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# HIV status and hearing loss among children between 6 and 12 years of age at a large urban health facility in south western Uganda

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ABSTRACT

*Introduction:* Pediatric HIV infection and treatment may increase the risk for hearing loss (HL), both sensorineural (SNHL) and conductive hearing loss (CHL). There is limited data on this subject, especially from sub Saharan Africa. The aim of this study was therefore to compare the prevalence of hearing loss among HIV positive and negative children, to determine the types of hearing loss and whether Nevirapine (NVP) based antiretroviral therapy (ART) is associated with HL.

*Methods:* We conducted a cross sectional study at two tertiary health facilities in south western Uganda. We consecutively enrolled 79 HIV negative and 148 HIV positive children aged between 6 and 12 years. Inclusion criteria were completion of written consent, ability to follow instructions to perform an audiogram and absence of congenital HL. We conducted hearing screening using the iPad Shoebox® audiometer, and confirmatory assessments were conducted using pure tone audiometry. Hearing was classified as either normal hearing, CHL, SNHL or mixed.

*Results:* Of the 227 children enrolled, 115 (50.7%) were female. The mean age was 9.2 years (median = 9). Based on self-report, frequency of HL among HIV positive children was 6.8% and 20.3% among HIV negative children (p=<0.01). Using objective measures, prevalence of HL among the HIV positive children was 8.8% compared to 10.1% among the HIV negative children (p = 0.74). CHL was generally more frequent than SNHL but SNHL occurred more frequently among HIV positive (7.4%) compared to HIV negative children (3.8%). No association was found between NVP based ART and HL (p = 0.41). Logistic regression showed that older age of the child (p = 0.01), previous ear infection (p=<0.01), tuberculosis (TB) treatment (p=<0.01) and long term duration on ART (p=<0.01) were significantly associated with HL. Age (p = 0.02), previous ear infection (p = 0.01) and TB treatment (p = 0.005) remained significant in the multiple regression model.

*Conclusion:* Prevalence of HL is similar among HIV positive and negative children. Older age of the child, previous ear infection, use of TB drugs and long duration on ART among the HIV positive children increase the odds of having hearing loss among children. However, use of NVP was not associated with HL.



## 1. Background

Occurrence of hearing loss (HL) among children in the developing countries is common and may even be on the rise [1]. Despite this, hearing loss does not receive sufficient attention in low to middle income countries, probably because of other competing health problems. Nevertheless, HL poses significant threat to social and economic growth and specifically among children, to the development of speech and language [2]. Because of this, HL has attracted significant international audience and WHO has established an international World Hearing Day on March 3rd every year to draw more attention [3].

Hearing loss may be classified as either conductive,

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sensorineural or mixed hearing loss. Sensorineural hearing loss (SNHL) has the profoundest effect on speech and language acquisition in children [4,5], but any form of hearing loss can be severe enough to impede language and speech development in a child [1]. When recognized and diagnosed early, hearing loss is commonly addressed by providing amplification using hearing aids. However, secondary prevention of the disability is inferior to primary prevention of hearing loss if possible as this deficit limits the child's communication abilities.

Hearing loss occurs regardless of age or gender and among children, the common causes are ear infections like otitis media, tympanic membrane perforations, congenitally acquired infections like Cytomegalo virus (CMV), trauma, foreign bodies in the ears and infections like Human Immunodeficiency Virus (HIV) and tuberculosis infections [6]. HIV and TB infections are common in sub Saharan Africa and may increase the burden of HL. HIV is known to increase the risk of both peripheral and central hearing loss among the exposed children by causing abnormal auditory processing [7]. However, there is limited research in sub Saharan Africa where the burden of HIV infection is high.

Few studies on HL and HIV have been done in sub Saharan Africa and additionally, results are variable. For instance, a study among HIV positive children under 5 years in Kampala, Uganda showed about 33% of them had HL and among those with HL, SNHL at 64% was the most prevalent form of HL [8]. Yet, another study to measure prevalence of hearing loss among primary school children in western Uganda estimated it at 3% [9], although the study did not consider the HIV status of the children. In Malawi, prevalence of HL was 24% among HIV infected children [10]. In addition, there are factors that could potentially modify the effect of HIV on HL and these include age, gender and prematurity but evidence regarding these factors is limited [11].

Antiretroviral therapy may have an impact on hearing loss [12]. HIV treatment protocols recommend early testing, diagnosis and treatment of HIV infected children [13]. This means that any child confirmed to be HIV positive is started on antiretroviral therapy (ART) soon after diagnosis. Although this standard of care has improved the health and survival of HIV positive children through protection from opportunistic infections and slowed progression of the disease [13,14], there is limited knowledge on the otologic effects of long term exposure to ART. Therefore, the aim of this study was to compare the prevalence of hearing loss among HIV positive and HIV negative children between 6 and 12 years of age, to determine the types of hearing loss among this population and to establish whether HIV treatment is associated with the hearing loss types.

## 2. Methods

### 2.1. Study design and setting

We conducted a cross sectional study at two referral health facilities in Mbarara, south western Uganda, serving a large region. HIV positive participants were recruited from the Pediatric HIV Clinic while the HIV negative participants were recruited from the Pediatric Out-Patient Clinic at Mbarara Regional Referral Hospital which also serves as the teaching hospital for Mbarara University of Science and Technology (MUST). HIV testing is routinely done at the OPD, and results for the children returned same day to the care givers. We used the results from this routine testing to identify the HIV negatives to enrol. Data collection was carried out by trained research assistants.

### 2.2. Inclusion and exclusion criteria

Children were included in the study if they were aged between 6 and 12 years, able to follow instructions to perform an audiogram the parents or guardians consented to participate and the child provided assent.

Children excluded from the study were those who did not assent or whose parents and guardians declined for them to take part in the study, children below the age of 6 years or over 12 years or those unable to cognitively follow instructions for audiometry using the ShoeBox App on the iPad audiometer. For instance children with Attention Deficit Hyperactive Disorder (ADHD), involuntary muscle movements (chorea) and other conditions that affect concentration were excluded. Also excluded were children with congenital anomalies like microtia and microcephaly and syndromes like Waadenberg and Treacher-Collins. Such conditions increase the likelihood of congenital hearing loss. Children with actively draining (infected) ears were not recruited but instead referred to the ENT clinic for proper diagnosis and treatment.

### 2.3. Study procedures

Following enrolment, the parent/guardian was interviewed and a questionnaire completed to document the biodata and demographic factors concerning the child. Each participant underwent otoscopy prior to hearing screening to check for active infection. The hearing screening was carried out in an ambient room using the ShoeBox Application on the iPad audiometer. The iPad and this application have both been validated as tools for hearing screening in children [15]. Unilateral or bilateral failure of the screening test was followed by a Pure Tone Audiology (PTA) to confirm the form and severity of hearing loss.

### 2.4. Data analysis

Data were exported to STATA 11.0 for analysis. Descriptive statistics were generated for demographic and baseline clinical characteristics like age, gender, history of hearing loss and duration of ART treatment. Frequency tables were used to describe the demographics of the study population.

The prevalence of hearing loss among HIV positive children in comparison to HIV negative children was calculated as a fraction of the total number of children screened. Chi square test was used to compare the two proportions. Two by two tables were used to examine the associations between the different factors and hearing loss. Logistic regression analysis was used to calculate the odds ratio of factors associated with hearing loss. In the logistic regression analysis, age of the child was highly correlated with duration on ART hence the latter was omitted from the multiple regression analysis due to collinearity. In the multiple regression analysis we aimed to build a parsimonious model; i.e. included variables that were of statistical significance and with biological importance.

### 2.5. Human subject issues

The study was approved by the Mbarara University of Science and Technology Research Ethics Committee UST Institutional Research and Ethics Committee. Individual informed consent was obtained from the parents or caregivers of the children and children were also asked to assent for the study procedures.

## 3. Results

### 3.1. Baseline characteristics

We consecutively enrolled a total of 227 children of which 79 were HIV negative and 148 were HIV positive children all aged between 6 and 12 years. The demographic and clinical history data