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## Prevalence of hearing loss in school aged Nepalese children

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## ABSTRACT

**Objectives:** The main objective of this study is to identify the prevalence of hearing loss in school aged children of Nepal.

**Methods:** This cross-sectional study was carried out on school aged children attending the government run schools of Nepal. A total of 79,340 children from grades 1 through 10 were included in the study. After taking brief history about ear diseases and hearing loss, children were screened for ear diseases in their respective classroom by otoscope. Hearing evaluation was carried out by pure tone audiometer and hearing threshold was obtained at 0.5–4 kHz. The results were then documented and analyzed.

**Results:** The prevalence of hearing impairment in school aged children in Nepal is found to be 5.73% (4551 of 79,340). Conductive hearing loss was the most common type of hearing loss and was observed in 70.47% (n = 3207) of the children.

**Conclusions:** This study shows that hearing loss is a common problem in children of Nepal. With the main cause of hearing loss due to preventable conditions such as chronic otitis media, it is believed that early standardized screening, detection and timely management of chronic otitis media in these children can prevent hearing loss and its impact on their educational, social and language development. School based ear health programs are a useful community-oriented solution for prevention of deafness. It shows how important it is to introduce hearing screening for primary school aged children to prevent hearing loss.

## 1. Introduction

There is a huge burden of deafness in the world with about 6.1% of the world's population suffering from disabling hearing loss (HL), and 34 million of these are children. In developing countries, 75% of the hearing loss in children is due to avoidable causes like chronic otitis media (COM) [1]. The prevalence of hearing loss in school aged children has been reported to be between 1.75% and 14.9% [2–8]. Though common and often neglected in all age groups, it can have severe consequences especially in children due to its impact to a child's overall development. In children, hearing loss of even 15 dB HL can lead to delayed language development and educational progress [9–12]. Children with hearing loss are significantly disadvantaged in speech articulation, behavioral development, verbal command, and academic performance [9–14].

School based health programs are one of the most efficient and common screening programs for the prevention and treatment of disease through awareness and early diagnosis. Screening of hearing loss in children provides the opportunity to detect a child's hearing status,

provide treatment to improve hearing or limit further loss and to improve learning [15].

In Nepal, a survey conducted in 1991 found that about 16.6% of the population had hearing impairment. In the school age group, 55.2% of hearing impairment was due to otitis media [16]. Subsequently, no other study covering a larger population has been conducted to evaluate the burden of hearing loss in Nepal. This is the first and largest study ever conducted on hearing loss in school aged children.

Nepal is one of the least developed countries and according to Asian Development Bank; about 25% of the population subsists on less than \$1 per day [17,18]. There are no national hearing screening programs. In most parts of Nepal, people still face grave challenges for basic health care due to lack of public health care, limited access due to difficult geographic terrain, inadequate skilled health personnel and poor socioeconomic status. As a result an invisible disability such as hearing loss is given a low priority, especially in the underprivileged population. A study done on the Nepalese population revealed that people with hearing loss were often stigmatized, isolated, and faced obstacles in education and employment which had direct impacts to their

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educational development and social behavior [19].

This study was conducted with an objective to find out the current prevalence of hearing loss in Nepalese school aged children. It aimed to discover if there was still a huge burden of hearing loss in children in Nepal and if the main causes of hearing loss are preventable. The study’s findings also delivers the message that school based hearing screening and awareness programs have a vital role to play in the prevention of avoidable hearing loss in Nepalese children.

**2. Methods**

This is a cross sectional study conducted at 509 government schools of Nepal covering all three regions of Nepal; plains, hilly and mountainous regions. The study was conducted from January 2015 through December 2019 by a team of Ear Nose and Throat surgeons and audio technicians associated with our institute. Children from grades 1 to 10 were included in the study. A written consent was obtained from the individual schools and the education department of the concerned district. Schools that did not give consent to conduct the study, and children who were absent during the time of the screening were excluded in the study.

All ear screenings were conducted during school hours. Two separate classrooms were utilized for screening, one for examination and the other for audiological assessment. For audiological assessment, a quiet room away from the screening room was used. Screening teams consisted of at least one Ear Nose Throat surgeon or physician, one audio-technician, one community ear assistant and one staff nurse.

All screening sessions started with an initial educational briefing to the teachers, the children and their parents. A short personal and family history of ear diseases and deafness and socio-demographic characteristics was then collected and documented. All the children were then examined class-wise for ear problems by a doctor using a Welch Allyn otoscope. On otoscopy, if children were suspected to have middle ear effusion, this was confirmed by using a Maico handheld Tympanometer. In this study, we have defined chronic otitis media (COM) according to G.G. Browning’s classification which is permanent abnormality of the tympanic membrane following a long-standing middle ear infection as a result of acute otitis media (AOM), otitis media with effusion (OME), or persistent negative pressure of the middle ear for a long time.

Audiological evaluation was carried out by an audio-technician using an Arphi Proton SX5 audiometer in a quiet room. The room was considered quiet if the examiner with a normal hearing could appreciate 10 dB HL sound at 1000, 2000 and 4000 Hz frequencies. Pure tone air conduction thresholds of 500, 1000, 2000 and 4000 Hz frequency across an intensity of -10 to 120 dB range were measured and documented. Normal hearing was defined according to WHO guideline as hearing thresholds up to 25 dB HL. Hearing loss was defined as a pure tone average higher than 25 dB in one or both ears. In the children with hearing loss with an average pure tone higher than 25 dB, a complete audiogram of all the frequencies of both air and bone conduction was conducted and documented. Data was collected and analyzed.

**3. Results**

A total of 79,340 school-age children from grades 1 to 10 were screened at 509 government schools of Nepal. Gender distribution of the children screened was 51.45% female (n = 40,824) and 48.54% male (n = 38,516). 49.89% of the children screened were between the ages of 11–15 years (n = 39,580) and 10.12% (n = 8030) were children less than five years old.

The prevalence of hearing loss among all children was found to be 5.73% (n = 4551): with male 51.70% (n = 2353) and female 48.29% (n = 2198). The remaining 94.26% (n = 74,789) were found to have normal hearing. More than half of the total hearing loss 57.11% (n = 2599) was observed in older children aged 11–15 years. Hearing loss in different age group is shown in Tables 1 and 2.

**Table 1**  
Age distribution of children with hearing loss.

Age distribution	Number of children examined (%)	Number of children with hearing loss (%)	Percent of total with hearing loss (%)
<5 years old	8030 (10.12%)	19 (0.03%)	0.41%
5–10 years old	21,514 (27.11%)	764 (0.96%)	16.79%
11–15 years old	39,580 (49.89%)	2599 (3.27%)	57.11%
>15 years old	10,216 (12.88%)	1169 (1.47%)	25.69%
Total	79,340 (100%)	4551 (5.73%)	100%

**Table 2**  
Type of hearing loss by age distribution.

Age distribution	Type of hearing loss	Number of children	Total
<5 years old	Conductive Hearing Loss	14 (0.30%)	19 (0.41%)
	Sensorineural Hearing Loss	5 (0.11%)	
	Mixed Hearing Loss	0 (0.00%)	
5–10 years old	Conductive Hearing Loss	511 (11.23%)	764 (16.79%)
	Sensorineural Hearing Loss	226 (4.97%)	
	Mixed Hearing Loss	27 (0.59%)	
11–15 years old	Conductive Hearing Loss	1890 (41.53%)	2599 (57.11%)
	Sensorineural Hearing Loss	621 (13.65%)	
	Mixed Hearing Loss	88 (1.93%)	
>15 years old	Conductive Hearing Loss	792 (17.40%)	1169 (25.69%)
	Sensorineural Hearing Loss	317 (6.97%)	
	Mixed Hearing Loss	60 (1.32%)	

Out of the 5.73% (n = 4551) of children with hearing loss, conductive hearing loss was the most common type of hearing loss observed in 70.47% (n = 3207) children followed by sensorineural hearing loss in 25.68% (n = 1169) of the children, and mixed hearing loss in 3.84% (n = 175) children (Table 3). Unilateral hearing loss was found to be more common than bilateral loss, with 68.18% (n = 3103) children having unilateral hearing loss; right side 34.72% (n = 1580) and left side 33.46% (n = 1523). Bilateral hearing loss was observed in 31.82% (n = 1448) children. The main cause of hearing loss was due to chronic otitis media seen in 58.29% (n = 2653) children, followed by wax in 15.42% (n = 702) children.

**4. Discussion**

This is the first study done in Nepal covering a large sample of school

**Table 3**  
Type and severity of hearing loss.

Type of Hearing Loss	Degree of Hearing Loss	N (%)
<b>Conductive Hearing Loss</b>	Mild	2532 (78.95%)
	Moderate	604 (18.83%)
	Moderately Severe	71 (2.21%)
	<b>Sub-Total</b>	<b>3207 (4.04%)</b>
<b>Mixed Hearing Loss</b>	Moderate	87 (49.71%)
	Moderately Severe	35 (20%)
	Severe	53 (30.29%)
	<b>Sub-Total</b>	<b>175 (0.22%)</b>
<b>Sensorineural Hearing Loss</b>	Mild	731 (62.53%)
	Moderate	256 (21.90%)
	Moderately Severe	35 (3%)
	Severe	25 (2.13%)
	Profound	122 (10.44%)
	<b>Sub-Total</b>	<b>1169 (1.47%)</b>
Total		4551 (5.73%)

aged children and the only large study investigating the prevalence of hearing loss in school aged children. A total of 79,340 children from grades 1 through 10 were screened for hearing loss. This study was conducted in 509 government schools. Government schools in Nepal are where the most economically deprived pupils attend because they are free of charge and are considered to provide a low quality of education. Therefore, in Nepal only the poorest children attend government schools.

The study cohort was comprised of 51.45% female (n = 40,824) and 48.54% male (n = 38,516) children. Of the children screened the majority fell into 11–15 year old age group 49.89% (n = 39,580). Although we screened children from grade 1 to grade 10 only, 12.88% (n = 10,216) of the children were over 15 years old. This is generally because children studying at the government run schools are from poor families whose children enter school much later than privileged children who also mostly attend private schools. In poor families, due to lack of guardian to take care of a child, older children typically look after their younger siblings so very often the younger children are sent to school along with their older siblings. This primarily explains why 10.12% (n = 8030) children screened were less than five years old even though the study included children from grades 1 to 10 only.

The prevalence of hearing loss among the children of our study was found to be 5.73% (n = 4551). The prevalence of HL in school aged children in our study is less than the national figure of 16.6% found in a study done by Little et al., in 1991 [16], this may be because the national survey was comprised of 15,845 of the general population, and not just school aged children. Also, since 1991 Nepal has made good progress in the improvement of overall health care, education and awareness about health. During this period, the life expectancy has improved from 55.26 years to 70.47 years and the per capita income from US\$202.081 to US \$1071.051 [18]. It could also be because compared to 1991 study which was community based, ours is a school based study. Severe and profound deaf children never make it to the normal schools and therefore, they were less prevalent in our study.

The only other study covering a large number of children in Nepal was done on Bhutanese refugees and was reported by Mishra et al. This study was done on Bhutanese children living in refugee camps in Nepal. Out of 37,872 children screened, they reported only 0.64% (n = 244) to have any HL [20]. The reason for low prevalence rate may be because Bhutan has relatively better public health care system and socio-economic status. The rest of the relevant studies reported in Nepal included only small sample sizes. Schmitz et al. has reported similar prevalence rate as ours of 6.1% in a study conducted in 3646 young adults aged 15–25 years in rural Southern Nepal in 2008 [21]. Maharjan et al. reported a prevalence of 12.47%. The reason for the higher prevalence reported by Maharjan et al. could be because it studied only one school with a small sample size where 85.6% of the children belonged to the Dalit community, so called the untouchables who are considered the poorest of the poor [22]. A very high prevalence rate of HL 64.99% was reported in a study conducted by Thakur et al. [23]. This was a result of the data of 1094 people collected during an eye/ear camp and not a population prevalence study. In this study examinations were done by a community health worker and hearing loss was confirmed by otoscope and tuning fork tests only, no other audiological tests were done to confirm the hearing loss. Similarly, high prevalence rate of 21.4% was reported by J Byanju et al. in this too, audiograms were not done to confirm HL [24].

In other parts of the world, the prevalence of hearing loss in school aged children has been reported in a wide range between 1.75% and 14.9% [2–8]. The large difference could be attributed to differences in definition of hearing loss, socioeconomic status of the participants and different diagnostic methods followed in the studies. In our study, average pure tone threshold at 0.5, 1, 2, and 4 kHz frequencies higher than 25 dB was considered HL. In contrast, Niskar et al. [9] defined HL as audiometric threshold of  $\geq 16$  dB HL and Skarzynski et al. [5] of  $\geq 20$  dB HL in at least one frequency and not an average of all four

frequencies.

We found the hearing loss was almost equal among boys and girls, which was consistent with the studies by Skarzynski, Elbeltagy and Ertzgaard et al. [5,25,26]. The prevalence rate of HL increased with age. More than half of the children with HL 57.11% (n = 2599) were older children aged 11–15 years. The reason for the high percentage of older children with hearing loss in our study is mainly due to factors associated with late enrolment in schools. For the government schools in rural parts of Nepal, the concept of school busing or transportation is non-existent. Children must often walk long distances to reach school or live in rented rooms close by. Therefore in general, they are only enrolled when they are able to walk to school daily or live independently. It could also be due to effect of long standing untreated COM with perforation of tympanic membrane exacerbated by recurrent untreated infection. This is consistent with the results of other studies [27, 28]. Interestingly however, other studies found HL was more common among younger children [5,29].

In this study, out of 5.73% (n = 4551) of the children with hearing loss, conductive hearing loss was the most common type of hearing loss observed among 70.47% (n = 3207). Hearing loss was unilateral in 68.18% (n = 3103) and bilateral in 31.82% (n = 1448) children. Likewise, several other studies also reported conductive, mild and unilateral HL to be more common than neural, severe and bilateral hearing loss [2, 5,25,29–32]. In children, mild HL is more often overlooked than severe hearing loss [33]. In noisy places like classrooms, children with even mild HL can have difficulties in communication. Children with mild hearing loss have behavior problems such as delayed responses, not following orders, carelessness and poor academic progress which is often unrecognized by their parents and teachers [6,8,9,25,32].

When etiology of hearing loss is considered, in our study chronic otitis media was the most common cause of deafness 58.29% (n = 2653) followed by wax 15.42% (n = 702). Similar findings were also observed by Osei, Lin, Hunt and Jacob et al. [6,27,32,34]. In contrast to this, ear wax was the commonest cause of hearing loss in other studies [7,8]. SNHL was seen in 25.68% (n = 1169), most of it was mild loss. This could be the result of previous unidentified infections such as mumps, measles and meningitis; the use of ototoxic liquids to treat minor ear problems; and noise induced hearing loss. Unlike low prevalence rates reported by Rao and Elbeltagy et al. [7,25], Bess et al. has reported high prevalence rate of SNHL [35].

In our study, the main cause of hearing loss was due to chronic otitis media, which could explain the correlation between hearing loss and a lower socioeconomic status. The majority of children in our study come from rural areas and lower socio-economic families. They have a higher incidence of COM due to associated risk factors such as poor health and nutrition, overcrowded living conditions and passive smoking which explains why it is more prevalent in children from this rural less privileged group [36]. In Nepal, especially in rural areas entire families live and cook on the same room. Children are exposed to firewood smoke as well as cigarette smoking from an early age. Several other studies also found hearing loss to be more prevalent in rural populations than in urban populations [7,27,37,38]. Contrary to this, Bastos et al. [39] found a higher prevalence of HL in urban rather than rural populations whereas Wang et al. [40] did not find any difference between the prevalence rate in rural and urban populations.

This study was conducted in government schools of Nepal where children usually come from the most underprivileged backgrounds; more than 70% of the children with hearing loss belong to ethnic minorities and indigenous communities. Disadvantaged and indigenous populations such as Inuits, Australian Aborigines, African Americans and Greenlandic children were also found to have a higher prevalence of hearing loss compared to advantaged population [28,41–44]. In developed countries' study of non-indigenous children, a higher prevalence of hearing loss has been reported: 7.7% in Canada (29), 15.2% in The United States of America [28] and 13.3% in Australia [45]. The reason for this high prevalence may be due to the definition of the hearing loss.

Children were considered to have hearing loss if there was a hearing loss of more than 15 dB HL in one or more of the four frequencies (0.5, 1, 2 or 4 kHz), whereas in our study hearing loss was defined as a pure tone average of four frequencies higher than 25 dB HL in one or both ears.

A variety of selection criteria and methodologies have also been used in these studies. This explains the wide range in the prevalence rate. Different selection criteria include the inclusion of only the younger children [7,32,38], a small study cohort [4,7,8,23–25,32,34,38,39] and a hospital outpatient based study [23,30]. Differences in methodology included the use of only tuning fork tests to evaluate hearing loss [23, 24] and a definition of hearing loss as >15 dB HL [39].

A limitation of our study is that we only covered government schools. Had we included private schools where more privileged children attend, we would have an opportunity to compare prevalence of hearing loss between two groups. Our aim was to find out the status of hearing loss in children from deprived backgrounds since the majority of the population lives below the poverty line. It was challenging to perform pure tone audiograms in younger children and due to lack of resources other tests couldn't be done. In children with wax impaction and hearing loss, a repeat audiogram after removal of the wax would have confirmed the underlying cause of hearing loss. However it was not feasible to remove wax at the time of screening due to a shortage of resources.

This is the first study done in Nepal covering such a large sample size to evaluate the prevalence of hearing loss in school aged children. No other study covering a population of this size has been reported since a national survey was conducted in 1991 which also included general population. Therefore, our study's results fill in this huge gap and provide recent data on hearing loss in children. Though the studies' show a decrease in the prevalence rate from 8.32% to 5.73% since 1991, the main cause of hearing loss is still unfortunately due to chronic otitis media. Routine hearing screening, early treatment of the causes such as otitis media and the raising of public awareness about ear care and hearing problems could easily prevent most of this hearing loss. The new findings from this study can be used to initiate national level hearing screening and school based awareness programs which could reduce the prevalence of avoidable hearing loss in children in Nepal.

## 5. Conclusion

Hearing loss is common among Nepalese children and the main cause of hearing loss is still due to preventable causes. Early detection and timely treatment of ear diseases such as chronic otitis media is essential to decrease the prevalence and impact of hearing loss. Routine hearing screening of school children is very important to prevent hearing loss at early stages of development. School based ear screening and awareness programs are a useful community based health program for prevention of deafness in developing countries like Nepal.

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## Declaration of competing interest

The authors disclose no conflict of interest.

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