International Journal of Pediatric Otorhinolaryngology 79 (2015) 2359–2363

Contents lists available at ScienceDirect

International Journal of Pediatric Otorhinolaryngology

journal homepage: www.elsevier.com/locate/ijporl

Prevalence of hearing loss among primary school children in Mbarara, Uganda

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ARTICLE INFO

Article history:
Received 26 August 2015
Received in revised form 25 October 2015
Accepted 29 October 2015
Available online 3 November 2015

Keywords:
Africa
Hearing loss
Schoolchildren
Uganda
Hearing screening
Audiology

ABSTRACT

Introduction: Hearing loss in children is a common entity worldwide. We examined the prevalence and etiology of hearing loss among primary school children in Mbarara, Uganda.
Methods: Cross-sectional study in primary school children aged 5–14 was performed to determine the prevalence of hearing loss. Ugandan primary school children were screened for disabling hearing loss (threshold >30 dB) and confirmatory audiometry was performed on those who failed the screening.
Results: There were 639 children screened. Thirty-five (5.5%) of children screened failed and were referred for further testing. Two children were lost to follow-up. The percentage of children with true hearing loss was 3.1%.
Conclusions: The incidence of failed hearing screening and hearing loss in Mbarara, Uganda is similar to other populations. Hearing loss is a significant problem in Uganda and efforts should be made for primary, secondary, and tertiary prevention of hearing loss.

1. Introduction

Hearing loss is a common cause of sensory disability worldwide. According to the World Health Organization (WHO), over 360 million people in the world suffered from moderate-to-profound hearing loss (HL) in 2012, and 80% of them were in low- and middle- income countries [1]. According to the WHO, *mild* HL is defined as the permanent unaided hearing threshold level average of the frequencies of 500, 1000, 2000, and 4000 Hz for the better ear between 26 decibels (dB) and 40 dB, *moderate* HL is defined as thresholds between 41 dB and 60 dB, *severe* HL is defined as thresholds between 61 dB and 80 dB, and *profound* HL is defined as thresholds above 81 dB [2]. The WHO defines *disabling* hearing loss in children under 15 years of age as the unaided thresholds for the better ear of 31 decibels (dB) or greater [3]. The WHO estimates that 50% of HL is primarily preventable, whereas the remaining can be readily be addressed by secondary or tertiary prevention [4].

Hearing loss can limit a person's participation in daily life, limit opportunities for employment, cause spiritual, social, and emotional problems and, early in life, it can delay child language and educational development [5]. Economic burden of disease studies are lacking in developing countries, but the economic impact of hearing loss has been shown to be significant in developed countries [4]. For example, Mohr et al. showed that, averaged across age at onset, severe to profound hearing loss is expected to cost society (United States of America) an additional $297,000 (1998 US Dollars) over the lifetime of an individual [6]. The largest component of the economic impact was found to be due to reduced work productivity (67%) [6]. Another analysis performed by Shield using a "quality of life" approach revealed that hearing loss of all grades cost Europe 284 billion euros for the year 2004 [7]. Since most of the economic impact is due to reduced work productivity, not medical costs (which might be much lower in the developing world), these results appear to have relevance for the developing world as well.

A recent study by Westerberg et al. in the Masindi district of Uganda demonstrated a prevalence of disabling hearing loss 10.2% in children—41% of which were due to correctable ear diseases such as chronic suppurative otitis media, cerumen impaction, or dry perforations of the tympanic membrane [8]. An earlier prevalence study by Turitwenka in Uganda on children aged 5 to 14 yielded a prevalence of hearing loss of 30 dB or greater in 5.6%

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http://dx.doi.org/10.1016/j.ijporl.2015.10.044
0165-5876/

of the study population [8]. Previous studies have revealed an association between hearing loss and poor school performance [9]. Recent analyses on cost-effectiveness of screening have shown that yearly screening of schoolchildren and treatment for chronic otitis media are highly cost effective [10,11].

The present study will assess the prevalence of hearing loss among primary school children aged 5–14 years in the municipality of Mbarara, Uganda—the largest urban center in southwest Uganda. The estimated population of Mbarara municipality is 83,700 (in 2011) [12]. The municipality has 39 primary schools (19 Government-aided and 20 Private) with a total enrolment of 19,699 (in 2007) [13]. The district of Mbarara has otolaryngology (ENT) services at the government-owned Mbarara Regional Referral Hospital (MRRH). The ENT clinic at MRRH is manned by two ENTs, three post-graduate students in ENT, and a clinical officer and only operates two days per week. Due to limited equipment and staffing for audiology at MRRH, screening for HL is not routinely done and to confirm diagnosis, patients are referred to private centers in Kampala for formal audiometry. This leads to late or no diagnosis of HL.

2. Methods

Using an expected prevalence of hearing loss of 6.9% (from prior unpublished pilot study), an acceptable margin of error of 2%, a total school-age population of around 20,000, and assuming a random sampling with a 95% confidence interval, we used Cochran's sample size formulas for categorical data to calculate that a sample size of 617 children would suffice in estimating the prevalence of hearing loss in school-aged children in Mbarara municipality (see Bartlett et al.) [14][1].

All screenings were be done by the principal investigator (PI) using a battery powered, portable Earscan 3 screening audiometer (Microaudiometric, NC, USA) with Telephonics TDH-39P headphones calibrated to ANSI 2010 standards. Otoscopy was performed using a Welch Allyn MacroView™ Otoscope (Welch Allyn, NY, USA). Tuning fork testing was performed using a standard C512 Hz tuning fork. A modified version of the WHO/PBD Ear and Hearing Disorders Examination Form (Version 8.3) was used to record data [15].

The PI discussed the purpose of the study to the school headmaster and teachers and obtained permission prior to arrival to the schools. The quietest room in the school was used to screen the children (e.g. the library). Biologic controls were performed by an audiogram-proven normal hearing individual who underwent screening audiometry at each location utilized in this study. The study protocol was explained to the students in both English and the local language to maximize understanding. Biographical information and their responses to a few questions related to hearing loss risk factors were recorded in the modified WHO/PBD form. Hearing screenings were performed by measuring hearing thresholds (in dB) at 500, 1000, 2000, 4000, and then again at 500 Hz. If both thresholds for 500 Hz do not differ by more than 5 dB, the screening test was considered valid. If the child had no thresholds above 30 dB, he/she was done with the study. If the child had a threshold greater than 30 dB for any frequency aforementioned, he/she underwent otoscopy and tuning fork testing (Weber and Rinne). All children who failed the hearing screening were flagged for further confirmatory testing at a later date. Of note, if the child failed the screening and had a cerumen impaction, the cerumen was removed and the child re-screened with clear ear canals.

The children that failed the hearing screening underwent diagnostic audiometry. Diagnostic audiometry was completed by an audiologist using a Madsen Itera audiometer. Testing was completed with insert earphones for air conduction thresholds (250–8000 Hz) and with mastoid oscillator placement and contralateral masking for ear-specific bone conduction thresholds (500–4000 Hz). Diagnostic audiometry was performed at either the MRRH audiology sound-treated room, or at the schools in the quietest-available room if the children could not travel to the clinic. The type of hearing loss was characterized in detail and recorded. Further appropriate referrals were made at that time depending on severity/type of hearing loss.

This study was approved by the Mbarara University of Science and Technology (MUST) Research Ethics Committee (REC) as study No. 02/03-15. Informed consent was obtained from the headmaster of the institutions since students were boarding students and their parents were not readily accessible. After identification of the students, associated medical records that arose from this study were kept in a secured storage area under a lock and key. The data extracted as noted above was kept on a separate database using a depersonalization code for the information. The list of codes and medical records were destroyed upon study completion. Only study personnel had access to the study documents using the key that was held solely by the principal investigator.

3. Results

A total of 639 children were evaluated. There were 258 (40.4%) boys and 381 (59.6%) girls screened (Fig. 1).

The total number of children who had a threshold greater than 30 dB for any of the frequencies tested for either ear was 35, or 5.5% (95% CI 3.7%, 7.2%; S.E.% 0.886), of whom 14 (40.0%) were boys and 21 (60.0%) were girls. Two children were lost to follow up for confirmatory audiometry. One child was absent the day of the return visit to the school for confirmatory testing. Another child presumably gave the wrong name at the initial screening, as his name was not familiar to any of the teachers or caretakers at the school when the authors returned to the school for confirmatory audiometry. The total number of students that underwent confirmatory testing and considered for further analysis was therefore 33. Out of the 33 students, 20 students had true hearing loss, whereas 13 children had normal hearing, yielding a false-positive screening rate of 39.4%. The true rate of hearing loss amongst those screened (excluding those lost to follow up) was therefore 3.1% (95% CI 1.8%, 4.5%; S.E.% 0.680)[2]. Twelve (12 of 20) had unilateral hearing loss whereas eight (8 of 20) had bilateral hearing loss. Eight (1.3% of total) children had conductive hearing loss, eleven (1.7% of total) children had sensorineural hearing loss, and one (0.2% of total) child had a mixed hearing loss. Eight (1.3% of total) children had a mild hearing loss, four (0.6% of total) had a moderate hearing loss, and eight (1.3% of total) had a profound hearing loss in at least one ear. Using the strict WHO criteria for *disabling* hearing loss as defined in the introduction section, disabling hearing loss was present in eight students, or 1.3% (95% CI

[1] Cochran's formula is $n_0 = (t)^2 \times (p)(q)/(d)^2$, where n_0 is the sample size, t (1.96) is the value for selected alpha level of 0.025 in each tail (for a total alpha value of 0.05), $(p)(q)$ is the estimate of variance, which form our pilot study is (0.069)(1–0.069), and d is the acceptable margin of error which is 0.02. This formula yields a sample size of 617 students.

[2] Looking at the profiles of the children who missed the follow-up confirmatory audiometry, it seems as though one of them might be a false positive screen and the other would have been a true positive. The first subject only failed the screening at 500 Hz by 5 dB in the right ear and by 10 dB in the left ear, which could have very well been due to the presence of ambient noise in the screening environment. The second subject had no responses on the right ear, and normal hearing on the left ear, which is more consistent with a true-positive screen. Taking this into account, the adjusted rate of hearing loss would be 3.3%, which is within the standard deviation of the confirmed hearing loss rate of 3.1%.