dB). Among the hearing impaired children most (88.2%) had CHL, 58 (8.3%) had SNHL and 24 (3.5%) children had mixed type of HL. A majority (61.2%) of children with CHL had impacted wax in one or both ears25. From a total of 354 students, 121 who failed the screening test left the study and did not present themselves to the second phase. As such the statistics in terms of type and grade of HL might have been underestimated.

Prakash et al conducted a prospective study of patterns of otologic diseases on 1245 school children aged between 5-12 years in the time period of June 2007 - May 200826. Out of 1245 children, 64.0% were male and 36.0% female. The most common otological diseases were ear wax (60.6%), followed by CSOM (5.7%) and OME (3.7%). In CSOM, 85.9% consisted of tubotympanic type. Overall otological diseases were present in 75.7% children.

Taha et al investigated the prevalence and causes of hearing impairment (HI) among Egyptian primary-school students where a total of 555 children (6-12 years of age) from a rural and an urban school in the Shebin El-Kom district of Egypt were screened for HI at their schools27. The prevalence of confirmed HI was 20.9%. Rhesus incompatibility, house crowding, passive smoking, consanguineous marriages, birth order > 3 were some of the risk factors associate with the high prevalence associated with the high prevalence rate. The rate of HI did not differ across the schools. Minimal to mild CHL was the most common type of HI. There was no difference in rate of HL between schools in urban and rural settings. The prevalence
of SNHL could have been underestimated because SNHL was considered to be elevated thresholds with ABG of $\leq 5$dB instead of $<15$dB.

Chishimba PN in 1997 carried out a case control study to identify risk factors for childhood HL among children in special education units in primary schools in the Copperbelt province in Zambia where 50 cases and 99 controls were selected from the school registry$^{28}$. The study demonstrated that children born of illiterate mothers residing in crowded and densely populated areas were more likely to have hearing impairment. History of meningitis, which was found in 30% of the cases studied, was the most important factor associated with HL. The odds of having hearing impairment were increased among children with history of OM, measles and family history of deafness. Chishimba’s study in Zambia found that meningitis was the most common cause of profound HL amongst deaf children enrolled in special education units.

Karanja at UON for his MMED thesis conducted at Kenyatta National Hospital (KNH) revealed a prevalence of 43.4% of SNHL in children who had suffered bacterial meningitis. Glasgow Comma Scale (GCS)$<8$ on admission, development of seizures, concurrent cranial nerve neuropathy, positive CSF culture and fever above 38.7 degree Celsius were found to be strong risk factors for HL secondary to meningitis$^{29}$. 

Clark J L conducted a HL survey on 2685 students with ages ranging from 1 to 20 years at a preschool and primary school in Chicuque and Maxixe, Mozambique$^{30}$. The study showed a prevalence of 5% with varying degrees of HL resulting from multiple etiologies. Cerumen impaction was the greatest otoscopic abnormality followed by OME in those students identified with hearing loss. Out of the 145 children with HL, 27 had actively discharging ears. In this study, 79% of the children had mild HL, which was interpreted to be high. One of the reasons for this finding was that the study was conducted in the winter season. The study used OAE in the screening phase and about 2255 students who passed were released from the study. This means that some students who had silent episodes of otitis media were not captured in the study as tympanometry was only done in cases of an OAE fail. Unlike most of these studies mentioned, the age range used in this study was very wide as older children were also included in the study population.
In Sierra Leone a community based study conducted by Seely et al found a 9.1% prevalence of HI\textsuperscript{31}. The prevalence of bilateral profound hearing impairment was 4.0 per 1000. A history of otorrhea persisting longer than 1 month was found to be a strong associated risk factor. Weaknesses of this study were that there was a greater number of boys compared to girls and age was difficult to verify as such the average age calculated did not reflect the real average age. The strength of this study is that it is a community-based study, which was able to capture more children that would be captured in either clinical or school settings.

From the reviews above it is clear that prevalence of HL in children varies from country to country in Africa. Western African countries reported a prevalence of 13.9% and 9.1% in Nigeria and Sierra Leone respectively\textsuperscript{(24,19)}. Rwanda in East Africa showed a prevalence of 13.3% while Mozambique in Southern Africa showed 5\%\textsuperscript{(23,30)}. We can safely conclude that prevalence of HL varies from country to country irrespective of the region of the continent. Taha’s study in Egypt showed that there were no differences between urban and rural settings. CHL was reported to be the most common type of HL with cerumen impaction and OME being the leading causes.
STUDY JUSTIFICATION
The effects of hearing loss rob a country of an underutilized human workforce made up of citizens who could potentially be more productive and contribute positively to their country’s economy. It further cripples the level of economy of a nation through expensive rehabilitative exercises.

Zambia is a low-income country where 45 percent of the population is under 15 years of age. The ability to communicate effectively is vital for breaking the cycle of poverty through education. In children HL is a major problem and is a cause of poor education and ultimately poor job prospects. Identification of this problem should be given high priority like it is done in developed countries. According to the WHO, 50% of hearing loss can be prevented through primary prevention. Literature reviewed shows that most of the causes of HL in school children are cerumen impaction and middle ear infection. These can be adequately treated and by so doing HL can be prevented.

The WHO is currently trying to implement a primary ear and hearing care (PEHC) program as part of primary health care in developing countries and urges its member states to prepare national plans, within the framework of primary health care. The magnitude of the problem caused by hearing loss and its significant cost is not accurately known and as such there is a lack of political will to deal with the problem. This study hopes to quantify the magnitude of HL in school children and provide prevalence data on HI among school children in Lusaka district in Zambia.

RESEARCH QUESTION
What is the prevalence of hearing loss among primary school children in the central zone of Lusaka district – Zambia?

OBJECTIVES

Broad Objective
To determine the prevalence of hearing loss in primary school children in the central zone of Lusaka district- Zambia
Specific Objectives

To determine the prevalence of hearing loss amongst primary school children aged 6-13 years in the central zone of Lusaka District.

1. To determine ear diseases associated with hearing impairment among school children with hearing loss in the central zone of Lusaka District.

2. To determine types of hearing loss in school children in the central zone of Lusaka District.

3. To determine severity of hearing loss in school children with hearing loss of the central zone in Lusaka District.
STUDY METHODOLOGY

Study design
Cross sectional school based survey

Study Setting
The study was done in five primary schools in the central zone in Lusaka district, Zambia.

Study Population
Primary school children in the central zone of Lusaka district.

Sample Size
The following sample size determination formula for incidence studies (Lwanga SK & Lameshow S, 1991) was used to estimate the proportion of population study size

\[ n = N \times p \times \left( Z^2 \times (1 - p)^2 \right) / \left( 0.001 \times d^2 \right) \]

\[ n = 225,000 \times 0.133 \times \left( (1.96^2 \times 0.5^2) / 0.001 \times (0.05)^2 \right) \]

\[ n = 1150 + 10\% \text{ attrition} \]
\[ n = 1260 \]

\( n \) = the required sample size
\( Z \) = statistic for 95\% level of confidence = 1.96
\( P \) = prevalence of hearing impairment (13.3\%) Rwanda prevalence (similarities in size of country’s population)
\( d \) = margin of error of 5\%
\( N \) = total population
\( q \) = 0.5 proportion of population affected (assumed 50\%)

For this study 1260 students was the targeted sample size. 1277 students were recruited for the study.

Sampling Procedure
Public schools in Lusaka district are grouped in four zones according to their geographical location. Schools in the central zone are centrally located in Lusaka district and easily accessible. As such this named zone was used for this study. Only
public schools were selected. From these schools only co-education (the education of pupils of both sexes together) schools were randomly sampled. Central zone has 10 co-education schools. Fifty percent of these schools (5 schools) were chosen through random sampling. Each school on an average has 7 classes per grade, and about 40-60 students per class. Seven to ten classes in each school were recruited for the study. The children were selected by convenience sampling.

**Inclusion Criteria**

The inclusion criteria was as follows:

1. Children aged 6 to 13 years old
2. Children whose parents/guardians did not consent to this study.
3. Children who cooperated throughout the evaluating process

**Exclusion Criteria**

The exclusion criteria was as follows:

1. Children outside the age bracket of 6 to 13 years old
2. Children whose parent/guardians did not consent to this study.
3. Children who did not cooperate throughout the evaluating process.

**STUDY DURATION**

The study was conducted between September and October 2015 after approval from KNH/UON Ethics and Research Committee (P232/04/2015) and The University of Zambia Biomedical Research Ethics Committee (REF. NO. 015-08-15).

**DATA COLLECTION PROCEDURE AND INSTRUMENTS**

**Training**

All research participants were given a one-day training by the principal investigator and the audiologist so as to familiarize themselves with registration, interviewing and examining the participants.

**Data collection**

The principal investigator was assisted by a research assistant to record participants’ biodata and socio-demographic characteristics using a standardized structured questionnaire.
**Materials:**
- Diagnostic audiometer (AD 27)
- MTP10 hand held tympanometer and plugs
- Sound level meter
- Headlight
- Otoscope
- Aural speculums
- Jobson probes
- Foreign body /wax hooks
- Crocodile forceps
- Metallic ear syringes
- Warm water and cold water containers
- Kidney dishes
- Towels and Macintosh
- Instrument container
- Ceruminolytic drops
- Consumables

**PROCEDURE**

An introductory letter was obtained from ministry of health explaining the nature of the study. This letter was taken to the district education office through the provincial education office seeking authority to conduct this study in Lusaka district primary schools. Random sampling was done for selection of schools and the district education office wrote an introductory letter to the selected schools. The purpose of the study was explained to the head teacher and teachers and the pupils were selected by convenience sampling. A meeting with the parents through a parent teacher association was organized where parents were informed of the research and consent was obtained.

On the day of the study a quiet classroom was selected at the school where the examination was conducted and the ambient noise was measured using a sound level meter. The examination procedure was explained and demonstrated to the children.

Bio data of each participant was recorded with the help of the class teacher prior to starting the examination. The examination commenced with otoscopic examination of
both the right and left outer and middle ear. In this study a swollen and tender pinna/EAC was considered to be otitis externa whilst fungal infection was diagnosed based on fungal debris in the EAC. Chronic suppurative otitis media (CSOM) was diagnosed based on the presence of mucopurulent discharge through a perforated tympanic membrane of more than 2 weeks duration. Tympanometry of both ears followed thereafter with a MTP10 tympanometer. OME was diagnosed based on a type B tympanogram with EAC volumes of less than 1ml. Eustachian tube dysfunction (ETD) was diagnosed based on a type C tympanogram. Subjects found to have impacted wax were subjected to audiometric screening first prior to removal of wax using jobson probes. Audiometric screening using an audiometer (AD 27) was performed in both ears at a tone of 30dB at 1, 2 and 4 kHz frequencies with the test repeated at 1 kHz. The child was asked to raise his or her hand when a sound was heard. Air-conduction hearing threshold levels of greater than 30dB at any of these frequencies were taken to indicate possible hearing loss. If the response obtained at 1 kHz was different from the first audiometry screening, the process was repeated on the subject. Subjects who failed to hear the screening tone at any of the frequencies were further subjected to audiometric testing (PTA) for thresholds to determine the severity of hearing impairment and type of HL. A pass was defined as correct responses to signals at all frequencies in both ears whereas a fail was recorded if no response to one or more frequencies in at least one ear was obtained.

PTA test was done on subjects who failed the audiometric screening test. The procedure was explained to each child before it was done. The child being tested was seated facing the examiner but shielded from the control panel. The subject was fitted with headsets and testing was done for the right ear and then the left. Each time the subject heard the sound, he/she would respond to the tester by raising their hand. Sound would be presented at 60dB at 1 KHz. If no response was obtained at this threshold, it would be increased in 10dB steps until the subject responded to the sound. Once the child heard a sound the threshold of hearing would be established by decreasing the tone by 10dB steps and increasing it by 5 dB steps until the child confirmed the threshold on 3 successive occasions. On the other hand if a response was obtained at 60dB, the sound level would be decreased by 10 dB until the child did not hear the sound. The threshold was then established by increasing threshold by 5 dB and decreasing by 10dB until the child confirmed it on 3 consecutive occasions.
The threshold would be established in a similar manner at 2, 4, 0.5 kHz and finally at 1 kHz again. The ambient sound levels ranged from 45 to 55dB.

**Figure 1: Study Flow Chart**

1. The principal investigator with the help of two ENT clinical officers carried out all otoscopic assessments and together with the audiology team performed the tympanometry, audiometry screening and PTA.
2. Parents were advised not to clean their children’s ears prior to conduction of the study.
3. Screening was conducted outside recess and lunchtime as the noise levels were expected to be high during these times.
4. Daily biological calibration was done.
Data Management and Statistical Analysis
Data was analyzed using SPSS version 20.0. Descriptive analysis was done to determine means, frequencies and proportions of the various variables and findings were presented by means of graphs, tables and charts where appropriate. Chi-square test was used to assess any associations/relationships between outcomes and other variables. Confidence level was be taken as 95% (p <0.05) where applicable. Data was stored under lock and key with password protected files under the custody of the principal investigator to prevent any illicit access to the data. Use of coded data was done to ensure maximum confidentiality.

ETHICAL CONSIDERATIONS
- Approval was sought from Ethical Committee of University of Nairobi – Kenyatta National Hospital in Nairobi Kenya and The University of Zambia Biomedical Research Ethics Committee.
- Permission from Ministry of education of Zambia was obtained.
- Consent was obtained from children parents/guardians.
- Pupils with other ENT disease(s) were referred to the ENT clinic at the Beit Cure Hospital for treatment and follow up free of charge.
- At the end of the study, the raw data will be destroyed and deleted from any existing hard copies by paper shredding and formatting and deleting from any soft copy storage devices including computers, flash discs and hard disks.
- The findings of this study will be shared with others via publications in scientific journals and scientific meetings

Dissemination and Application of Results
The report of the study findings will be submitted to the university in form of a thesis. The findings will also be shared with various stakeholders through presentations in meetings, seminars, conferences and other scientific forums. Copies of the study report will be available in the resource centers for the ENT department and the University of Nairobi Library and online portal, for reference and dissemination. The findings will advise on concrete suggestions on which noble and effective strategies should be implemented.
RESULTS

The study was conducted in five different primary schools in the central zone of Lusaka district. Among the children screened for hearing impairment there was representation of pupils from grade 1 through to grade 7. There were a total of 1277 children recruited into the study from five schools namely Jacaranda, Mtendere, Kabulonga, Kalingalinga and Vera Chiluba primary schools.

Distribution of Children Recruited

![Bar graph showing the distribution of children recruited amongst primary schools in central zone of Lusaka district.]

Figure 2: Distribution of children recruited amongst primary schools in central zone of Lusaka district.

The study was conducted in five different primary schools in central zone of Lusaka district. We recruited 403 children from Vera Chiluba Primary School, 344 pupils from Jacaranda Primary School, 248 pupils from Mtendere Primary School and 204 pupils from Kalingalinga Primary School. The least number of pupils was 78 from Kabulonga Primary School.
Age Distribution of Children Recruited (The ages represented here are complete years)

Figure 3: Age distribution of children (6-13 years) attending school in central zone, Lusaka district

The mean age of the children was 10.3 years (SD ± 1.97) and ranged from 6 to 13 years. The age distribution of the participants is presented in Figure 3. The most frequent group was age 12-13 years, which accounted for 443 (34.7%) participants, whilst the least frequent group was ages 6-7 years recording a total of 126 (9.9%).

Participant’s Sex

Figure 4: Sex distribution of children attending schools in central zone, Lusaka district

There were 640 (50.12%) male pupils and 637 (49.9%) female pupils screened for hearing impairment during the study corresponding to a male to female ratio of approximately 1:1.
Ear Disease

The frequency distribution of ear diseases in primary school children in central zone of Lusaka district is presented in Figure 5. There were 470 (36.8%) children diagnosed with ear disease. Diseases of the external auditory canal (EAC) were the most commonly diagnosed ear diseases. Among the EAC diseases wax impaction was the most common disease. In this chart otitis externa represents both bacterial and fungal etiologies.

Factors Associated with Ear Diseases

<table>
<thead>
<tr>
<th>Ear disease</th>
<th>Age Groups</th>
<th></th>
<th></th>
<th></th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6-7 y</td>
<td>8-9 y</td>
<td>10-11 y</td>
<td>12-13 y</td>
<td></td>
</tr>
<tr>
<td>Auricle malformation</td>
<td>0(0.0)</td>
<td>4(1.2)</td>
<td>0(0.0)</td>
<td>2(0.5)</td>
<td>0.094</td>
</tr>
<tr>
<td>Foreign body</td>
<td>2(1.6)</td>
<td>6(1.8)</td>
<td>5(1.3)</td>
<td>5(1.1)</td>
<td>0.863</td>
</tr>
<tr>
<td>Fungi</td>
<td>0(0.0)</td>
<td>1(0.3)</td>
<td>0(0.0)</td>
<td>2(0.5)</td>
<td>0.541</td>
</tr>
<tr>
<td>Otitis externa</td>
<td>0(0.0)</td>
<td>2(0.6)</td>
<td>0(0.0)</td>
<td>0(0.0)</td>
<td>0.119</td>
</tr>
<tr>
<td>CSOM</td>
<td>0(0.0)</td>
<td>2(0.3)</td>
<td>4(1.0)</td>
<td>3(0.5)</td>
<td>0.413</td>
</tr>
<tr>
<td>Wax impaction</td>
<td>33(26.2)</td>
<td>79(24.2)</td>
<td>103(27.0)</td>
<td>96(21.7)</td>
<td>0.337</td>
</tr>
<tr>
<td>ETD</td>
<td>4(3.2)</td>
<td>11(3.4)</td>
<td>5(1.3)</td>
<td>9(2.0)</td>
<td>0.266</td>
</tr>
<tr>
<td>OME</td>
<td>12(9.5)</td>
<td>19(5.8)</td>
<td>28(7.3)</td>
<td>35(7.9)</td>
<td>0.536</td>
</tr>
</tbody>
</table>

Table 3: Association between ear disease and age of school children in central zone of Lusaka district.
Table 3 shows the occurrence of ear disease according to child’s age. Association between ear disease and child’s age was not statistically significant.

**Hearing Impairment**

![Prevalence of HL](image)

**Figure 6.1:** Prevalence of hearing impairment in school children in central zone, Lusaka district.

![Laterality of Hearing Loss](image)

**Figure 6.2:** Laterality of hearing loss in school children in central zone, Lusaka district.

Figure 6.1 shows that hearing impairment occurred in 147 out of the 1277 school children corresponding to a prevalence of 11.5%. The proportion of children with unilateral HI was 22.4% (114/1277) and bilateral hearing impairment was present in 77.6% of children (33/1277) as is shown in Figure 6.2.
Type of Hearing Impairment

<table>
<thead>
<tr>
<th>Type of HI</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHL</td>
<td>129</td>
<td>87.8</td>
</tr>
<tr>
<td>SNHL</td>
<td>10</td>
<td>6.8</td>
</tr>
<tr>
<td>MHL</td>
<td>8</td>
<td>5.4</td>
</tr>
</tbody>
</table>

Table 4: Shows the type of hearing impairment (n=147)

The most prevalent type of hearing impairment was CHL followed by SNHL and MHL respectively as shown in Table 4.

Severity of Hearing Impairment

Figure 7: Severity of hearing impairment in school children in Lusaka

Figure 7 presents severity of hearing impairment in school children. Most of the HI seen in the study were slight in severity. Out of all the 147 children with HI only 5 had severe HI and 1 had profound HI.

Hearing impairment and its association with child’s age

<table>
<thead>
<tr>
<th>Age in years</th>
<th>Hearing impairment</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>6-7</td>
<td>19(15.1)</td>
<td>107(84.9)</td>
</tr>
<tr>
<td>8-9</td>
<td>30(9.2)</td>
<td>296(90.8)</td>
</tr>
<tr>
<td>10-11</td>
<td>39(10.2)</td>
<td>343(89.8)</td>
</tr>
<tr>
<td>12-13</td>
<td>59(13.3)</td>
<td>384(86.7)</td>
</tr>
</tbody>
</table>

Table 5: Hearing impairment and its association with child’s age
Table 5 shows association of HI with child’s age. There was no statistical significant association between HI and age of the child (p = 0.149).

### Hearing impairment and its association with child’s sex

<table>
<thead>
<tr>
<th>Sex</th>
<th>Hearing Impairment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Male</td>
<td>88(13.8)</td>
</tr>
<tr>
<td>Female</td>
<td>59(9.3)</td>
</tr>
</tbody>
</table>

**Table 6: Hearing impairment and its association with child’s sex**

As shown in Table 6 hearing impairment was more common in male children 13.8% compared to female children 9.3%. The prevalence of hearing impairment showed a statistical significant association with child’s sex (p = 0.012).

### Tympanometry Findings

Tympanometric findings are summarized in Figure 8 according to the classification recommended by Jerger. Majority of children with impaired hearing had type A tympanograms. The most common tympanogram was type A whilst the least common
was type As. Children with impacted wax that was not successfully removed and those with discharging ears were excluded from tympanometry assessment.

**Hearing Impairment and its Association with various Ear Diseases**

<table>
<thead>
<tr>
<th>Ear disease</th>
<th>Hearing impairment</th>
<th>OR (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Otitis externa</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>147(11.5)</td>
<td>1128(88.5)</td>
<td>NA</td>
</tr>
<tr>
<td>Yes</td>
<td>0(0.0)</td>
<td>2(100.0)</td>
<td>NA</td>
</tr>
<tr>
<td>Wax impaction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>109(11.3)</td>
<td>857(88.7)</td>
<td>1.00</td>
</tr>
<tr>
<td>Yes</td>
<td>38(12.2)</td>
<td>273(87.8)</td>
<td>1.09(0.74-1.62)</td>
</tr>
<tr>
<td>Foreign body</td>
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<tr>
<td>No</td>
<td>145(11.5)</td>
<td>1114(88.5)</td>
<td>1.00</td>
</tr>
<tr>
<td>Yes</td>
<td>2(11.1)</td>
<td>16(88.9)</td>
<td>0.96(0.22-4.22)</td>
</tr>
<tr>
<td>Fungi</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>147(11.5)</td>
<td>1127(88.5)</td>
<td>NA</td>
</tr>
<tr>
<td>Yes</td>
<td>0(0.0)</td>
<td>3(100.0)</td>
<td>NA</td>
</tr>
<tr>
<td>ETD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>145(11.6)</td>
<td>1103(88.4)</td>
<td>1.00</td>
</tr>
<tr>
<td>Yes</td>
<td>2(6.9)</td>
<td>27(93.1)</td>
<td>0.56(0.13-2.39)</td>
</tr>
<tr>
<td>OME</td>
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<td></td>
</tr>
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<td>No</td>
<td>133(11.2)</td>
<td>1050(88.8)</td>
<td>1.00</td>
</tr>
<tr>
<td>Yes</td>
<td>14(14.9)</td>
<td>80(85.1)</td>
<td>1.38(0.76-2.51)</td>
</tr>
<tr>
<td>CSOM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>142(11.8)</td>
<td>1126(88.2)</td>
<td>1.00</td>
</tr>
<tr>
<td>Yes</td>
<td>5(55.6)</td>
<td>4(44.4)</td>
<td>9.9(2.63-37.34)</td>
</tr>
</tbody>
</table>

Table 7: Hearing impairment and its association with various ear diseases

Table 7 shows the associations between hearing impairment and ear diseases. Of all the ear diseases seen in the study only CSOM showed statistical significant association with hearing impairment. Children with CSOM were at higher risk of developing hearing impairment compared to those without CSOM (57.1 versus
11.3%), $P = 0.002$. The odds of developing hearing impairment in children with CSOM was nine times greater than that of children without CSOM, $OR = 9.9$ (95% CI, 2.33-47.43).

**Ear diseases and its associated gender**

Table 8 shows association between ear disease and gender. There were more boys with CSOM, ETD, aural foreign body and OME than girls. More girls than boys had wax impaction.

<table>
<thead>
<tr>
<th></th>
<th>Gender</th>
<th></th>
<th>Chi square</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CSOM</td>
<td>No</td>
<td>635 (99.5)</td>
<td>0.148</td>
<td>0.700</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>5 (0.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ETD</td>
<td>No</td>
<td>625 (97.7)</td>
<td>0.031</td>
<td>0.861</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>15 (2.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foreign body</td>
<td>No</td>
<td>630 (98.4)</td>
<td>0.216</td>
<td>0.642</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>10 (1.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fungal infection</td>
<td>No</td>
<td>639 (99.8)</td>
<td>0.339</td>
<td>0.560</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>1 (0.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OME</td>
<td>No</td>
<td>588 (91.9)</td>
<td>1.098</td>
<td>0.295</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>52 (8.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wax impaction</td>
<td>No</td>
<td>492 (76.9)</td>
<td>1.052</td>
<td>0.305</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>148 (23.1)</td>
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</tr>
</tbody>
</table>
DISCUSSION
Hearing in children is critical to speech development, communication and learning as it can have devastating developmental results in children. Amongst these consequences are poor vocational choices due to low academic achievements, challenges of social interaction with peers and the public at large. HI has been known to be a potential inhibitor of development. At a national level managing hearing loss can be costly for the country’s economy. Screening of school children is a practical way of ensuring that children are evaluated for hearing capabilities. The results obtained from this study will provide an estimate of hearing impairment and ear disease prevalence for primary school children of central zone in Lusaka district.

A total of 1277 children aged 6-13 years from 5 primary schools in the central zone of Lusaka district were recruited and examined in this study. The majority of the students examined (403) were from Vera Chiluba primary school reason being that the school had the highest number of children who had signed consent forms by their parents/guardians. The total number of boys examined was 640 (50.12%) whilst 637 (49.88%) girls were examined, bringing the gender ratio to almost 1:1. This is a true reflection of the gender ratio at the national level. For our study we chose to include children from grade 1 to 7 from all the five schools. The most frequent age group was age 12-13 years, which accounted for 443 (34.7%) participants. The least frequent age group was 6-7 years and this was because most children start attending school by age 8 years.

One hundred and forty seven children failed audiometry screening at 30dB giving a HI prevalence of 11.5%. This prevalence is lower than what was found in some sub-Saharan African countries such as Nigeria (13.9%) but higher than Mozambique’s prevalence rate (5%)30. These varying prevalence rates could be as a consequence of different methodologies and definitions of HI used. High levels of background ambient noise (45-60 dB) in this study is the primary reason for using 30dB, rather than 25dB, as the lower threshold for defining hearing loss. According to the WHO’s definition of DHL the prevalence rate of 11.5% found represents children with DHL. Prevalence rates of DHL in other countries were 5.6% and 7.3% in Kenya and Uganda respectively (34,35). The high prevalence rate seen in this study could be as a result of poor availability of ear nose and throat (ENT)
services to the public. There are currently 2 ENT surgeons to serve a population of 14 million people (i.e. 1 surgeon per 6 million people) in Zambia. This is contrary to Kenya and Uganda which each have an ENT surgeon per 1 million people (35,36).

Out of the 147 pupils with hearing loss 78.5% had slight hearing loss, which was comparable to Rajab’s study in Rwanda (72%) and Clark’s study in Mozambique (79%) (23,30). There was one case of profound SNHL in a 7 year old who had a 4 years history of CSOM. SNHL can occur as a result of damage to hair cells of the cochlear secondary to passage of toxins through the round window released by bacteria (37). This was the likely cause of the SNHL in this case. Children with profound HL were few because they do not go to mainstream school but instead attend special schools.

There were 77.6% of unilateral hearing loss (UHL) recorded and 22.4% of bilateral hearing loss. Children with UHL are more likely to experience academic challenges in comparison to their peers without HL (38). Unfortunately this aspect could not be assessed in this study, as data for academic performance of each child was not collected.

The commonest type of hearing loss was CHL (87.8%) whilst SNHL and mixed HL accounted for 10 (6.8%) and 8(5.4%) children respectively. The prevalence of CHL has been reported to be high in many studies, Rwanda and India reporting a prevalence of 65% and 96.2% respectively (23,39).

The prevalence of HL in male children was 13.8% whilst in females it was 9.3%. There was a statistical significant association between HL and the male sex (p=<0.05). Other studies have reported similar findings, Iran 8.9%: 7.7%, Egypt 12.2%: 7.4% in favour of the male sex (25,40). Ogunleye in Nigeria and Ahmad in Iraq showed that there was a male predominance of otic foreign bodies in their studies (41,42). There was a similar finding in our study (Table 8). Apart from traumatizing the tympanic membrane aural FB can interfere with sound transmission in the ear and this adventurous practice is also likely to disturb the normal self-cleaning process of the ear hence provoking occluding cerumen impaction, which could cause HL. CSOM, ETD, aural foreign body and OME were also more common in the male than in female children.
In this study, ear disease was present in 36.8% children. This was comparable to Rajab’s study in Rwanda (34%) but lower than Prakash et al study in Kathmandu (75.7%)\textsuperscript{23,26}. The most common ear disease in this study was impacted wax 66%, which was mostly bilateral. This was followed by OME (20%), ETD (6%), foreign body ear (3.8%), CSOM (2%). Wax impaction in this study could have been the most common ear disease because in the majority of cases it is asymptomatic and a coincidental finding. Wax impaction was noted to be a common ear disease amongst school children in Nigeria (52.6%) Southeast India (53.8%), and Kathmandu valley (60.6%)\textsuperscript{43-45}. In a Saudi Arabian study, Afaf\textsuperscript{46} noted wax impaction in 12% of the total number of children aged 4-15 years. This low percentage could have been because the study included a higher age group unlike our study, which was restricted to children between 6-13 years old. Wax impaction is predominantly common in the younger age groups. Regional factors could also explain the wide variation in these findings.

CSOM was identified in 9 children (prevalence 2%), which is regarded as a high prevalence rate according to the WHO\textsuperscript{17}. This is comparable to findings from a study done in Mozambique (2%)\textsuperscript{47}. This prevalence rate is slightly higher than that reported in Angola, Tanzanian, Kenya, which reported prevalence rates of 1.6%, 1.6% and 1.1% respectively\textsuperscript{48,49,34}. Lack of specialized ENT services to the public could be the explanation behind this high prevalence rate. Of all the ear diseases seen in the study only CSOM had a significant association with hearing impairment. Children with CSOM were at a higher risk of developing hearing impairment compared to those without CSOM. The odds of developing hearing impairment in children with CSOM was nine times greater than that of children without CSOM, OR = 9.9 (95% CI, 2.33-47.43).

The prevalence rate of OME in this study was 7.3%, which is slightly lower than that of Saudi Arabia and Chile at 13.8% and 10% respectively\textsuperscript{50,51}. The prevalence is not as high probably because the study was conducted in the months of September and October, which fall in the summer season of Zambia. Upper respiratory tract infections are less frequent during this season. The age group with the highest number of children in this study was 6-7 years (9.5%). Highest prevalence rates are seen at two peak ages, the first one at 2 years whilst the second is at 5 years\textsuperscript{52}. In this current
study all the children were above the age of 5 years and perhaps this would explain why group ages 6-7 years recorded the highest prevalent rate of OME as this age group falls immediately after the second peak.

STUDY LIMITATIONS
There was background noise, which made screening of younger children more challenging hence a good number of them were dropped from the study.

CONCLUSION
The prevalence of disabling hearing loss in primary school children in the central zone of Lusaka district is high with the most common type being conductive hearing loss. Wax impaction is the most common ear disease in this population.
This study shows that CSOM has significant association with hearing loss and that the male children are at a higher risk of developing hearing impairment than the female children.

RECOMMENDATION
There is need for ear and hearing care awareness at the community level and screening programs in schools should be created. Health personnel training in the field of ENT in the country needs to be supported in order to increase the number of ENT surgeons in Zambia.
Future studies can investigate the association between unilateral hearing loss and poor academic performance in school children in order to establish the role of amplification devices in children with unilateral hearing loss.
A study in the future can look at the association between hearing loss and cerumen impaction in a larger population.
REFERENCES


7. Olusanya BO, Ruben RJ, Parving A. Reducing the burden of communication disorders in the developing world: An opportunity for the millennium development project *JAMA*. 2006; 29: 441–44.

8. WHO. Millions of people in the world have hearing loss that can be treated or prevented. World Health organization, 2011 Available at <http://www.who.int/mediacentre/factsheets/fs300/en> [24 April 2014]


APPENDICES

APPENDIX I: INFORMATION SHEET

Title: Prevalence of hearing loss in primary school children in central zone in Lusaka district – Zambia

Background

Hearing in children is critical to speech development, communication and learning. Hearing loss can have devastating developmental results in children. Amongst these consequences are poor vocational choices due to low academic achievements, challenges of social interaction with peers and the public at large. At a national level managing hearing loss can be costly for the country’s economy. In developing countries like Zambia, the ability to communicate effectively is vital for breaking the cycle of poverty through education. Unfortunately the magnitude of hearing loss in school children in Lusaka district in Zambia is not known. According to WHO, 50% of hearing loss cases can be prevented through prevention and promotional health programs. The researcher is carrying out a study on “The prevalence of Hearing Loss in Primary school children in the central zone of Lusaka district in Zambia”. This entails testing your child for hearing loss. This form will provide you information you require to make an informed consent.

This thesis aims at quantifying the magnitude of hearing loss among pupils/children in selected primary schools central zone in Lusaka district in Zambia. The information obtained will serve as a platform for primary ear and hearing health care programs with an aim to reduce the prevalence of hearing loss in Zambia.

General Patient Information:

I am a resident doctor in The Ears Nose and Throat-Head &Neck Surgical unit. I would like to seek your consent for your child to participate in a study aimed at documenting Prevalence of Hearing Loss in Primary School Children in the central zone of Lusaka district - Zambia.

How your child will participate

1. I will carry out the complete ear examination on your child and will need to assess the ear through the help of a machine to be able to detect if there is any hearing impairment.

2. There will be no monetary benefits for participating in the study and it will be purely on a voluntary basis.
3. You will incur no financial costs and confidentiality will be maintained at all times
4. You will reserve the right to withdraw your child from the study at any time without any penalty.
5. You will be informed about investigations and the results.
6. Participation in this study is voluntary
How your child’s participation affects him/her

The study does not affect your child negatively in any way because:

. All the information you give will be confidential.
. The conclusions drawn from the study shall be useful to improve the current management of hearing impairment and will later on be published in Medical journals.

. If your child is found to have excessive ear wax or foreign body in the ear, I will clean his/her ears through ear syringing. Those with other ear conditions will be referred to an ENT clinic in Lusaka for management of the same.

Are there any hidden dangers in your child’s participation or non-participation?

None whatsoever.

Objecting to any part or whole of this study will not affect your child in anyway.

What will I do with the information I get?
The information I get may not be of immediate benefit to you but it will help in the long run in better management of ear conditions.
Like all scientific information I will seek to share our findings with other people undertaking similar studies. Therefore we may publish our findings in scientific journals or present them in scientific meetings.

If you require discussing this matter with the family or friend you are free to do so and I will be ready to answer any questions. If you are satisfied with my explanation and are willing to participate, please, sign the consent form below.

NDODOMEKO YA FOLOMU YACHILOLEDZO MNDANDANDA WA ZITHU ZIMENE ODWALA AYENERA KUDZIWA KOMANSO KOPE YA CHILOLEDZO(CHICHEWA VERSION)MUTU: KUCHULUKA KWA ANA AVUTO LOSAMVA MU MA PULAIMALE SUKULU MUCHIGAWO CHAPAKATI CHA MU MZINDA WA LUSAKA- ZAMBIA MAU OYAMBA
Kusamva m’makutu kutha kuononga makulidwe amwana. Mwamavuto amenewa zimasokoneza chisankho cha mwana mumaphunziro ake amsogolo, kukhalira limodzi ndi anzake zimahalanso zithu zovuta. Kuthandiza anthu oterewo kumakhala kovutirapo pa chuma cha mdziko. Mumaiko amene akutukuka ngati la Zambia kusakhala ndi vutoli ndikofunika kwambiri pothetsa umphawi kudzera mmaphunziro. Chodandaulitsa chiwerengero cha ana osamvetsetsa m’makutu chigawo cha mzinda wa Lusaka sichiziwika. Monga mwakafukufuku a WHO theka la anthu osamvawa litha kupewedwa kupyolera mu uphungu wa zoona za u moyo. Wochita kafukufukuyi akuchuta kafukufuku wothe tsa vuto la kusamvetsetsa m’makutu ana mu asukulu achigawo chapakati mu mzinda wa Lusaka –zambia. Izi zizachitika pomuyeza mwana wanu. Folomu idzakupatsani ndandanda wa chiloledzo. NDANDANDA CHIWERENGERO CHIWERENGERO CHIWERENGERO CHIWERENGERO CHIWERENGERO.

Ine dokotala wokhudza za makutu, phuno ndi pa khosi (ENT-HEAD &NECK SURGICAL UNIT) ndikufuna kupeleka ndi mbali pa kafukufuku wa kuchuluka kwa ana avuto losamva m’makutu mumasukulu apulaimale muchigawo chapakati mu mzinda wa Lusaka –Zambia.

MUNGATENGEPO MBALI BWANJI?

1. Azayesedwa mumaku tu mwana wanu mothandizidwa ndi zipangizo zathu zowunikira m’makutu ndikuona ngati muli vuto lakusamva m’makutu ake.
2. Kafukufukuyi ndiopanga modzipeleka ndipo palibe cholowa thumba chilichonse mukatengapo mbali.
4. Mulino ndi ufulu kupitiliza kapena kusapitiliza kafukufukuyi nthawi iliyonse mungafune ndipo sipazakhala mulandu.
5. Zotsatira za kafukufukuyi muza uzidwa.

KODI KUTENGAPO MBALI KWA MWANA WANU KUZAMUKHUZA BWANJI? KAFUKUFUKUYI SAZAKHALA NDI MBALI YOIPA PA MWANA WANU CHIFUKWA

Zonse zomwe zitazapede pamwana wanu zizasungidwa mwa chinsinsi. Zotsatira zonse zafukufukuyi zizathandiza kupeza njira zothonisira vutoli ndi palo maliza zizatsindikizidwa mumabuku athu a zachipatala.
Ngati mwana wanu angapezeke ndi ulimbo wambiri mumakutu ake azathandizidwa posukidwa ndi zipangizo zathu. Ndipo iwo amene atapezeke ndi mavuto okhuzana ndi m’makutu azakalandira chithandizo kuchipatala cha ENT ku Lusaka.

**KODI PALI CHIOPYEZO CHINA CHILICHONSE PAKUTENGAPO MBALI NDI PAKUSATENGAPO MBALI PA MWANA WANU**

1. Ai palibe
2. Kusatengapo mbali pakafukufukuyi sikuzakhuzapo kathu mwana wanu.

**KODI ZOTSATIRA ZAKAFUKUFUKUYI TIZAPANGA NAZO CHIYANI?**

zotsatira za kafukufukuyi zizatithandiza kuti matenda tiwadziwe mozama komanso zitithandiza kuti tigawane nawi madototlo ena komanso kutsindikiza mabuku athu azachipatala zomwe tapeza ndikukambirana mumisokhano yathu Ngati mungafune kudziwa zambiri kapena mulu mafunso ndi banja lanu kapena anzanu mutha kutero ndipo muzatha kundifunsa mafunso ndizatha kuyakha onse. Ngati mwakhutisidwa ndi kafotokozeredwe kanga ndipo mwamvetsetsa chonde sainani folomu yachiloledzo musimu
APPENDIX II: CONSENT FORM

Patient number:....................... Consent by patient’s parents/guardian:
I.............................................of...........................hereby give consent for
...........................................................................................................................................................................................................................................................................................................................(Name of child) to be included in this study, on “Prevalence Of Hearing Loss in Primary School Children In the Central Zone of Lusaka district - Zambia” The nature of the study has been explained to me by Dr. .............................

Date....................... Signed..................... (Parent/ guardian/other)

I Dr........................................ confirm that I have explained to the patient the nature of the study.

Date.......................signed.............................. or thumb print...................

Investigator: DR HAPUNDA RACHAEL, Resident in ENT Head and Neck Surgery,
Cell Phone +260 962936681 or +254 707182358; email karanda2007@gmail.com; University of Nairobi; Department of Surgery P.O. Box 30197, Plot 9122, Kalundu Close, Kalundu, Lusaka, Zambia

Supervisors:
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   Cell Phone +254 722814483 Email: joyceaswani@gmail.com
2. Dr. Nadia Lukwasa MB ChB, MMed ENT/HN
   Cell Phone +260 977899247 Email: nadialuk@yahoo.com

KNH/UON-ERC: Prof. CHINDA, Secretary, 2726300, Ext 44355
Email: uonknh_erc@uonbi.ac.ke
UNZAREC: Administrator, +26 021 1256067 Email unzarec@unzm.zm
FOLOMU YACHILOLEDZO

Nambala yaodwala.................................................Ineyo modzipeleka ndavomeleza kakhala m’modzi wa anthu otengapo mbali pakafukufukuyi wa chiwerengero cha ana avuto losamva m’makutu mumasukulu a pulaimaleza chigawo chapakati chamzinda wa Lusaka –Zambia. Dzina la mwana.........................................................

Saini...........................................Tsiku
......................................................................Kafukufukuyi walongosoledwa kwa ine ndi. Dr .....................................................................Tsiku
......................................................................Saini ya kholo kapena womusunga
......................................................................Ine Dr  .....................................................................................ndafotokozera odwala wanga zakafukufukuyi. Saini
...........................................................................................................Tsiku
.................................................................................................................Wapanga kafukufukuyi ndi

Dr HAPUNDA RACHEL, WA ENT Head and Neck Surgery,Cell Phone +254 707182358  +260 962936681;email karanda2007@gmail.com; University of Nairobi; Department of Surgery P.O. Box 30197.

Mothandizidwa ndi

1. Dr Joyce Aswani MB CHB Mmed ENT/HN Cell Phone +254 722814483

2. Dr Nadia Lukwasa MB CHB Mmed ENT /HN Cell Phone +260 977899247, Email: Nadialuk@yahoo.com

KNH/UON-ERC Secretary 2726300,ext 44355, Email uonknh-erc@uonbi.ac.ke

Administrator Phone +260 2112560267 UNZAREC:Email : unzarec@unzm.zm
APPENDIX III: ASSENT FORM FOR CHILDREN/DEPENDENTS

Title: Prevalence of hearing loss in primary school children in Central Zone in Lusaka- Zambia

Investigator:
DR HAPUNDA RACHAEL, Resident in ENT Head and Neck Surgery, Cell Phone +254 707182358 +260 962936681; email karanda2007@gmail.com; University of Nairobi; Department of Surgery P.O. Box 30197.

Child (parent/guardian on their behalf) / young person to circle all they agree with:

Have you read (or read it to you) the information about this study? Y/N
Has somebody else explained this study to you? Y/N
Do you understand what this study is about? Y/N
Have you asked all the questions you want? Y/N

Do you understand that you may stop taking part at any time? Y/N
If any answers are ‘no’ or you don’t want to take part, don’t sign your name!
If you do want to take part, you can write your name below

Your name ___________________________ Date ___________________________

Parent/guardian to write their name if they agree for you to participate in the study.

Name___________________ Sign _____________ Date _____________

The researcher who explained this project to you needs to sign too.
## APPENDIX IV: BIODATA AND EAR EXAMINATION

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**RECOMMENDATION:**

**DATE:**

**DONE BY:**
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**REMARKS:**

**RIGHT EAR:**

**LEFT EAR:**

**PURE TONE AVERAGE:**

**AUDIOMETER**

**SERIAL NUMBER**

**DATE:**

**DONE BY:**
APPENDIX VI: TYMPANOGRAM

Study Number                                            Age
Grade
School
RIGHT EAR                                              LEFT EAR

REMARKS:

RIGHT EAR                                           LEFT EAR
Volume:                        Volume:               
Compliance:                    Compliance:            
Pressure:                       Pressure:             
Gradient:                       Gradient:             

DATE:

DONE BY: