

## **A Critical Appraisal of Hearing Impairment among Primary School Children in Port Harcourt, Nigeria**

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### **Authors' contributions**

*This work was carried out in collaboration between all authors. Author OJE designed the study, wrote the protocol and the first draft of the manuscript. Authors OLO and AI reviewed the protocol, did analysis and reviewed the literature searches. All authors approved the final manuscript.*

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### **ABSTRACT**

**Background:** Hearing impairment is the most frequent sensory deficit in human populations affecting over 250 million people in the world. Undetected hearing impairment among primary school children has been linked with poor school performance, low self-esteem and thus poor psycho-social/intellectual development in the child. This paper determines the pattern and prevalence of hearing impairment in primary school children in Port Harcourt.

**Methodology:** This study was carried out in Port Harcourt. Primary school children of both public and private schools were recruited for this study from January 10<sup>th</sup>, 2010 to May 21<sup>st</sup>, 2010. At the schools, Pure Tone Audiometry (PTA) screening was carried out on the pupils whose parents gave informed consent. The data of each child screened was entered into the forms provided (Appendix i and ii) by the research assistants and crosschecked by the researchers. The data was then entered into the database of a software package designed for collection, completion and reporting, the EPI\_INFO (version 6) statistical package for epidemiology. Data from

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the study was analyzed using the computer program EPI-INFO (VERSION 6) and SPSS11.0. The age and sex distribution of the study population; the social class; the prevalence of hearing impairment in relation to age, sex, social class and school type; the risk factors of hearing impairment and its relationship with school performance were determined from the data collected. These data were presented as charts, graphs and tables in simple proportions, and comparisons of sub groups carried out with chi square test. Statistical significance at 95% confidence interval was p value < 0.05.

**Results:** From 13 selected schools, a total of 802 pupils were screened, 461 (57.5%) were from public schools while 341(42.5%) were from private schools; giving a public to private school population ratio of 1.4:1 The number of pupils was almost equally distributed in all the age groups; 281 pupils (35.0%) were between 5-7 years whereas 253 pupils (31.6%) were > 10 years. There were 405 males (50.5%) and 397 (49.5%) females, giving a male: female ratio of 1.02:1.

Majority of the pupils were from social class III (268 pupils, 33.4%). The prevalence of hearing impairment in primary school children in Port Harcourt was found to be 29.4%. The prevalence of hearing impairment was higher in children in public schools (30.2%) than amongst those in private schools (28.4%). Of the 236 pupils with hearing impairment 76 pupils (52%) had Conductive Hearing Loss (CHL), 35 (24%) had Mixed Hearing loss (MHL) and 35 (24%) had Sensorineural Hearing Loss (SNHL). Of the 236 pupils with hearing loss, 128 (54.1%) had unilateral hearing loss while 108 (45.9%) had bilateral hearing loss.

**Conclusion:** The prevalence of hearing impairment in primary school children in Port Harcourt was found to be 29.4%. This was significantly higher among the older children and in females. Hearing impairment was more prevalent in children in public than private schools. Conductive hearing loss (CHL) was the commonest type of hearing impairment seen. Moreover, hearing impairment was significantly associated with poor school performance.

*Keywords: Hearing impairment; pure tone audiometry; hearing assessment; primary school children; public schools; private schools.*

## 1. INTRODUCTION

Hearing impairment is the most frequent sensory deficit in human populations affecting over 250 million people in the world [1,2] at least two-thirds of which reside in developing countries [3]. In developed countries including United State of America, the prevalence of hearing impairment among school children was found to be between 0.05%-0.7percent, with a higher prevalence seen amongst African-American children [2]. In Thailand, a prevalence of 3.9%-6.1% was seen in school children, with a higher prevalence amongst those in rural areas [2,4]. Studies done in Africa have shown that between 2% (South Africa) and 13.9% (Nigeria) of school children have varying degrees of hearing impairment [2,5,6]. Hearing impairment can be as a result of disorders affecting the inner ear or cochlea (sensory loss), the auditory nerve (neural loss), or the middle ear and/or outer ear (conductive loss). Conductive hearing loss could occur with sensory hearing loss (mixed hearing loss) [7,8]. The World Health Organization (WHO) classifies hearing impairment according to the hearing threshold level, using audiometry. It is taken as the better ear average for four frequencies- 0.5, 1, 2, and 4

kHz [6]. The amount or degree of hearing loss may range from slight (16-25 dB HL), mild (26-40 dB HL), moderate (41-70 dB HL), severe (71-95 dB HL), to profound (>95 dB HL) [2,5].

Hearing impairment may be congenital (genetic or non-genetic) or acquired [9]. Significant hearing loss is present in 1-6 per 1000 newborns [8]. However, some congenital hearing loss may not become evident until later in childhood [8]. Hearing impairment may also be acquired in infancy and childhood. Infectious diseases such as meningitis and otitis media are leading causes of sensorineural hearing loss [8,10,11]. Other causes include ototoxic drugs, trauma to the nervous system, environmental pollutants such as damaging noise and chemicals like toluene, tobacco smoke and lead [2,8,10,11,12,13].

There are various screening tests for hearing impairment [8,14,15]. They include automated auditory brainstem evoked response, otoacoustic emissions, behavioral audiometry (this includes visual reinforcement and play audiometry), pure tone audiometry and speech audiometry [8,14,15].

Early detection of hearing loss in newborn and young children is an essential prerequisite for effective aural rehabilitation and educational intervention [1]. The school health program as part of its components provides for routine school medical examination at school entry, mid-way through school and at completion [16,17]. In places where this is routinely done, up to 14-15% of children are found to have defects, mainly visual and hearing, at the initial examination [16]. In developing countries (including Nigeria) however, lack of a simple and practical screening protocol often deters routine and systematic hearing screening at school entry [10,18]. Thus, there are some children in primary schools with varying degrees of undetected hearing impairment. This results in speech and language delay, difficulties in parent-child, peer-child, and child-teacher interactions. It leads to poor school performance, low self-esteem and thus poor psycho-social/intellectual development in the child [11].

The adverse impact of hearing impairment on the acquisition of linguistic skills in children and their psycho-social development are well established [2,3,5,7,11]. Hearing impairment results in inability to interpret speech sounds, often producing a reduced ability to communicate, delay in language acquisition, economic and educational disadvantages, social isolation and stigmatization [2]. This places some limitations on educational and economic pursuits essential to achieving a good quality of life [3].

Studies done in Nigeria (Lagos and Ilorin) have shown significant association between hearing threshold of pupils and their school performance [5, 6]. The earlier the hearing loss is detected and addressed, the better the outcome [11]. Majority of children with hearing impairment (especially those due to otitis media with effusion), benefit from medical and surgical treatment (ventilator insertion or cochlear implantation) [8,9]. Others may require hearing aid fitting and speech therapy [19,20]. Prompt and appropriate referral for effective treatment, specialist care and rehabilitation would minimize disability and enhance the child's total development [11].

Port Harcourt City is a fast developing industrialized urban centre. Children here are exposed to environmental pollutants deleterious to hearing function. There is a dearth of literature on hearing impairment amongst primary school children and no available report from this part of

Nigeria. This paper determines the pattern and prevalence of hearing impairment in primary school children in Port Harcourt.

## 2. METHODOLOGY

This study was carried out in Port Harcourt. Primary school children of both public and private schools were recruited for this study from January 10<sup>th</sup>, 2010 to May 21<sup>st</sup>, 2010. A questionnaire was used to collect the data and that the data was drawn from individual children's medical reports. The age and sex distribution of the study population; the social class; the prevalence of hearing impairment in relation to age, sex, social class and school type; the risk factors of hearing impairment and its relationship with school performance were determined from the data collected (Appendix i and ii). At the schools, Pure Tone Audiometry (PTA) screening was carried out on the pupils whose parents gave informed consent. After this, every child had a complete ear, nose and throat evaluation done by the researchers. The pupils were then taken to a very quiet location in the school for audiometry. The ambient noise was measured with a sound level meter and found to be acceptable (< 50 dB) [5,14]. The pre-calibrated pure tone audiometer used (Madsen 1004) had a noise-reducing headset providing extra attenuation of about 25dB to outside noise thus bringing the ambient noise further within the acceptable range. The tests tones were presented to each child at the various tests frequencies (0.5, 1.0, 2.0 and 4.0 kHz) at an intensity level of 20dB and each ear tested separately.

The child was instructed to listen carefully and raise the appropriate hand each time he or she heard the tone. The children were encouraged to view the test as a game to reduce anxiety. The child was considered to have failed the test, and thus be hearing impaired, if he failed to respond to any of the frequencies tested in at least one ear. Such children were then screened again using the special head set for bone conduction. The various tests frequencies were once again presented using the pure tone audiometer. When both air and bone conduction were within normal limits (<15 dB HL) and equal, hearing is normal. Where both air and bone conduction are abnormal (>15dB HL) but equal, the child has sensorineural hearing loss (SNHL). Where bone conduction is normal but air conduction is > or= by 15 dB HL, the child has conductive hearing loss (CHL). Where both air and bone conduction

are abnormal and unequal, the child has mixed hearing loss (MHL).

Children who failed the audiometric test were subsequently referred to the University of Port Harcourt Teaching Hospital for further audiological assessment and expert management. The last school year's examinations average score for each child (over three terms), was then obtained from the appropriate class register. The class mean score was calculated. An average score less than 2 standard deviation below the class mean score (-2SD) was considered as a fail. A score above this was considered as a pass [10]. The data of each child screened was entered into the forms provided by the research assistants and crosschecked by the researchers. The data was then entered into the database of a software package designed for collection, completion and reporting, the EPI\_INFO (version 6) statistical package for epidemiology. Data from the study was analyzed using the computer program EPI-INFO (VERSION 6) and SPSS11.0. These data were presented as charts, graphs and tables in simple proportions, and comparisons of sub groups carried out with chi square test. Statistical significance at 95% confidence interval was  $p$  value < 0.05.

### 3. RESULTS

Out of 13 selected schools, a total of 802 pupils were screened, 461 (57.5%) were from public schools while 341(42.5%) were from private schools; giving a public to private school population ratio of 1.4:1 (Fig. 1). The number of pupils was almost equally distributed in all the age groups; 281 pupils (35.0%) were between 5-7 years whereas 253 pupils (31.6%) were > 10 years. There were 405 males (50.5%) and 397 (49.5%) females, giving a male: female ratio of 1.02:1 (Table 1).

Majority of the pupils were from social class III (268 pupils, 33.4%) and class II (222 pupils, 27.7%). The prevalence of hearing impairment in primary school children in Port Harcourt was found to be 29.4% (Fig. 2).

The highest prevalence of hearing impairment was seen amongst those > 10 years of age. The least prevalence was seen among pupils aged 5-7 years. These differences were statistically significant ( $X^2=5.765$ ,  $p=0.027$ ) (Table 2).

The prevalence of hearing impairment was higher in females (34.0%) than in males (24.9%) as shown in Table 4. The gender difference was statistically significant ( $X^2=7.936$ ,  $p=0.003$ ) (Table 3).

The prevalence of hearing impairment was higher in children in public schools (30.2%) than amongst those in private schools (28.4%). The difference however was not statistically significant ( $X^2=0.275$ ,  $p=0.328$ ) (Table 4).

The prevalence of hearing impairment was lowest amongst those in social class II and I (27.0%). This difference was however not statistically significant ( $X^2=1.369$ ,  $p=0.138$ ) (Table 5).

Of the 236 pupils with hearing impairment (hearing loss), 76 pupils (52%) had Conductive Hearing Loss (CHL), 35 (24%) had Mixed Hearing loss (MHL) and 35 (24%) had Sensorineural Hearing Loss (SNHL) (Fig. 3). Of the 236 pupils with hearing impairment, majority-139 (58.9%) had slight hearing impairment. Eighty-four pupils (35.6%) had mild, 12 (5.1%) had moderate, and 1 (0.4%) had severe hearing impairment. None had profound hearing impairment (Table 6).

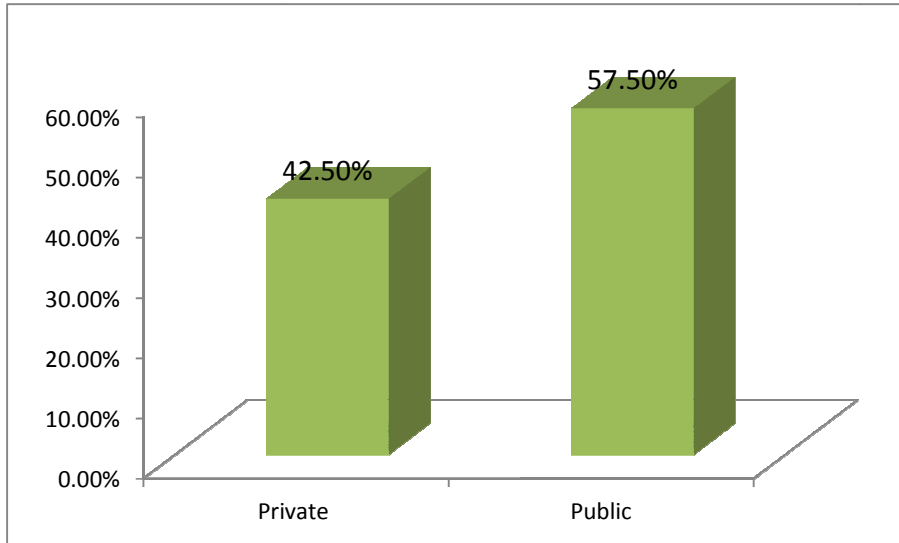
Of the 236 pupils with hearing loss, 128 (54.1%) had unilateral hearing loss while 108 (45.9%) had bilateral hearing loss (Fig. 4). Among those with unilateral hearing loss, 86 (67.2%) had right-sided hearing loss, while 42 (32.8%) had left-sided hearing loss.

The association of certain risk factors with hearing impairment showed that neonatal fever was the commonest risk factor (24.6%) significantly associated with hearing impairment (Table 7).

The relationship between hearing impairment and school performance is shown in Table 8. Out of the 802 pupils studied, 774 (96.5%) had their previous school year's result available. Of these, 662 pupils (85.5%) passed the school performance test while 112 (14.5%) failed. Hearing impairment occurred more in pupils who failed the school performance test, 56(50.0%), compared to the 176(26.6%) in those who passed the performance test. The observed difference was statistically significant ( $X^2=25.019$ ,  $p=0.000$ ).

The relationship between unilateral/bilateral hearing loss and school performance is as shown in Table 9. Eighty- six (79.6%) of the 108 pupils with bilateral hearing loss failed the school performance test, whereas 93 (72.7%) of the 128

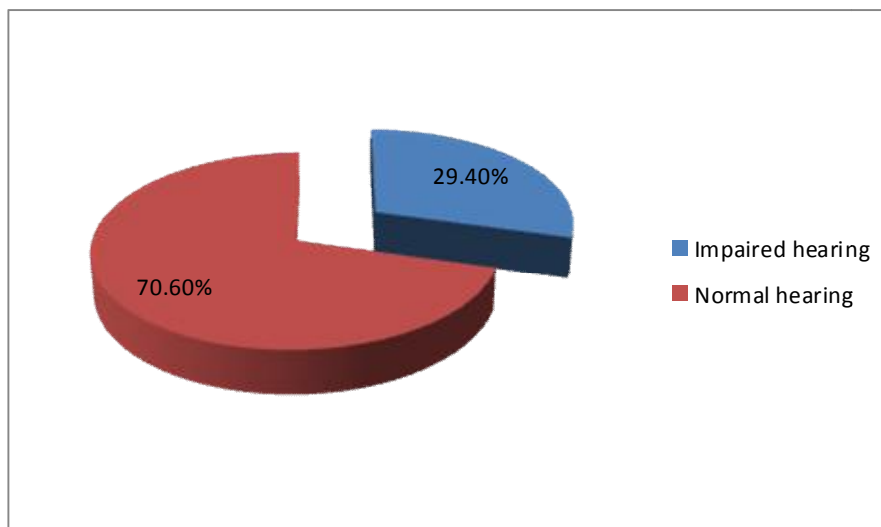
pupils with unilateral hearing loss failed the school performance test. This difference however, was not statistically significant ( $X^2=1.046$ ,  $p=0.306$ ).



**Fig. 1. Distribution of pupils screened according to school proprietorship**

**Table 1. Age and sex distribution of study population**

Age group (years)	Males (%)	Females (%)	Total number (%)
5-7	144(51.25)	137(48.8)	281(35.0)
8-10	133(49.6)	135(50.4)	268(33.4)
>10	128(50.6)	125(49.4)	253(31.6)
Total	405(50.5)	397(49.5)	802(100.0)



**Fig. 2. Prevalence of hearing impairment in primary school children in PHC**

**Table 2. Age specific prevalence of hearing impairment**

Age group (years)	Normal hearing (%)	Impaired hearing (%)	Total (%)
5-7	213 (75.8)	68 (24 .2)	281 (100)
8-10	183 (68.3)	85 (31.7)	268 (100)
>10	170 (67.2)	83 (32.8)	253 (100)
Total	566 (70.6)	236 (29.4)	802 (100)

**Table 3. Sex specific prevalence of hearing impairment**

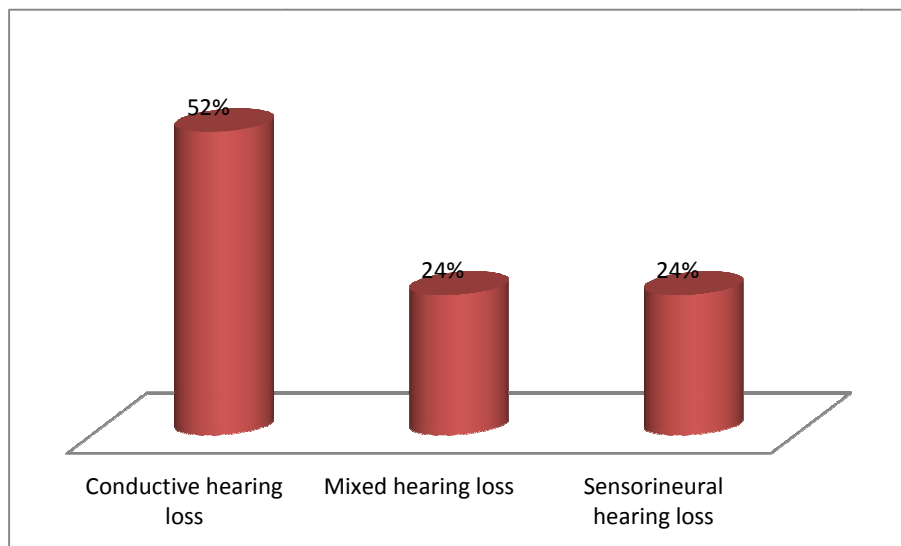
Gender	Normal hearing (%)	Impaired hearing (%)	Total (%)
Male	304 (75.1)	101 (24.9)	405 (100)
Female	262 (66.0)	135 (34.0)	397 (100)
Total	566 (70.6)	236 (29.4)	802 (100)

**Table 4. Prevalence of hearing impairment according to school proprietorship**

School type	Normal hearing (%)	Impaired hearing (%)	Total (%)
Private	244 (71.6)	97 (28.4)	341 (100)
Public	322 (69.8)	139 (30.2)	461 (100)
Total	566 (70.6)	236 (29.4)	802 (100)

**Table 5. Prevalence of hearing impairment according to social Class**

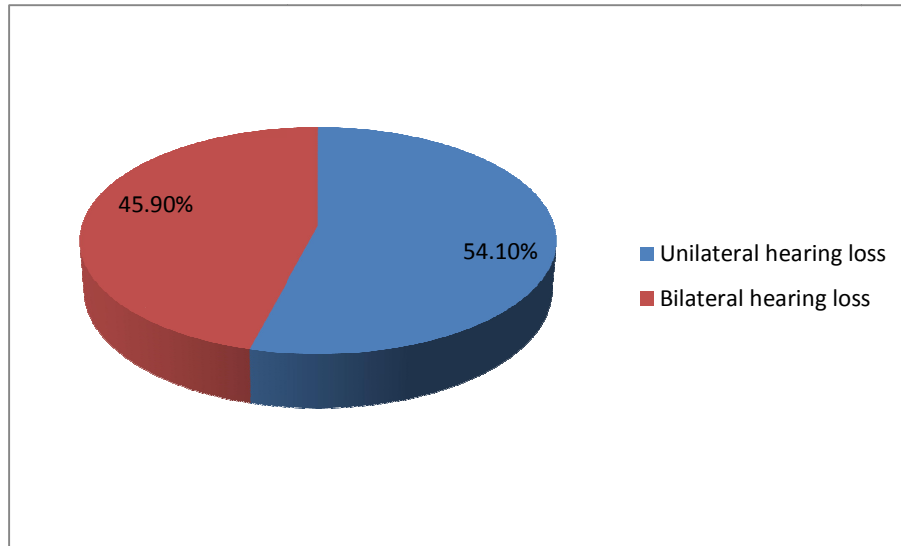
Social class	Normal hearing (%)	Impaired hearing (%)	Total (%)
I	54 (73.0)	20 (27.0)	74 (100.0)
II	162 (73.0)	60 (27.0)	222 (100.0)
III	192 (71.6)	76 (28.4)	268 (100.0)
IV	111 (66.5)	56 (33.5)	167 (100.0)
V	13 (56.5)	10 (43.5)	23 (100.0)
Unclassified	34 (70.8)	14 (29.2)	48 (100.0)
Total	566 (70.6)	236 (29.4)	802 (100.0)



**Fig. 3. Types of Hearing impairment**

**Table 6. The severity of hearing impairment**

Severity of hearing impairment	Number of pupils (%)
Slight(16-25dB HL)	139 (58.9)
Mild (26-40 dB HL)	84 (35.6)
Moderate (41-70 dB HL)	12 (5.1)
Severe (71-95 dB HL)	1 (0.4)
Profound (dB HL)	0 (0.0)
Total	236 (100)



**Fig. 4. Unilateral / Bilateral hearing loss**

**Table 7. Risk factors associated with hearing Impairment**

Risk factors	Normal hearing (%)	Impaired hearing (%)	X <sup>2</sup>	P value
Emergency C/S	62 (11)	35 (14.8)	2.354	0.080
Prolonged labour	85 (15.0)	47 (19.9)	2.905	0.056
Cried poorly at birth	41 (7.2)	13 (5.5)	0.799	0.233
Low birth weight	20 (5.8)	8 (7.1)	0.274	0.372
NNJ	75 (13.3)	31 (13.1)	0.002	0.533
Neonatal convulsion	32 (5.7)	27 (11.4)	8.184	0.004*
Neonatal fever	73 (12.9)	58 (24.6)	16.623	0.000*
Ear pain	90 (15.9)	56 (23.7)	6.854	0.007*
Ear discharge	51 (9.0)	31 (13.1)	3.084	0.054

C/S = Caesarean section; \*= Statistically significant

**Table 8. School performance specific prevalence of hearing impairment**

School performance	Normal hearing (%)	Impaired hearing (%)	Total (%)
Passed	486 (73.4)	176 (26.6)	662 (100.0)
Failed	56 (50.0)	56 (50.0)	112 (100.0)
Not available	24 (85.7)	4 (14.3)	28 (100.0)
Total	566 (70.6)	236 (29.4)	802 (100.0)

**Table 9. Unilateral/ Bilateral hearing loss and school performance**

School performance	Hearing impairment		Total (%)
	Unilateral (%)	Bilateral (%)	
Passed	33(25.8)	20(18.5)	53 (22.5)
Failed	93(72.7)	86(79.6)	179 (75.8)
Not available	2(1.5)	2(1.9)	4 (1.7)
Total	128(100)	108(100)	236 (100)

#### 4. DISCUSSION

This study showed a high prevalence rate of hearing impairment among primary school pupils in PHC of 29.4%. This finding is comparable to that reported by Taha et al which showed a prevalence of 25.6% in primary school children in Shebin El-Kom district, Egypt [21]. Mourad et al reported a prevalence of 36.2% in another population of school children (in Alexandra) in Egypt [22]. The slightly higher prevalence rate observed may be due to the fact that in addition to pure tone audiometry and otoscopy, tympanometry was used in the evaluation of the pupils. Thus, some hearing-impaired pupils with middle ear problems who otherwise might have been missed out were detected by tympanometry [22]. Olusanya et al. [5] reported a lower prevalence of 13.9% among school entrants in Lagos, Nigeria. This study however, was carried out on only school entrants and therefore, significantly younger children (median age-6.7 years), thus excluding the older children who were reported to have a higher prevalence of hearing impairment. Daud et al also reported a lower prevalence of 15% in primary school children in Malaysia [23]. This study, however, included only primary 5 pupils and those with mild hearing loss (20-39 dB HL). Thus, those with slight hearing loss and moderate to profound hearing loss were excluded. A much lower prevalence rate was reported by studies done in more developed countries such as USA (0.4-0.7%) [2] and South Africa (2.5%) [24]. This may be as a result of the generally higher standard of living, better access to adequate health care, early screening programs and reduced exposure to recurrent infectious diseases (such as otitis media, mumps and meningitis).

Females had a significantly higher sex specific prevalence of hearing impairment (34.0%) than males (24.9%). Most studies suggest hearing impairment occurs more commonly in boys than girls [25-30]. It has been reported that girls have a shorter stiffer cochlear which provides a more sensitive frequency response [27] and that the hair cells are stiffer and therefore more sensitive

in girls than in boys [28]. Traditionally, boys have been noted to be more likely to be exposed to loud noises from work machines or firearms, and thus hearing loss. Henderson et al [31] however, recently reported that more and more children of both sexes are listening to very loud music from headphones. They reported a significant increase in noise induced hearing loss among girls from 12% to 17% when comparing results of studies they had carried out in 1994 and 2006 respectively [31]. The contrasting result seen in this study (among pupils in PHC), may be explained by the fact that in our environment children of both sexes are increasingly exposed to loud noise from television sets and portable music devices, and thus, more females are being affected than previously reported.

Hearing impairment was most prevalent amongst older children (> 10 years) and least amongst those 5-7 years of age. This is similar to that noted by Olusanya et al. [5]. The higher prevalence observed among older children may be due to noise induced hearing loss which occurs as a result of prolonged exposure to loud noise [32]. Many researchers have highlighted the importance of loud noise /prolonged exposure to noise as it relates to hearing loss [2,8,10,11]. Unfortunately, we did not go specifically to look for it as a risk factor in our study. No doubt the importance of prolonged exposure to loud noise cannot be over emphasized when discussing risk factors of hearing loss in the environment. This shortcoming adds to our limitation of the study.

There was no significant difference in prevalence between children in public and private schools even though there were more children with hearing impairment in public schools (30.2%) than those private schools (28.4%). Similarly, Taha et al reported no difference in the rate of hearing impairment across school types in Egypt [21]. The slight differences observed, however, may be due to the relatively higher standard of living, hygiene and access to medical facilities of those in private schools compared to those in public schools.



Three social classes (III, IV and V) have been reported to constitute 87.9% of a typical urban city population in Nigeria [33]. The prevalence of hearing impairment was highest among those in social class V (43.5%) and noted to reduce with increase in social class (Class I and II-27.0%). Though this difference was not statically significant, it is comparable to that found in study done in USA, [2] which reported a higher prevalence of hearing impairment of 0.78% in African-American children than their Caucasian counterparts (0.38%). This difference was attributed to a lower socioeconomic status of the African-American children [2]. This is similar to the findings of the study done by Prescott and Kibel in a poor rural city in the Western Cape, South Africa [24]. It has been reported that hearing loss is more common in children whose mothers are less well educated [34]. This is probably due to the lower socio-economic status and consequently, poorer standard of living, increased risk of recurrent ear infections and reduced access to health care facilities of those in the lower social classes [21].

Conductive hearing loss was the most common type of hearing impairment seen among the pupils with hearing impairment in this study (52%). Twenty-four percent had SNHL and 24% had MHL. This is similar to the findings reported by Akinpelu and Amusa in a study done in the Western part of Nigeria, which showed CHL to be the most common type (54%) among school children [35]. These findings are also comparable to that reported by Olusanya et al where 36% of the pupils with hearing impairment/loss had CHL, 24% had SNHL and 40% had MHL [5]. This has also been confirmed by several studies carried out in other countries [8,21,23,36,37]. In fact, it has been established that CHL is the most common type of hearing loss in young children [8,35,36,38]. Conductive hearing loss may result from cerumen blocking the external ear canal, fluid in the middle ear preventing the ear drum from vibrating or a disruption or fixation of bones in the middle ear [39]. Middle ear disease (otitis media) is a leading cause of visits to the paediatrician. Research studies have determined that 50% of children less than 5 years of age will experience a conductive hearing loss [38]. Anderson in 1995 noted that 80% of primary school pupils (4-10 years) suffer from temporary hearing loss (usually CHL) at some time during the school year [38].

Most of the pupils (58.9%) with hearing impairment had slight hearing loss (16-25 dB

HL). Only 5.5% had moderate to severe hearing loss. None had profound hearing loss. This finding is comparable to a study done in Tanzania which shows 3.0% of school had mild to moderate hearing loss while only 0.35% had severe to profound hearing loss [40]. Also in Sierra Leone, 2.58% of children were shown to have mild hearing loss while only 0.65% had moderate hearing loss and 0.5% had severe hearing loss [41]. In Nigeria, in a study which shows the prevalence of hearing loss of 9.3%, only 0.58% and 0.93% of the study population had profound and severe hearing loss respectively [2]. Children with more severe degrees of hearing impairment are more likely to have been detected earlier and most likely may have been enrolled in special schools for the deaf.

Hearing loss was unilateral in 54.1% of hearing impaired pupils and bilateral in 32.8%. Similarly, Daud et al also reported unilateral hearing loss as being more common (61.1%) [23]. This is in contrast to that reported by Olusanya et al, where bilateral hearing loss was reported as being more common [5]. Kiese-Himmel and Schoff also reported bilateral hearing loss as being more common (73%) [42]. This study however, included only 3 year olds and excluded those with recurrent episodes of conductive hearing loss (which is often unilateral) [42].

The commonest risk factors shown to be significantly associated with hearing loss by this study, includes history of neonatal fever (24.6%), ear pain (23.7%) and neonatal convulsions (11.4%). This is comparable to the results obtained by several other studies [36,43,44,45]. Post natal infections (which may present with neonatal fever and/or convulsions) such as group B streptococcal sepsis in the neonates, bacterial meningitis, mumps, rubella and rubeola all cause SNHL [20]. Deafness occurs in about one third of children with rubella [36]. Meningitis is one of the most common causes of acquired hearing loss with deafness occurring in some children with bacterial meningitis [37]. A study done amongst Sudanese children revealed hereditary factors (due to intermarriages of close relatives), damaging medication (quinine), and infections (especially meningitis) as the causative factors of the needlessly high prevalence of hearing impairment [46]. Chronic ear infections are the most common cause of hearing loss among Nigerian children, with as many as one in three children presenting at an otology clinic in Ife, being diagnosed with middle ear infection (one in

four of which suffer from hearing loss) [32]. The children often present late at the health facilities with complications such as hearing loss because of poverty [32]. Otitis media with effusion (OME) is more common in children than adults because of their shorter, more horizontal, straighter Eustachian tube (making it easier for bacteria to enter). The tube is floppier and the opening is thinner [47]. Also their relatively immature immune system makes them more susceptible to upper respiratory tract infections and consequently, OME [47]. Trauma (both direct and indirect) is also an important cause of CHL [36,37]. Severe hyperbilirubinaemia is a strong risk factor for SNHL [21,36,43,45]. Periods of neonatal apnoea and hypoxia strongly predispose to subsequent hearing loss [48]. Low birth weight increases the risk of hearing loss. The growth of the foetus during pregnancy, not the duration of the pregnancy, determines the hearing development [32]. The risk of hearing loss is greater in children weighing less than 1.5 kg [32]. Conversely, premature birth has been reported to lead to hearing loss in 5% of cases [34]. These and other associated factors, including preterm delivery, low birth weight and prolonged labour were however, not shown to be significantly associated with hearing impairment by this study [36,43,33,45].

The study showed a strong association between hearing impairment and poor school performance. About 50% of the pupils who failed the school performance test had impaired hearing. Similarly, a study done among pupils in Ilorin showed a significant association between the hearing thresholds of pupils and their school performance [6]. Daud et al. [23] reported that among Malaysian school children, hearing loss was significantly associated with poor academic performance. Martinez-Cruz et al. [49] reported that children with unilateral SNHL presented with lower intelligence coefficients than those with normal hearing. Some authors reported a significant association between poor school performance and varying degrees and types of hearing loss; and that the difference between language-age equivalence and chronological age increased sharply with age [50,51]. This is comparable to the findings of several other studies [2,3,7,8,10,11,42,37,52,53]. Unilateral hearing loss can impair a person's ability to localize sounds (e.g determine where traffic is coming from) and distinguish sound from background noise in noisy environments. This is important in learning in a classroom environment [34]. In the classroom, undetected hearing loss is

more common than teachers realize. Slight, mild and unilateral hearing loss are not 'loudness' problems per se, but are distortion and clarity problems which negatively impact the speech signal [38]. In these situations, the teachers voice may be audible (loud enough) but not intelligible (not clear). Children with these hearing profiles will respond when their name is called, yet will confuse or not discern distinctive sounds needed for reading and language skills [38]. Bilateral hearing loss has been shown to more severely affect the acquisition of language skills and thus school performance [8,37,43]. Though more children with bilateral hearing impairment failed the school performance test (79.6%) than those with unilateral hearing impairment (72.7%), the difference was not statistically significant ( $p=0.306$ ). The study done by Olusanya et al [5] similarly reported that the association was not statistically significant.

Early detection of hearing loss, prompt treatment and rehabilitation of school children facilitates better language development and thus, school performance [11,54]. In a retrospective study involving 5 year olds, Moeller reported better verbal reasoning skills in those who were enrolled earlier in intervention services than those who enrolled later [54]. Most of the children with hearing impairment would benefit from medical and surgical treatment, hearing aids fitting and speech therapy [8,19,20]. Thus, the need for early detection cannot be overemphasized. Prompt and appropriate referral for effective treatment and rehabilitation would minimize disability and enhance the child's total development [11]. In developed nations, screening starts at birth and children are screened at first entry into school, every year from kindergarten through the 3rd grade, 7th grade, and 11<sup>th</sup> grade and upon grade repetition [43,52]. However, in most developing countries like Nigeria, provisions for hearing screening in schools are lacking, due to the collapse of the School Health Program in the country. If the present initiatives in enhancing the School Health Program in Nigeria are not improved upon and sustained, the prevalence of hearing impairment in children may continue to rise and the economic and social consequences on the child, family and nation may become worse. To curb this trend, educating the public about the causes, effects, treatment and preventive measures of hearing impairment becomes imperative. This study was limited to those children present at school on days of study and thus, those that were not present in school during the study

period were not evaluated. Besides, information on risk factors associated with hearing impairment was based on history alone and should be taken with caution.

## 5. CONCLUSIONS

The prevalence of hearing impairment in primary school children in Port Harcourt was found to be 29.4%. This was significantly higher among the older children and in females. Hearing impairment was more prevalent in children in public than private schools. Conductive hearing loss (CHL) was the commonest type of hearing impairment seen. Moreover, hearing impairment was significantly associated with poor school performance.

Routine hearing screening should be carried out in school children for early detection of hearing impairment. This should be implemented as an integral part of the school health program and should be repeated yearly. Public health education about the causes, effects, treatment and preventive measures of hearing impairment should be emphasized at all levels and possibly incorporated into other existing preventive health care programs. Exclusive breastfeeding, improving hygiene, noise reduction, avoiding smoking and overcrowding should be promoted to reduce recurrent ear infections and thus hearing impairment.

## ETHICAL APPROVAL

All authors hereby declare that ethical approval was given by the appropriate ethics committee of the primary school board and from the association of private school owners in Port Harcourt in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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## APPENDIX I

### QUESTIONNAIRE

#### Child's History

Name-

Date of birth- (Dd/M/Yr) Age- (years)

Sex: M/F

Home address (not P.O. Box) :

Phone no.:

#### Pregnancy history

Any rash? Yes No

Fever? Yes No

Any other problems?

Duration of pregnancy in months: Normal/Premature

If premature, what was the duration of the pregnancy?

#### Delivery (Birth)

Normal (vertex) delivery Yes No

Breech (buttocks) delivery Yes No

Caeserean section (C/S) Yes No

-Emergency C/S  
-Elective (planned) C/S

Labour lasted more than 24 hours? Yes No

Difficult delivery? Yes No

Place of birth

What was the birth weight? (Kilograms)

Did the child cry well immediately after birth?

What problems did he/she have after birth?

-Jaundice? Yes No

-Convulsion? Yes No

-Fever? Yes No

At what age did he/she smile?

At what age did he/she sit without support?

At what age did he/she crawl?

At what age did he/she walk without help?

At what age did he/she speak?

Has he/she had any illness, accidents or operations?                      Yes                      No

If yes, list the problems and the age at which they occurred:

Problem	Age
1.	
2.	
3.	
4.	

Has he/she ever had?

Ear pain?    Yes                      No

Ear discharge?                                      Yes                      No

Difficulty in hearing?                              Yes                      No

Difficulty speaking or being understood?      Yes                      No

Others

Family history

Father's occupation:

Mother's occupation:

Parent's educational attainment:

	Father	Mother
--	--------	--------

No formal education

Primary 6

Basic 9/Junior Secondary School Class 3

West African School certificate/SSCE

Teacher Training College

Technical Education, OND/HND

University Degree

Any family history of deafness (hearing impairment/loss)?      Yes                      No

## APPENDIX ii

### FINDINGS

#### Physical Examination:

General:

Height:\_\_\_\_(metres)                      Weight:                      (Kilograms)

#### ENT profile:

Rhinorrhoea	Yes	No
Enlarged turbinates	Yes	No
Engorged turbinates	Yes	No
Enlarged tonsils	Yes	No
Pre-Auricular sinus	Yes	No

Others

External Ear Profile:

#### Otoscopy:

Cerumen	Yes	No
Debris	Yes	No
Foreign body	Yes	No
Mucoid discharge	Yes	No
Normal	Yes	No

Tympanic Membrane Findings:

Dull	Yes	No
Hyperaemia	Yes	No
Perforation	Yes	No
Scar	Yes	No
Retracted/Bulging	Yes	No
Normal	Yes	No



**Audiometry:**

Frequency (kHz)	Hearing threshold (dB)-left ear	Hearing threshold-right ear
0.5		
1		
2		
4		

Pure tone average in worse ear:

Passed test (<15dB):                      Failed test (>15dB):

Degree of hearing loss, if any:

-Slight (16-25 dB HL)

-Mild (26-40 dB HL)

-Moderate (41-70 dB HL)

-Severe (71-95 dB HL)

- Profound (>95 dB HL)

Air conduction threshold:                      Normal/Abnormal

Bone conduction threshold:                      Normal/Abnormal

Air-Bone gap:

Type of hearing loss:

**Last school year's examinations average score (over 3 terms):**

Class mean score:

Pass (>-2SD):                      Fail (<-2SD):

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