

Prevalence and Patterns of Hearing Loss Among Primary School Pupils in Dodoma Municipality, Tanzania

Zephania Saitabau Abraham^{a*}, Castern Dickson Kiiza^a

^aDepartment of Surgery, School of Medicine and Dentistry, University of Dodoma, Dodoma, Tanzania.

Correspondence to Zephania Saitabau Abraham (zsaitabau@yahoo.com)

ABSTRACT

Background: Hearing is one of the crucial senses during early childhood development, as it plays an essential role in language acquisition, speech development, and social interaction. This study aimed to determine the prevalence and patterns of hearing loss among primary school pupils in Dodoma Municipality.

Methods: A cross-sectional study was conducted among children aged 5 to 15 years in eight public and private primary schools in Dodoma Municipality. Hearing loss was assessed using a calibrated Amplivox 207 diagnostic audiometer. Data were analyzed using Statistical Package for Social Sciences version 26, with descriptive statistics used to summarize participant characteristics and hearing loss patterns. Chi-square tests were used to examine associations between hearing loss and socio-demographic factors, with statistical significance set at $P < .05$.

Results: A total of 206 primary school pupils from eight schools were screened for hearing loss. Of these, 117 (56.8%) were males and more than half of the pupils, 116 (56.3%), were from public schools. The prevalence of hearing loss was 5.3%, with conductive hearing loss accounting for the majority of cases (81.8%). Among the 11 pupils identified with hearing loss, 10 (90.9%) had mild hearing loss, while 1 (9.1%) had moderate hearing loss. Regarding lateralization of hearing loss, 45.5% had bilateral hearing loss and 54.5% had unilateral hearing loss, with the unilateral cases equally distributed between the left and right ears. A statistically significant association was observed between hearing loss and type of school attended, with all affected pupils coming from public schools.

Conclusion: Hearing loss was found to be present among primary school children, with conductive hearing loss being the predominant type. Most affected pupils had mild hearing loss, involving either one or both ears. Regular screening of hearing loss among primary school children should be conducted so that prompt treatment can be initiated for those affected.

BACKGROUND

Hearing loss is a significant public health problem and a potentially disabling condition affecting both children and adults in developing as well as developed countries.¹ The primary school period is one of the most critical stages in a child's life, during which children acquire important skills that influence their future development and adulthood.² If hearing loss goes unnoticed, particularly among pupils in lower classes who have not yet fully developed speech and language skills, it may have devastating consequences. Hearing loss can impair academic performance, intellectual development, social interaction, and the acquisition of appropriate communication and moral skills.³

Hearing loss remains a major global health problem, with approximately 466 million people worldwide, representing about 6% of the global population, requiring rehabilitation for disabling hearing loss. Among these, nearly 34 million (7%) are children. According to the World Health Organization, about 60% of childhood hearing loss cases are attributable

to preventable causes.^{4,5}

Studies worldwide have reported varying prevalence and patterns of hearing loss among school children.⁶⁻¹⁴ An Iranian study found a relatively low prevalence of hearing loss, with higher rates observed in older children and boys. Conductive hearing loss was the most common type, followed by sensorineural and mixed hearing loss.¹⁵

A study conducted among school children in Uganda reported a notable prevalence of hearing loss, with sensorineural hearing loss being slightly more common than conductive hearing loss, while mixed hearing loss was least frequent. Mild and profound forms of hearing loss were the most observed severities.¹¹

A study conducted in Zimbabwe found that hearing loss affected a proportion of school children, with sensorineural hearing loss being slightly more common than conductive hearing loss. The study also reported a higher occurrence of hearing loss among children living in rural areas compared to urban areas.⁸

Studies conducted in Dar es Salaam and Kilimanjaro reported varying prevalence of hearing loss among school children, with higher rates observed among rural children compared to urban children. Cerumen impaction and otitis media were identified as the most common possible causes of hearing impairment.¹³

Despite primary school children being at risk of hearing impairment, information on hearing loss in this population remains limited in Tanzania. In particular, no prior study has examined the prevalence and patterns of hearing loss among primary school children in Dodoma Municipality, creating a clear gap in the existing knowledge. Therefore, this study was undertaken to generate local evidence on the burden and characteristics of hearing impairment among school-aged children in the area. Overall, the study was motivated by the need to address this knowledge gap and to support early detection and timely intervention for hearing problems among school children.

METHOD

Study Design, Area and Duration

This was a school-based cross-sectional study conducted among primary school pupils in Dodoma Municipality. The region is located in central Tanzania and is bordered by Singida Region to the west, Manyara Region to the north, Iringa Region to the south, and Morogoro Region to the east. It covers an area of 41,311 km². According to the 2022 national census, the region had a population of 3,085,625, comprising 1,512,760 males and 1,572,865 females. Dodoma Municipality has a total of 111 primary schools, including 92 public schools and 19 private schools.

Study Population

The study population comprised primary school pupils in Dodoma Municipality.

Sampling Technique

Study participants were selected from primary schools in Dodoma Municipality using a multistage stratified random sampling approach. A complete list of public and private primary schools was obtained from the municipal education office, and schools were first stratified into these two categories. From each stratum, four schools were randomly selected, giving a total of eight schools. Within the selected schools, pupils were then randomly sampled from each class among those whose parents or guardians had provided consent to participate and similarly, assent was obtained from the children who participated in the study. This process was repeated across all selected schools until the required sample size was achieved.

Sample size Estimation

The sample size was estimated using a Kish-Leslie formula (1965) for a cross-sectional study;

$$N = \frac{Z^2 P(1-P)}{E^2}$$

Where;

N= estimated sample size

Z=standard normal deviation of 1.96 corresponding for

95% confidential interval.

P= proportion of the target population estimated.

e=margin error.

Z=1.96 (95% confidence interval)

P= 0.167 which is prevalence of hearing loss among primary schools in Kilimanjaro, Tanzania.¹³

$$N = \frac{1.96^2 \times 0.167(1-0.167)}{0.05^2} = 206$$

The estimated sample size was 206 primary school pupils.

Inclusion Criteria

All pupils attending the selected primary schools and aged 5 to 15 years.

Exclusion Criteria

Pupils with pre-existing hearing loss were excluded from the study, as well as those with acute mental conditions such as mental illness, attention deficit disorders, and hyperactivity due to anticipated difficulties in following instructions. In addition, pupils with obvious congenital ear anomalies, including congenital external auditory canal stenosis or atresia, were also excluded.

Questionnaire Administration

A structured questionnaire with closed-ended questions was used to collect data. The original English version was translated into Kiswahili to suit participants' language proficiency and similarly consent/assent forms were in Kiswahili version. The principal investigator provided clarification whenever participants had difficulty understanding the questions. Data collection was conducted in selected schools following approval from the municipal council, which also facilitated introduction to school authorities and informed teachers about the importance of hearing screening. Class teachers assisted in responding to the questions included in the questionnaire.

Auditory Assessment Procedures

Necessary equipment, including an otoscope, audiometer, and related supplies, was used during the assessment. Otoscopic examination was performed first, and any cerumen impaction or ear discharge was managed before proceeding with audiometric testing.

Pure tone audiometry was conducted for all participating pupils by a qualified and well-trained clinical audiologist using accepted international audiometric procedures. A fully calibrated Amplivox 207-micro diagnostic audiometer was used, with calibration performed according to standard recommendations to ensure measurement accuracy. The audiometer was calibrated in accordance with the manufacturer's guidelines and relevant international standards like the International Organization for Standardization (ISO 389) and International Electrotechnical Commission (IEC 60645-1).

Screening was carried out in a quiet room with ambient noise maintained below 35 dB, which is within acceptable limits for hearing assessment. Ambient noise levels were controlled in accordance with recommended

standards for maximum permissible ambient noise during audiometry (e.g., ISO 8253-1). Environmental noise was basically minimized to prevent interference with threshold measurements. Hearing status was classified using a pure-tone average threshold of 25 dB HL (decibel hearing level), in line with WHO classification, whereby thresholds ≤ 25 dB HL (decibel hearing level) were considered normal hearing, while thresholds > 25 dB HL (decibel hearing level) were classified as hearing loss. Both air conduction and bone conduction testing were performed; air conduction was assessed using over-ear headphones, while bone conduction was assessed using a bone vibrator placed on the mastoid process of the tested ear. Hearing thresholds were evaluated at frequencies of 500, 1000, 2000, 4000, and 8000 Hz at varying intensities, and pure tone averages were calculated and reported in decibels (dB). Hearing impairment was classified according to World Health Organization (WHO) criteria: normal (≤ 25 dB), mild (26–40 dB), moderate (41–60 dB), severe (61–80 dB), and profound (≥ 81 dB). Hearing loss was categorized as unilateral or bilateral and further defined as conductive, sensorineural, or mixed based on air–bone gap criteria (> 10 dB).¹

Measurement of Variables

Exposure Variables: The exposure variables for the study were (i) socio-demographic characteristics such as age and sex (ii) type of school (public versus private)

Outcome Variables: The outcome variables for the study were (i) presence, (ii) type, (iii) severity, and (iv) pattern of hearing loss.

Reliability

Reliability was ensured through the use of standardized data collection procedures and a fully calibrated Amplivox 207 Diagnostic Audiometer for hearing assessment. Research assistants were trained on questionnaire administration and audiometric examination techniques. Class teachers assisted in responding to the questions included in the questionnaire. The questionnaire was pretested before the actual study, and test–retest procedures were used to assess the consistency of responses over time. The same hearing assessment protocol was uniformly applied across all selected schools to ensure consistency of measurements. A pilot study was conducted among 10% of the study participants from selected primary schools that were not included in the final data collection process.

Internal Consistency

Internal consistency of the questionnaire items was assessed using Cronbach's alpha coefficient. A Cronbach's alpha value of 0.80 was obtained, indicating acceptable internal consistency of the survey tool.

Content Validity

Content validity of the modified English-version questionnaire was evaluated by experts in otorhinolaryngology and public health based on relevance, clarity, simplicity, and ambiguity.

Data Processing and Analysis

The data was gathered through a structured electronic questionnaire and analyzed using Statistical Package

for Social Sciences version 26 (IBM Corp., Armonk, New York, USA). Descriptive statistics were employed to analyze socio-demographic characteristics as well as the prevalence and patterns of hearing loss among primary school pupils, presenting results as percentages and frequencies. Inferential analysis was then conducted to assess associations between hearing loss and selected socio-demographic variables. The Chi-square test was applied to determine relationships between independent and dependent variables, and a $P < .05$ was considered statistically significant.

Quality Control Measures

Misclassification bias was minimized through the use of standardized diagnostic tools such as pure tone audiometry and otoscopic examination to accurately classify hearing status and ear conditions. Clear operational definitions of hearing loss, including WHO-recommended thresholds for mild and moderate impairment, were applied to reduce ambiguity in classification. Examinations were conducted by trained personnel to enhance consistency and reduce observer error. In addition, well-structured data collection tools and standardized recording procedures were used, and quality checks were carried out to ensure data accuracy.

Ethical Approval and Consent to Participate

Ethical approval for the study was obtained from the Institutional Research Review Committee (IRREC) of the University of Dodoma on 6th September 2024, under approval number MA/84/261/80/18. Administrative permission to conduct the study was granted by the Executive Director of Dodoma City Council. Data confidentiality was strictly maintained by excluding participants' names from the questionnaires, with each participant instead assigned a unique numerical code to ensure anonymity and protect privacy. Written informed consent was obtained from parents or guardians prior to the enrolment of children in the study and similarly assent was obtained from children who participated in the study.

RESULTS

Socio-demographic Characteristics of Primary School Pupils

A total of 206 primary school children aged 5–15 years participated in the study, with a mean age of 10.26 ± 1.6 years. Most participants were aged 8–10 years (57.8%) and males predominated in this study, (56.8%). More than half of school children belonged to public schools, (56.3%) (Table 1).

Prevalence of Hearing Loss Among the Recruited Primary School Pupils

In this study where 206 primary school children were recruited, 11(5.3%) of them had hearing loss. The prevalence of hearing loss observed in this study was lower than the estimate used for sample size calculation, possibly due to differences in study settings and populations. Although the sample size was sufficient for estimating overall prevalence, the smaller number of affected participants may have reduced the power of subgroup analyses and limited the ability to detect significant associations or perform detailed stratification.

TABLE 1: Sociodemographic Characteristics of Primary School Pupils, n=206

Variable	Frequency, n (%)
Age group (years)	
5 – 7	7(3.4)
8 – 10	119(57.8)
11 – 13	78(37.9)
13- 15	2(1.0)
Gender	
Male	117(56.8)
Female	89(43.2)
School type	
Public	116(56.3)
Private	90(43.7)
Class	
I	4(1.9)
II	3(1.5)
III	11(5.3)
IV	54(26.2)
V	80(38.8)
VI	50(24.3)
VII	4(1.9)

Prevalence of Hearing Loss Among Primary School Pupils According to Age, Sex, School Type and Class.

Hearing loss was most common among pupils aged 11 to 13 years and was more frequent in females than males. There was a statistically significant association between hearing loss and type of school attended, with all affected

pupils identified in public schools (Fisher's exact test, $p=0.003$). However, potential confounding factors were not adjusted for.

Hearing loss was most common among pupils in class five (7.5%) and class four (7.4%), followed by class six (2.0%), with no statistically significant association between class level and hearing loss (Fisher's exact test, $p = 0.831$ (Table 2).

Types of Hearing Loss Among Primary School Pupils

In this study where 206 primary school pupils were recruited, 11 (5.3%) pupils were found to have hearing loss. Majority of the pupils had conductive hearing loss, 9(81.8%) while 2 (18.2%) pupils had mixed hearing loss.

Type of Hearing Loss According to Age Among Primary School Pupils, n= 11

All pupils aged 8–10 years had conductive hearing loss, while among those aged 11–13 years, 71.4% had conductive hearing loss and 28.6% had mixed hearing loss. There was no statistically significant association between age and type of hearing loss ($p=0.491$) (Table 3).

Type of Hearing Loss According to Sex Among Primary School Pupils, n=11

All females with hearing loss had conductive hearing loss, while among males, 50% had conductive and 50% had mixed hearing loss. There was no statistically significant association between sex and type of hearing loss among the pupils (Table 4).

TABLE 2: Prevalence of Hearing Loss among Primary School Pupils According to Age, Sex and School Type

Demographic characteristics	Hearing loss		Total, N (%)	P value
	Present (%)	Absent (%)		
Age group (years)				
5 – 7	0(0.0)	7(100.0)	7 (100.0)	.325
8 – 10	4(3.4)	115(96.6)	119(100.0)	
11 – 13	7(9.0)	71(91.0)	78(100.0)	
13-15	0(0.0)	2(100.0)	2 (100.0)	
Total	11(5.3)	195(94.7)	206 (100.0)	
Gender				
Male	4 (3.4)	113(96.6)	117 (100.0)	.213
Female	7(7.9)	82(92.1)	89 (100.0)	
Total	11(5.3)	195(94.7)	206 (100.0)	
Type of school				
Public	11 (9.5)	105(90.5)	116 (100.0)	.003
Private	0 (0.0)	90(100.0)	90(100.0)	
Total	11(5.3)	195(94.7)	206 (100.0)	
Class				
I	0(0.0)	4(100.0)	4(100.0)	.831
II	0(0.0)	3(100.0)	3(100.0)	
III	0(0.0)	11(100.0)	11(100.0)	
IV	4(7.4)	50(92.6)	54(100.0)	
V	6(7.5)	74(92.5)	80(100.0)	
VI	1(2.0)	49(98.0)	50(100.0)	
VII	0(0.0)	4(100.0)	4(100.0)	
Total	11(5.3)	195(94.7)	206 (100.0)	

TABLE 3: Type of Hearing Loss among Primary School Pupils According to Age

Age (years)	Conductive hearing loss, n (%)	Mixed hearing loss, n (%)	P value
8 – 10	4(100.0)	0(0.0)	.491
11 – 13	5(71.4)	2(28.6)	

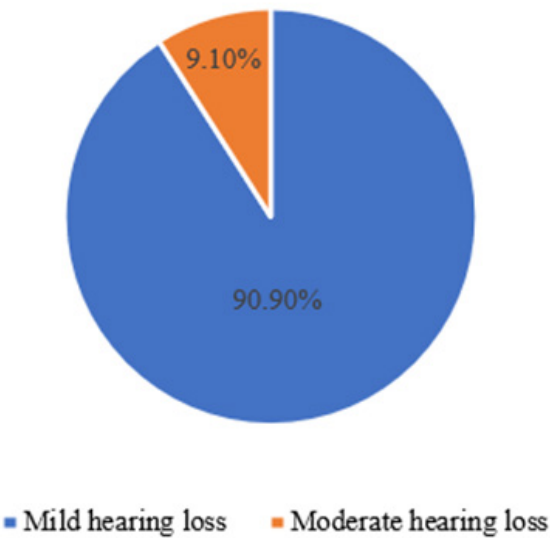
TABLE 4: Type of Hearing Loss According to Sex among Primary School Pupils

Sex	Conductive hearing loss, n (%)	Mixed hearing loss, n (%)	P value
Female	7(100.0)	0(0.0)	.109
Male	2(50.0)	2(50.0)	

Severity of Hearing Loss Among Primary School Pupils, n= 11

Among the 206 recruited pupils, 11 (5.3%) had hearing loss, of whom 10 (90.9%) had mild hearing loss and one student had moderate hearing loss, (9.1%) (Figure 1).

FIGURE 1: Severity of Hearing Loss



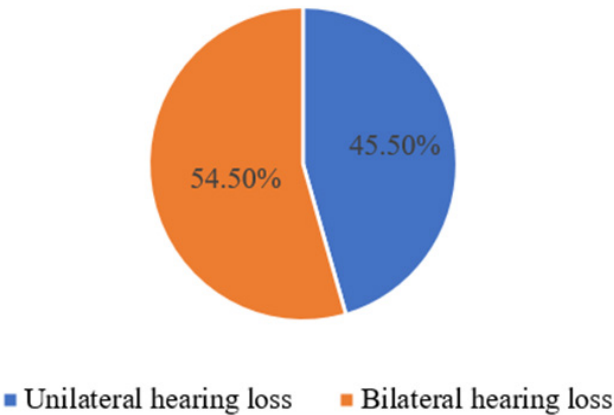
Severity of Hearing loss According to Type Among Primary School Pupils, n=11

Among the 10 pupils with mild hearing loss, 8 (80%) had conductive hearing loss and 2 (20%) had mixed hearing loss. The only pupil with moderate hearing loss had conductive hearing loss. There was no statistically significant association between type and severity of hearing loss ($p=.621$) (Table 5).

Lateralization of Hearing Loss Among Primary School Pupils, n=11

Among the 206 pupils, 11 (5.3%) had hearing loss, with the majority 6 (54.5%) having bilateral hearing loss, while 5 (45.5%) had unilateral hearing loss. Among pupils with unilateral hearing loss, the left and right ears were equally affected, each accounting for 50% of cases (Figure 2).

FIGURE 2: Lateralization of Hearing Loss



Relationship Between Lateralization of Hearing Loss Among Primary School Pupils According to Age, Sex, and Type of Hearing Loss

There was no significant statistical association between lateralization of hearing loss with age, sex and type of hearing loss among primary school pupils with P values being .061, .061, .0455 respectively (Table 6).

TABLE 5: Severity of Hearing Loss According to Type Among Primary School Pupils

Severity of hearing loss	Conductive hearing loss, n (%)	Mixed hearing loss, n (%)	<i>P value</i>
Mild	8(80.0)	2(20.0)	.621
Moderate	1(100.0)	0(0.0)	

TABLE 6: Relationship Between Lateralization of Hearing Loss Among Primary School Pupils According to Age, Sex and Type of Hearing Loss

Variables	Bilateral hearing loss	Unilateral hearing loss	<i>P value</i>
Age (years)			.061
8-10	0(0.0)	4(100.0)	
11-13	5(71.4)	2(28.6)	
Sex			.061
Female	5(71.4)	2(28.6)	
Male	0(0.0)	4(100.0)	
Type of hearing loss			.455
Conductive	5(55.6)	4(44.4)	
Mixed	0(0.0)	2(100.0)	

DISCUSSION

Hearing is of paramount importance during early childhood, particularly among children under five years of age, as it is essential for language acquisition and social development. It also plays a significant role in facilitating academic adaptation and learning. Hearing impairment during early childhood may negatively affect a child's social and emotional wellbeing. Therefore, school-based hearing screening serves as a practical approach for early assessment and identification of hearing problems among children. It was based on the assumption that some children with varying degrees of hearing loss may be attending the same classrooms as children with normal hearing, which could contribute to poor academic performance among affected pupils. This study aimed to determine the prevalence and patterns of hearing loss among primary school pupils in Dodoma Municipality, Tanzania.

This study recruited primary school children aged between 5 and 15 years. Most pupils were aged 8 to 10 years, males outnumbered females, and the majority attended public schools. These findings are comparable to those reported in other studies conducted in Tanzania.¹³ Rural South India, Malaysia and Brazil respectively.^{9,17,18} In contrast, studies conducted in Uganda and Egypt reported a higher proportion of female participants than males.^{11,12} The findings has public health implication including routine school-based hearing screening to be done especially for children aged 8–10 years as this is a critical period for language development, learning, and academic performance. The predominance of pupils in public schools indicates that public schools should be prioritized when implementing school-based hearing assessment and

intervention programs. The sex distribution highlights the need for equal access to hearing health services for both boys and girls. Overall, the similarity with other studies shows that childhood hearing problems are a common issue across different countries, supporting the integration of hearing care into school health systems to prevent learning and communication difficulties.

The study revealed that hearing loss was present among enrolled primary school pupils, with higher occurrence among older children, males, and pupils attending public schools. Pupils in class V were the most affected, followed by those in class IV and VI. These findings are comparable to those reported in a study conducted in Kilimanjaro, Tanzania, where hearing loss was also identified among primary school children.¹³ The finding that all pupils with hearing loss were from public schools in this study is notable and may reflect underlying socioeconomic and environmental disparities between public and private school pupils. Possible explanations include differences in socioeconomic status, overcrowding, recurrent upper respiratory tract infections, poor hygiene conditions, limited access to healthcare services including otological services, delayed treatment of ear infections, and differences in parental awareness regarding ear health, all of which have been associated with hearing impairment in children. This finding should be interpreted cautiously as socio-economic and clinical variables including previous ear infections, nutritional status, access to healthcare and environmental exposures were not assessed in this study.

Similar findings were observed in a systematic review conducted in Africa, which reported hearing loss among school children, as well as in another study where girls were more affected than boys.^{19,20} However, studies from

Egypt, Malaysia, United States, Tajikistan, and Nigeria reported varying prevalence rates and differences in the commonly affected sex and age groups.^{12,17,21,23,24} These variations may be explained by differences in the hearing loss thresholds used across studies and inclusion criteria, particularly regarding children with ear wax impaction. The findings highlight the need for standardized hearing screening methods to allow accurate comparison across settings. They also emphasize the importance of routine school-based screening for early detection and treatment of hearing loss. Differences in affected groups suggest that prevention strategies should be context-specific, while the role of preventable causes like wax impaction shows that many cases could be reduced through simple, low-cost interventions in schools and primary care settings.

Conductive hearing loss was the predominant type among the primary school pupils, while mixed hearing loss was less common and no cases of isolated sensorineural hearing loss were identified in this sample. Similar findings have been reported in studies from South India, Egypt and Malaysia where conductive hearing loss also predominated among children.^{9,12,25} The absence of isolated sensorineural hearing loss in this study may be related to the small number of detected cases. The finding of conductive hearing loss predominance suggests that most childhood hearing loss is preventable or treatable, mainly linked to ear infections and wax impaction. This highlights the need for routine school hearing screening and stronger primary ear care services to enable early detection and simple, low-cost treatment, helping to prevent learning and speech problems.

Among children with hearing loss, mild hearing loss was the predominant form, while moderate hearing loss was less common. Similar findings have been reported in studies conducted in Egypt, Malaysia, Ghana and United States.^{6,7,10,25} The predominance of mild hearing loss has important public health implications, as it suggests that most affected children may go undetected without routine screening due to subtle symptoms. This underscores the need for school-based hearing screening programs to identify cases of hearing impairment early before they progress or significantly affect learning and communication.

Most pupils with hearing loss had a unilateral pattern of hearing impairment, with no predominance of either the left or right ear, while fewer pupils had bilateral hearing loss. Similar findings were reported in a study conducted in the United States, where unilateral hearing loss predominated among school children. In contrast, a study among Malaysian primary school children found bilateral hearing loss to be more common.²⁵ The predominance of unilateral hearing loss has important public health implications because children with one normal-hearing ear may still function relatively well in everyday communication, thus these cases can be easily missed without routine screening. This increases the risk of undetected hearing impairment affecting classroom learning, attention, and language development. It therefore highlights the need for school-based hearing screening programs that assess both ears individually, rather than relying on obvious signs of disability.

Strengths of the Study

The study has moderate external validity since findings can be generalized to similar school-going children in comparable settings, but not to all children in Tanzania due to exclusion of out-of-school children and regional differences. The study employed standardized diagnostic tools such as pure tone audiometry and otoscopic examination, structured and pretested questionnaires, and included participants from both public and private primary schools, which enhanced the accuracy, reliability, and representativeness of the findings. Ethical procedures, including informed consent and assent, were appropriately observed. Additionally, the study provides important baseline information that may support future hearing screening and intervention programs among school children.

Study Limitations

The study was conducted in a single region in central Tanzania and involving a modest number of primary school children and therefore results cannot be generalized countrywide. Although the findings cannot be generalized to the entire country due to the single-municipality study setting, the use of an appropriate sampling strategy involving primary school children from Dodoma Municipality allows the findings to be considered reasonably representative of the studied municipality. Future studies with larger multicenter samples or studies specifically powered for subgroup analyses are recommended to provide more robust estimates and strengthen the generalizability of findings. The study did not provide specific socio-economic information for the children identified with hearing loss; therefore, no conclusions can be drawn about their socio-economic backgrounds. Another limitation of this study was the limited number of questionnaire variables related to potential causes of hearing loss, which may have restricted comprehensive assessment of associated risk factors.

CONCLUSION

The study revealed that hearing loss existed among primary school children, with conductive hearing loss being the most frequently observed type and mild hearing loss being the predominant level of severity. These results emphasize the need for routine hearing screening in primary schools, as hearing impairment can often remain undetected and may negatively affect learning and academic achievement.

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