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*Research Article*

# Prevalence and Determinants of Hearing Loss Among Primary School Children in Selected Schools in the Central Region of Ghana

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**ABSTRACT**

Hearing loss in children often inhibits speech and language development, thus affecting academic performance, social and emotional well-being. Thus a comparative cross-sectional study was conducted in three primary schools in Ghana to assess hearing of the children attending those schools and also compare differences between these schools based on the pupils' socioeconomic backgrounds. The data was used to determine prevalence of hearing loss in the schools. A comparison was then made between the results obtained among children attending the more affluent school and the less affluent schools. A total of 773 pupils were included in this study even though 839 pupils were screened as some pupils failed to adequately complete the questionnaires. The average age was 10 years with a standard deviation of 2.65. Significant hearing loss was identified in 4 children (0.5%). Abnormal tympanometry was identified in 86 (10.2%). Abnormal otologic findings identified included cerumen impaction in 73 children (36.5%), acute otitis externa in 7, acute otitis media in 6 and foreign bodies in 10. Schools with lower socioeconomic pupils had a higher prevalence of abnormal tympanometry but there was no difference in hearing loss prevalence. In conclusion, unidentified hearing loss in the three basic schools in Ghana was uncommon and prevalence was not impacted by the school's socioeconomic background. However, a significant portion had abnormal middle ear function or external auditory canal occlusion from cerumen impaction and thus required further management.

**Keywords:** *Hearing screening, audiometry, tympanometry, air-bone gap*

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## INTRODUCTION

Hearing loss can have dire consequences on health, independence, communication and daily function. World Health Organization (WHO) estimates as of March, 2015 report that over 5% of the world's population, live with disabling hearing loss (Lancet editorial, 2016). Disabling hearing loss refers to hearing loss greater than 40 decibels (dB) in the better hearing ear in adults and a hearing loss greater than 30 dB in the better hearing ear in children. Low- and middle-income countries have the majority of people with disabling hearing loss (https://www.who.int/news-room/fact-sheets/detail/deafness-and-hearing-loss).

Hearing loss in infants and children often inhibits speech and language development, thus affecting academic performance, social and emotional well-being (Karchmer et al,1999, Venail et al, 2010). In developing countries, these problems can be magnified as children with hearing loss are often identified late, isolated and neglected with most rarely receiving any schooling. Adults with hearing loss also have a much higher unemployment rate. The problem of hearing healthcare is exacerbated by the high cost of care. Cost of hearing aids are high and surgical treatment methods are expensive and not readily available in developing countries.

## MATERIALS AND METHODS

**Study design:** A comparative cross-sectional study was undertaken among primary school children in two towns of Ghana.

**Study location:** The study was conducted at the University of Cape Coast Primary School at Cape Coast and the M/A Primary and Bantuma Primary Schools at Elmina, all in the Central Region of Ghana

**Ethical considerations:** Ethical approval for this study was obtained from the Institutional Review Board of the University of Cape Coast, Ghana, West Africa.

**School and Participants' selection:** Three schools were included in the study. A university primary school (urban) which had children of staff of the University and people living in the environs of the institution and children from two primary schools (rural) in a fishing community were involved in the study. Children in the University Primary School were generally considered to be coming from affluent homes while children from the fishing community were considered to come from less affluent homes and sometimes accompanied their male guardians on fishing expedition on high seas. Access to health care and other social amenities was poorer in the fishing community and thus their children were generally regarded as coming from homes with low socioeconomic status. Two schools were chosen from the fishing community so as to have a comparable number of the pupils to that of the University Primary school which had a larger population of pupils.

The total number of children across the communities where the survey was conducted was estimated to be 9000. Assuming a prevalence of hearing impairment of 9%, a non-response rate of 8%, our target sample size of 800 school children across the three schools enabled a determination of the prevalence of hearing impairment within a margin of error of 2%, at a confidence level of 95% [http://www.raosoft.com/samplesize.html]

**Data collection:** Participants whose parents consented, completed a simple questionnaire and then pre-test ear examinations carried out by otolaryngologists and nurses. Hearing assessments including pure tone audiometry and tympanometry were performed on the school children using a hearing assessment van. Hearing assessments were conducted by audiologists. Screening audiometry was done for all the respondents whilst those who failed had diagnostic pure tone audiometry which involved testing air and bone conduction thresholds to identify the type and degree of hearing loss (if any) at various frequencies (250, 500, 1000, 2000, 4000, 8000 Hz) using an AC 40 clinical audiometer and the modified Hughson-Westlake method to plot a standard audiogram. This was done for each ear separately in a sound-proof environment (in the test van) using headphones, bone conductors and earphones [Schroeder et al, 2006]. Tympanometry using a 226-Hz tympanometer was performed to identify the presence of a middle ear pathology by measuring the patients' static admittance and ear canal volumes (middle ear pressure limit, -100 – 100 daPa; eardrum compliance, 0.2 – 2.0 cc, ear canal volume, 0.2 – 2.0 cc) (Fagan, 2014). The AC 40 clinical audiometer and tympanometer which were used for the testing of the participants were all calibrated to ensure the equipment is in compliance with the ANSI 53.6-2004 standards (Campbell, 2017).

Parents who did not wish to have their wards screened were given the opportunity to inform the class teacher or other school authorities. Such children were excluded. Each participant was assigned an identification number (to be used in possible follow-up care) during data collection. Administrative approval was obtained from the Heads of the participating institutions.

### Data analysis

The data was double-entered into a computer using a platform created in EPI-INFO (Version 7.2). Cleaned data was exported into SPSS version 20 for analysis.

## RESULTS

Cross tabulation of the name and location of the schools of the respondents sampled for the study is presented in Table 1. A total of 773 pupils were included in this study even though 839 pupils were screened as some pupils failed to adequately complete the questionnaires. Table 1 also shows that a slight majority of the respondents were in rural areas, i.e. 401 respondents representing 51.9%.

**Table 1:**
Cross tabulation of the name and location of the schools of the respondents

| | | Location (N, %) | | Total |
|---|---|---|---|---|
| | | Urban | Rural | |
| Name of School | Urban School | 372 (48.1) | 0 (0.0) | 372 (48.1) |
| | Rural School 1 | 0 (0.0) | 130 (16.8) | 130 (16.8) |
| | Rural School 2 | 0 (0.0) | 271 (35.1) | 271 (35.1) |
| | *Total* | 372 (48.1) | 401 (51.9) | 773 (100.0) |

**Table 2:**
Cross tabulation of gender and age of the respondents

| | | Gender (N, %) | | Total |
|---|---|---|---|---|
| | | Boys | Girls | |
| Age | 0-5 years | 7(0.9) | 1(0.1) | 8 (1.0) |
| | 6-10 years | 258(33.4) | 217(28.1) | 475 (61.4) |
| | 11-15 years | 151(19.5) | 126(16.3) | 277 (35.8) |
| | Above 15 years | 7(0.9) | 6(0.8) | 13(1.7) |
| *Total* | | 423(54.7) | 350(45.3) | 773(100.0) |

Table 2 and Figure 1 show that there were more boys (54.7%) than girls and 61.4% of participants were between 6-10 years of age and were mostly in the primary three (41.8%) or primary four (30.3%) grades.

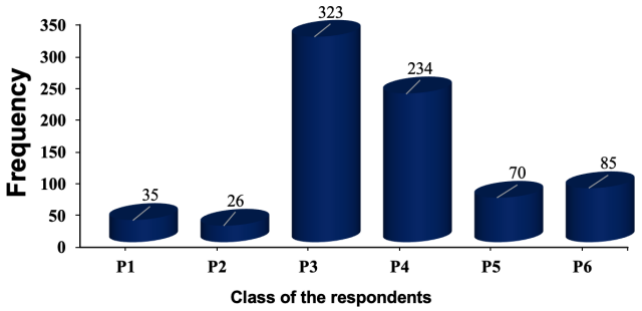


**Figure 1**
Class of respondents

**Table 3:**
Occupation of the Respondents' Parents

| Parents' Occupation | Father's Occupation | | Mother's Occupation | |
|---|---|---|---|---|
| | F(n) | P (%) | F(n) | P (%) |
| Professional/Formal e.g. lecturer, civil or public service, business, teaching | 342 | 44.2 | 257 | 33.2 |
| Informal e.g. fishing, petty trading | 431 | 55.8 | 516 | 66.8 |
| *Total* | 773 | 100.0 | 773 | 100.0 |

Table 3 also shows that 431 respondents (55.8%) indicated that their fathers' occupations were fishing and petty trading whilst 66.8% also indicated that fishing and petty trading were their mothers' occupations.

Audiologic testing as shown in Table 4, found that 1.9% of the respondents in the urban area failed the pure tone test in the right ear compared to 1.0% of the respondents in the rural area. With respect to pure tone test of the left ear, 2.2% of the respondents tested failed the pure tone in the left ear in the urban area compared to 1.0% of the respondents in the rural.

Consequently, to find out whether location of pupils (urban and rural areas) is independent of the pure tone audiograms of the pupils for both left and right ears, the findings show that location of pupils is independent of the pure tone audiograms of the right ear [$\chi^2(1, N = 773) = 1.09, p = 0.29$] and the left ear [$\chi^2(1, N = 773) = 1.09, p = 0.25$]. Thus, pass/fail status was not associated with location where participants lived. Of the pupils who failed their audiometric testing for either the right or left ear, 4 failed in both ears. Failure in one ear of audiometric testing with mild hearing loss was attributed to their untreated otologic conditions especially cerumen impaction.

**Summary of Results of Respondents with Bilateral Abnormal Audiometry:** Urban Primary School had 3 cases of bilateral abnormal audiometry. One pupil had bilateral moderate conductive hearing loss and another had left mild sensorineural hearing loss and right moderately severe sensorineural hearing loss. A third pupil had right mild to profound and left moderate to profound sensorineural hearing loss.

For the rural schools, one pupil had left moderate to profound and right moderately severe to profound sensorineural hearing loss

**Results of Follow-Up of Children with Bilateral Abnormal Audiograms:** Follow-up of the children with bilateral abnormal audiograms found the following results. One child had a febrile convulsion at 2 years and the parents had noticed children could not hear well for varied periods ranging from 3 months to 5 years but had not sort appropriate treatment. The hearing loss manifested in various ways. Some children were not performing well at school. For example, a 15-year-old boy was in Class 2 - a grade for 7-year olds. The speech of one child was not clear as he was unable to pronounce some consonants. Another child talked loudly and was thus made fun of by his peers.

**Table 4.**
Relationship between the pure tone audiograms (PTA) and location of pupils

| | | Urban | | Rural | | Total | | Chi-square | df | P value |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Freq | % | Freq | % | Freq | % | | | |
| PTA of right ear | Pass | 364 | 98.1 | 397 | 99.0 | 761 | 98.6 | 1.085 | 1 | .289 |
| | Fail | 7 | 1.9 | 4 | 1.0 | 11 | 1.4 | | | |
| PTA of left ear | Pass | 364 | 97.8 | 397 | 99.0 | 761 | 98.4 | 0.195 | 1 | .249 |
| | Fail | 8 | 2.2 | 4 | 1.0 | 12 | 1.6 | | | |

**Table 5.**
Relationship between the types of tympanometry and location of pupils

| | | Urban | | Rural | | Total | | Chi-square | df | P value |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Freq | % | Freq | % | Freq | % | | | |
| Tympanogram (right ear) | A | 354 | 95.2 | 395 | 98.5 | 749 | 96.9 | 7.26 | 2 | .026* |
| | B | 16 | 4.3 | 5 | 1.2 | 21 | 2.7 | | | |
| | C | 2 | 0.5 | 1 | 0.2 | 3 | 0.4 | | | |
| Tympanogram (left ear) | A | 347 | 93.3 | 383 | 95.5 | 730 | 94.4 | 7.13 | 2 | .028* |
| | B | 16 | 4.3 | 17 | 4.2 | 33 | 4.3 | | | |
| | C | 9 | 2.4 | 1 | 0.2 | 10 | 1.3 | | | |

To find out whether there was association between the tympanogram findings and pupils' location for both ears, Chi-Square analysis was conducted. This analysis identified a difference between the tympanograms obtained for pupils from the urban area compared to pupils from rural areas for the right ear [$\chi^2\ (2, N = 773) = 7.26, p = 0.026$] and the

left ear [$\chi^2(2, N = 773) = 7.13, p = 0.28$]. These outcomes from the study implied that pupils from urban areas were more likely to have abnormal tympanograms compared to pupils from rural areas.

**Tympanometry Results**

To investigate the association between the types of tympanograms and demographic location of pupils, chi-square analysis was conducted as shown in Table 5.

To find out whether there was association between the tympanogram findings and pupils' location for both ears, Chi-Square analysis was conducted. This analysis identified a difference between the tympanograms obtained for pupils from the urban area compared to pupils from rural areas for the right ear [$\chi^2\ (2, N = 773) = 7.26, p = 0.026$] and the left ear [$\chi^2(2, N = 773) = 7.13, p = 0.28$]. These outcomes from the study implied that pupils from urban areas were more likely to have abnormal tympanograms compared to pupils from rural areas.

**Other Otologic Pathologies Found During Study**

86 pupils were found to have various otologic conditions during the study for which they were referred to health facilities for further management. 73 pupils had cerumen impaction, 6 had acute otitis media, 7 had acute otitis externa and 10 had foreign bodies.

## DISCUSSION

In Ghana, universal newborn hearing screening is not performed. The prevalence of congenital hearing loss or hearing impairment in school age children is unknown in Ghana. Early identification and management of hearing loss can be effectively achieved through pre-school, school and occupational screening for ear diseases and hearing loss thus enhancing appropriate intervention when indicated. The goal of this study was to determine the prevalence of hearing loss in the three primary schools and compare differences based on the socioeconomic statuses of the children at the schools.

The age of identification of hearing loss and initiation of therapeutic / interventional modalities positively affects language or speech development (Yoshinaga-Itano, 2003). The most common age groups in this study were 6 – 10 years, representing 61.4% of respondents. Delayed identification of hearing loss as in this study, at age 6 may be too late as plasticity of the brain could have set in and thus hearing rehabilitation would not be effective. This however does not mean that school screening is not necessary. Even in countries where neonatal hearing screening is well established, some children were found to have delayed-onset hearing loss even after passing the neonatal screening. This buttresses the point that school screening is very important (Lu et al, 2011). This study identified a relatively low prevalence of unidentified hearing loss in basic school children. However, there were a relatively significant number of children with abnormal tympanometry or otologic findings, particularly cerumen impaction. Cerumen impaction was also found to be the most common diagnosis for referral in another study [Tamanani et al, 2015]. Almost 3% with unilateral failed hearing tests were also found.

Poor academic performance was found in a study to be common among children with mild hearing loss. They therefore recommended that all children performing poorly at school undergo hearing assessment [Daud et al, 2010]. Though our study found few pupils with obvious hearing loss, those with abnormal tympanograms and other otologic conditions must be followed up as even a mild undiagnosed hearing loss could lead to poor academic performance. Even a 15dB hearing loss could significantly impair a child's mental development (Absalan et al, 2013). In fact, we identified one child with bilateral moderate sensorineural hearing loss who was much older than expected for his grade. Some of his academic delay could be attributable to his hearing loss. He has since been provided with a hearing aid.

Our assumption that the rural schools would have more hearing loss was not supported by this study as there was no difference in pure tone audiometry between the rural and urban students. However, our results implied that pupils from urban areas were more likely to have abnormal tympanograms compared to pupils from rural areas. Thus, to assume that a pupil was likely to have abnormal tympanogram because he/she lived in a rural area which might have an impact on hearing threshold was also not true.

Conductive hearing loss was 8.8% and 7.1 % in males and females respectively in an Iranian study. In our study, 8.7% of respondents had types B or C tympanograms. The Iranian study also found 20.2% of elementary school children needed further medical treatment whereas in our study 11.1% needed referral to hospitals for further management [Absalan et al, 2013]. A lower percentage of children i.e. 2.08% were referred for further evaluation in another study (Lu, 2011). This might have been due to the fact that the Ghanaian children in our study may have had easy access to health care thus the lower percentage of referrals.

School screening performance is improved when a four-tone audiometry is done with tympanometry. Sensitivity is 65% (Sliwa, 2011). Combined modality of testing with audiometry and tympanometry employed in this study was thus a better mode of school screening.

Hearing loss from our study was found to have significant influence on the social development of the affected individuals. For example, there were two children, a 15-year-old boy who was in Class 2 - a grade for 7-year olds and another child who was 14 years old and in Class 4 (a grade for 9-year-olds). Some of these children were teased by their peers and thus prevented them from interacting with society with a good self-image. Whether hearing loss is the sole cause of these children's school delay is unknown. Some of the hearing-impaired children also had speech impairment.

Parents' perception and thus their reaction to their children's hearing loss was not encouraging. Some of the parents had not noticed that their children could not hear well or assumed children were feigning a hearing difficulty. This is consistent with findings in Poland where some parents failed to recognize their children in school had hearing loss (Skarzynnski, 2011). None of these parents had sought any proper intervention for their children until this study was conducted. This might have been attributable to ignorance or

the poor financial status of the parents. As noted in our study, most respondents had parents of low socio-economic status i.e. fishing and petty trading.

Mild hearing losses were not captured in this analysis as these could have been due to untreated cerumen impaction which when treated would restore the hearing. Hearing losses beyond 25dB were included. Additionally, pupils with abnormal tympanograms were not further investigated so the cause of the abnormality was not elucidated. Completing the questionnaires by both teachers and pupils were largely problematic. Thus, pupils who did not fill their questionnaires were excluded and the teachers' perception of pupils' hearing could not be assessed.

In conclusion, this study found a relatively low incidence of hearing loss. However, there were a significant number of children with cerumen impaction and abnormal tympanograms and the urban population was more likely to have an abnormal tympanogram. Further studies investigating the impact of abnormal tympanogram and developing a feasible approach for routine school screening are needed.

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