

## Original Research Article

# Hearing among children with neurological disorders

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## ABSTRACT

**Background:** Neurologic disorders are not rare in our environment but studies determining the hearing of these children are almost non-existent. This study therefore is to determine the prevalence of hearing loss in these children and also determine the care seeking attitude of the parents/guardians concerning the hearing.

**Methods:** A hospital based descriptive study of all children attending the children neurologic clinic of university of Port Harcourt teaching hospital. A semi structured questionnaire was administered to parents / guardians who gave their consent for their children to be recruited into the study. Hearing loss in the children was taken as reported by the parents/guardians. Data collected were then entered into Microsoft Excel and then exported to the IBM Statistical Package for Social Sciences (SPSS) version 20 for statistical analysis.

**Results:** The study comprised 49 children; 29 males and 20 females. Age range was from 8months to 18years. Age group 1-5 years comprised the majority of the study population. Commonest neurological disorder seen was childhood epilepsy n=27, 55.1%. Prevalence of hearing loss was 26.5%. Children with childhood epilepsy had 15.4% having hearing loss while children with cerebral palsy, autistic spectrum disorder and microcephaly had 50% hearing loss recorded. Maternal illness during pregnancy was significantly related to the hearing loss with a p value = 0.045 and presence of neonatal illness with p value = 0.009. Only 7.7% was formally treated while 92.3% had no form of treatment whatsoever.

**Conclusions:** Childhood epilepsy was the commonest type of neurologic disorder seen while highest point prevalence for hearing loss was in cerebral palsy. Majority of parents/caregivers did not seek medical care concerning the hearing loss neither were there any form of treatment given to the children.

**Keywords:** Audiological assessment, Hearing loss, Neurological disorder

## INTRODUCTION

It is known that neurological disorders are responsible for more than 20% of disease burden of the world with most it affecting Africa. The factors responsible for this increased prevalence includes, malnutrition, malaria, adverse perinatal conditions, persistent regional conflicts etc. and these are more in Africa.<sup>1</sup> In addition, studies have shown a high prevalence of childhood disabilities; for instance, childhood epilepsy has an increased

incidence values up to 11.29 per 1000 has been recorded in Africa.<sup>2</sup> Some studies concluded that the congenital brain anomalies and syndromes seen could result from the cultural background of consanguineous marriages. A study in Enugu Nigeria concluded that the spinocerebellar ataxia in their study was high and attributed to intertribal marriages and high consanguinity.<sup>3</sup> It is also known that insufficient or lack of stimulation of the auditory cortex during the all-important periods of plasticity invariably affects adversely the function of hearing, language and vision

development.<sup>4</sup> It has also been found that there is sex predilection among children with neurological disorders with the male sex predominating.<sup>5</sup> Epilepsy and seizure disorders are the commonest neurological disorders seen and managed in most clinics.<sup>4</sup>

Epilepsy represents a temporary neuronal dysfunction giving abnormal and excessive electric discharges.<sup>6</sup> The causes of this condition are numerous; pre and post-natal infections, trauma, strokes, genetics etc. prevalence of epilepsy in developing countries is about 15 to 50/1000 inhabitants.<sup>7</sup> Temporal lobe epilepsy is the most common type and also the most difficult to control. It affects 70-80% teenagers and less in adults.<sup>7</sup> Anatomically, the primary and secondary auditory cortex is found at the temporal lobe which is where the auditory pathway ends. Therefore, auditory processing requires this area needed for this activity to be healthy otherwise the processing function could be affected. Neuronal losses could occur in this region due to the excessive electrical discharges from the epilepsy. This is thought to result in possible mental difficulty in processing information received.<sup>6</sup> However, temporal lobe epilepsy appears to affect sound discrimination and selective attention.<sup>6</sup> There also is a syndrome known as the EAST syndrome which comprises epilepsy, ataxia, sensorineural hearing loss and tubulopathy. This condition is associated with recessive mutations in the KCNJ10 gene. The children with this condition are known to present with seizures early in the first year of life. They also have evidence of early motor delay and differing degrees of sensorineural deafness. While they all have high frequency loss, the tympanometry shows normal readings and there is absence of otoacoustic emissions (OAE).<sup>8</sup>

Meningitis is another common neurological disorder seen in a typical children neurologic clinic. Hearing loss is a major complication of meningitis.<sup>9</sup> Some studies have recorded up to 22% incidence of hearing loss following acute meningitis.<sup>10</sup> The incidence of hearing loss in meningitis was found to be 18.5% by Khowayr et al in Pakistan however; different researchers have recorded different prevalence from different regions.<sup>11</sup> In America ranges of 5 to 35% with 4% of profound deafness was obtained.<sup>10</sup> A study in Kenya had 43% while one in UK and Netherlands had 7.4% and 13% respectively.<sup>12-14</sup> The increased incidences noted in the developing countries could be attributed to inadequate coverage of vaccinations and therefore complicated course of meningitis in these regions. Studies in Africa show that *Neisseria meningitidis* could cause hearing loss in up to 30% of the cases especially in areas known as the endemic meningitis belt.<sup>10,15</sup> The deafness is believed to be due to damage to the cochlear and labyrinthine system. It is also known that more than half of the acquired childhood deafness is due to meningitis.<sup>10,16</sup> However, the severity of the meningitis and the presence of comorbidities are important risk factors in the development of hearing loss.<sup>17</sup> A study in Denmark found rate of hearing loss post meningitis to be 54% and noted

that without proper audiological screening, some will be missed. It was found that 38% of those presumed to have normal hearing were found to have impairment by audiometry. Therefore, proper and timely audiological assessment post meningitis in all cases was recommended.<sup>10,17</sup>

Cerebral palsy is a commonly seen neurological disorder in children especially in Africa.<sup>18</sup> It is a non- progressive motor disorder arising due to brain impairment in early stages of child development. This motor disorder with time disrupts or delays the sensory motor development.<sup>19</sup> Resultant effect may be seen as delay in language acquisition, changes in articulation and speech fluency. It is known that cerebral palsy and sensorineural hearing loss have similar aetiological factors such as congenital infections; hyperbilirubinemia, prematurity, low birth weight, perinatal hypoxia etc. Other disabilities seen include hearing, visual and cognitive deficit as well as behavioral and learning problems.<sup>20</sup> Hearing loss in these children ranged from 4-13% however in Developed countries rates of 2-12% of severe hearing loss was documented while in Australia 7% of cerebral palsy patients had bilateral hearing loss of moderate to profound degree while some other studies recorded a prevalence of 39% and 51% respectively.<sup>19,21,22</sup>

Autism and deafness can coexist and confound each other's diagnosis and the auditory impairment could also be a masker for brain damage in autism.<sup>23</sup> It is known that about 3.5% of children with autism also have hearing impairment or are deaf.<sup>24</sup> Attention deficit hyperactivity disorder (ADHD) and learning disabilities are often seen as comorbidity to auditory processing disorders.<sup>25</sup> It is also noteworthy that many symptoms of ADHD tend to overlap with those of auditory processing disorders.<sup>26</sup> However, learning disabilities tend to be more associated with auditory processing disorders than ADHD.<sup>27</sup> Some studies showed that children with ADHD had very poor result in all tests of auditory processing even more than children with dyslexia therefore, it is taken that the two disorders are closely related.<sup>26,28</sup> Children with ADHD when assessed with basic audiological evaluations such as Pure Tone Audiometry, speech audiometry and tympanometry may all appear to have normal values since theirs is not a peripheral hearing disorder.<sup>29</sup> Rather, they may have abnormal brainstem transmission with a resultant deficit inactivating the central auditory processing. Hence it is a central and not a peripheral problem. Therefore there is a need to often carry out audiological evaluation of these children but more with electrophysiological tests which will assess the central auditory processing as well as the cognitive functions in these children.<sup>30</sup>

Down syndrome is another neurologic disorder seen commonly in the clinic. It is significantly associated with high incidence of hearing loss.<sup>31</sup> Hearing disorders can be found in up to 80% of the children with down syndrome.<sup>32</sup> It is known that children tend to acquire

language by hearing words spoken around them therefore good hearing is needed if speech and language must be developed. Children with Down's syndrome tend to have middle ear problems and these accounts for 83% of the hearing loss seen in these children.<sup>33</sup> Due to their peculiar anatomic ear structure, they tend to be prone to conductive hearing loss and middle ear pathologies such as; middle ear effusion, acute otitis media and tympanic membrane perforations.<sup>34</sup> Otitis media with effusion has been recorded in up to 93% of children with down's syndrome.<sup>35</sup>

It is known that deaf children often have hearing parents who do not have any prior experience deafness and how to raise a deaf child.<sup>36,37</sup> Often the parents of and caregivers first go through a period of denial concerning the condition of their children and in disorders such as autism the contribution of these parents to the diagnostic process is very essential. Therefore if parents do not have prior experience or very little experience of what might be of concern or what to look out for as possible characteristics of the disorders in these children, early diagnosis and management becomes more complex.<sup>38</sup> Generally in these children, attention is rarely shown to the hearing aspect of their condition since this may not be considered as serious as the neurologic problems themselves. This study therefore is to determine the prevalence of hearing loss in these children and also determine the care seeking attitude of the parents/guardians concerning the hearing.

## METHODS

A hospital based descriptive study of all children attending the children neurologic clinic of university of Port Harcourt teaching hospital. The study comprised all children aged 1 month to 18 years that presented to the clinic from the month of March 2019 to February 2020.

### Sample size calculation

Using the formula for cross-sectional studies, a sample size of 49 was obtained based on the standard normal deviate of 1.96, confidence limits of  $\pm 0.15$ , and proportion of 55.3%, representing the highest frequency of paediatric neurological disorders in a study in a tertiary facility in Zaria, and non-response of 10%.<sup>39</sup>

A semi structured questionnaire was administered to parents/guardians who gave their consent for their children to be recruited into the study. Ethical approval was sought and obtained from the hospital ethical committee. The diagnosis of these disorders was clinically based and supported by available neuroimaging facilities and basic neurophysiological tests. There is no genetic service available. Hearing losses in these children were taken as reported by the parents/guardians. All patients with properly diagnosed neurologic disorder aged below 18 years presenting within the period of study were included. However children with hearing loss not

related to neurologic disorder were excluded as well as those that the parents/guardians failed to give consent. Data obtained from the questionnaire included demographics, birth and delivery history, developmental and social history, forms of neurological disorder, hearing and language skills of the children and care seeking attitude of parents/ guardians concerning the hearing. Data collected were then entered into Microsoft Excel and then exported to the were then IBM Statistical Package for Social Sciences (SPSS) version 20 for statistical analysis. Data presentation involved tables and charts. Frequencies and proportions were used to summarize categorical variables while numerical variables employed mean  $\pm$  standard deviation, and median/ranges. The differences in mean ages of patients were compared across sex using independent t test and presented using table format. Differences in proportions were compared using Chi square test. A p-value of less than 0.05 was considered statistically significant.

## RESULTS

The total number of children studied was 49; 29 males and 20 females. The male to female ratio was 1.45: 1. The age ranged from 8 months to 18 years and a mean age of 6.68  $\pm$  4.34 years.

**Table 1: Demographic characteristics of children with neurological disorder.**

Variables (N = 49)	Frequency	Percentage
<b>Age category</b>		
<1 year	4	8.2
1 – 5 years	19	38.8
6 – 10 years	17	34.7
11– 15 years	6	12.2
>15 years	3	6.1
<b>Sex</b>		
Male	29	59.2
Female	20	40.8
<b>Any other sibling with abnormalities</b>		
Yes	4	8.2
No	45	91.8

The age group 1-5 years made up 38.8% of the study population followed by age group 5-10 years with 34.7%. Age > 15 years were the least affected with 6.1% (Table 1) the commonest neurological disorder seen among these children was childhood epilepsy seen in n=27, 55.1% followed by cerebral palsy in n=14, 28.6%. Others were autistic spectrum disorder and microcephaly seen in 12.2% each (Figure 1) social history of these children showed that 57.1% were already attending normal school while 22% goes to special school with 64.3% of these reported to be doing well and 35.7% doing poorly in school. While 71.4% could talk, 42.9% could not talk properly for age. 49.0% had delayed developmental milestone for age. (Table 2) prevalence of hearing loss among these children was found to be 26.5%

while 73.5% had normal hearing. (Figure 2) hearing loss was reported among 18.52% of the children with childhood epilepsy while 50% of the children with

cerebral palsy, autistic spectrum disorder and microcephaly all had hearing loss recorded (Figure 3).

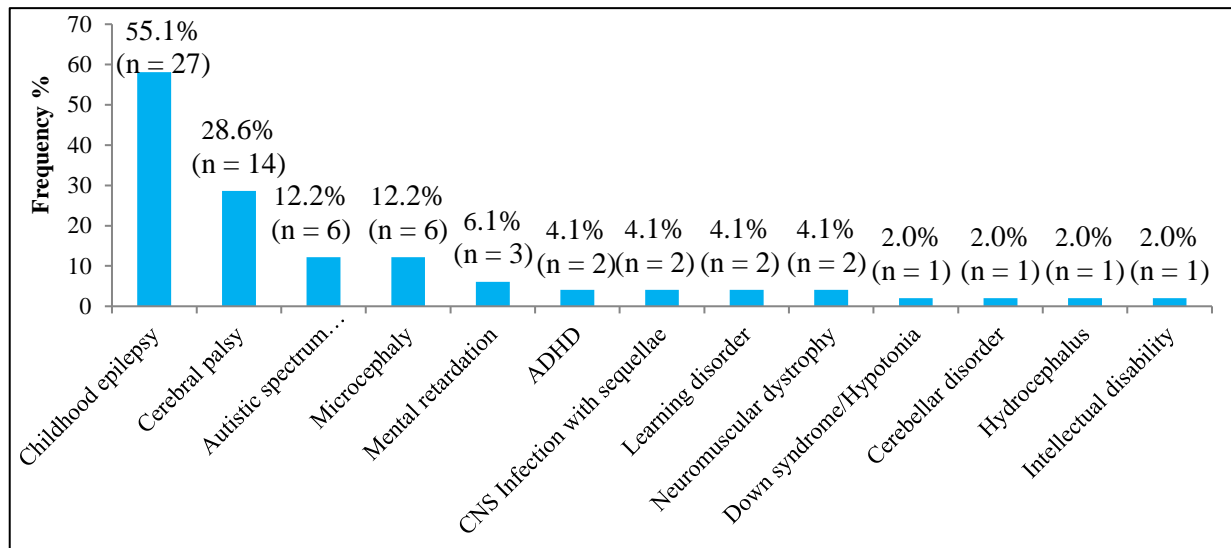


Figure 1: Forms of neurological disorders.

Table 2: Social history of children with neurological disorder.

Variables (N = 49)	Frequency	Percentage
<b>Child attends normal school</b>		
Yes	28	57.1
No	11	22.4
Not yet in school	10	20.4
<b>Child doing well in school (N = 28)</b>		
Yes	18	64.3
No	10	35.7
<b>Child attends special school (N = 11)</b>		
Yes	5	45.5
No	6	54.5
<b>Can child talk</b>		
Yes	35	71.4
No	14	28.6
<b>How well can child talk (N = 35)</b>		
Properly	17	48.6
Not very well for age	16	42.9
Unintelligible noise	1	2.0
<b>Developmental milestone</b>		
Delayed	24	49.0
Normal for age	25	51.0
<b>Behavioural abnormalities</b>		
Yes	17	34.7
No	32	65.3

When hearing loss was correlated with some demographic factors of these children, even though age

1-5 years was found to have 36.8% with hearing loss, it was not statistically significant, there was also no significance in terms of sex however, the age at onset of neurological disorder among the children were mainly from 1month to 2 years and was found to be statistically significant with hearing disorder with a p value =0.020. (Table 3).

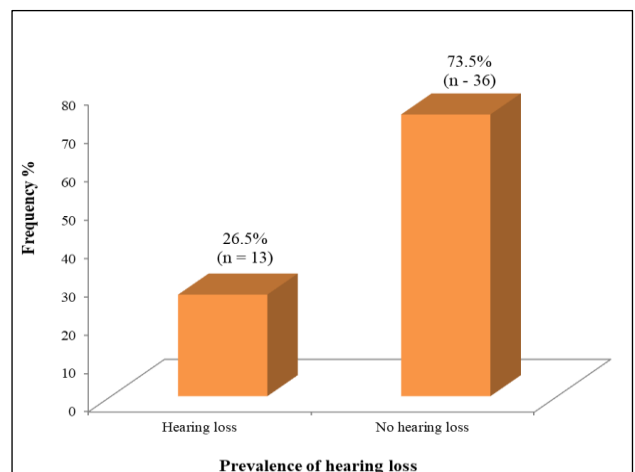


Figure 2: Prevalence of hearing loss among children with neurological disorder.

Maternal factors found to be significantly related to hearing loss among the children with neurological disorder was mainly illness during pregnancy with a p value = 0.045 and presence of neonatal illness with p value =0.009 (Table 4). The children though 53.9% of

them have been seen by a physician for the hearing loss, only 38.5% has been formerly assessed, 61.5% had not been assessed formally and 46.2% has not had any form of audiological work up done. Among those assessed, only 7.7% was formally treated while 92.3% has had no form of treatment whatsoever.

Majority of the parents devised different ways of communicating with these children. About 15.3% just keep talking to the children while about 84.7% does different things; signing, loud speaking and unspecified methods (Table 5).

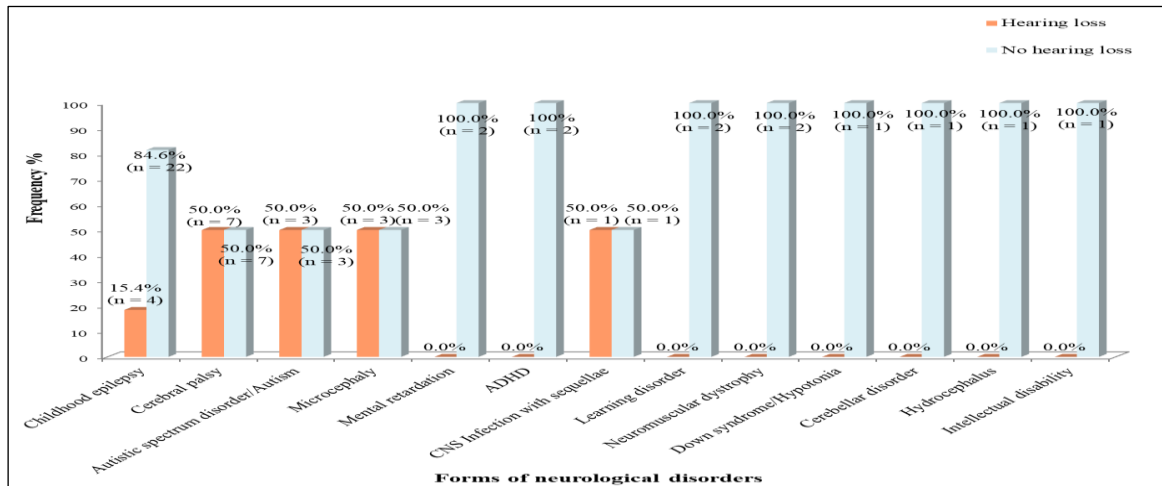


Figure 3: Prevalence of hearing loss according to the forms of neurological disorders in children.

Table 3: Factors associated with hearing loss among children with neurological disorder.

Hearing loss			
Variables	Yes, n (%)	No, n (%)	Total, n (%)
Age category			
<1 year	2 (50.0)	2 (50.0)	4 (100.0)
1 – 5 years	7 (36.8)	12 (63.2)	19 (100.0)
6 – 10 years	4 (23.5)	13 (76.5)	17 (100.0)
11– 15 years	0 (0.0)	6 (100.0)	6 (100.0)
>15 years	0 (0.0)	3 (100.0)	3 (100.0)
Fisher’s exact test = 4.826; p-value = 0.274			
Sex			
Male	5 (17.2)	24 (82.8)	29 (100.0)
Female	8 (40.0)	12 (60.0)	20 (100.0)
Chi Square = 3.145; p-value = 0.076			
Age at onset of neurological disorder			
At birth	3 (60.0)	2 (40.0)	5 (100.0)
1 – 11 months	4 (36.4)	7 (63.6)	11 (100.0)
1 – 2 years	6 (37.5)	10 (62.5 )	16 (100.0)
3 – 5 years	0 (0.0)	7 (100.0)	7 (100.0)
Above 5 years	0 (0.0)	10 (100.0)	10 (100.0)
Fisher’s exact test = 10.461; p-value = 0.020*			
Developmental milestone			
Delayed	8 (33.3)	16 (66.7)	24 (100.0)
Normal for age	5 (20.0)	20 (80.0)	25 (100.0)
Behavioural abnormalities			
Yes	6 (35.3)	11 (64.7)	17 (100.0)
No	7 (21.9)	25 (78.1)	32 (100.0)
Fisher’s exact p-value = 0.331			

\*Statistically significant

**Table 4: Maternal factors associated with hearing loss among children with neurological disorder.**

Hearing loss			
Variables	Yes n (%)	No n (%)	Total, n (%)
<b>Mother had antenatal care</b>			
Yes	13 (27.7)	34 (72.3)	47 (100.0)
No	0 (0.0)	2 (100.0)	2 (100.0)
Fisher's exact p-value = 1.000			
<b>Mother had illness during pregnancy</b>			
Yes	8 (44.4)	10 (55.6)	18 (100.0)
No	5 (16.1)	26 (83.9)	31 (100.0)
Fisher's exact p-value = 0.045*			
<b>Child delivered at term</b>			
Yes	11 (25.6)	32 (74.4)	43 (100.0)
No	2 (33.3)	4 (66.7)	6 (100.0)
Fisher's exact p-value = 0.650			
<b>Prolonged labour</b>			
Yes	6 (40.0)	9 (60.0)	15 (100.0)
No	7 (20.6)	27 (79.4)	34 (100.0)
Fisher's exact p-value = 0.178			
<b>Any neonatal illness</b>			
Yes	9 (47.4)	10 (52.6)	19 (100.0)
No	4 (13.3)	26 (86.7)	30 (100.0)
Chi Square = 6.913; p-value = 0.009*			

\*Statistically significant

**Table 5: Attitude of caregivers to problems of children with hearing loss in the study.**

Variables (N = 13)	Frequency	Percentage
<b>What has been done about child's hearing disorder</b>		
Consulted a physician	7	53.9
Nothing	6	46.2
<b>Has child been formally assessed</b>		
Yes	5	38.5
No	8	61.5
<b>Has child been given any objective hearing assessment</b>		
Yes	7	53.8
No	6	46.2
<b>Type of hearing assessment (N = 7)</b>		
Audiological	4	57.1
Unspecified	3	42.9
<b>Has there been any form of treatment</b>		
Yes	1	7.7
No	12	92.3
<b>Any amplification</b>		
Yes	1	7.7
No	12	92.3
<b>Means of communication with child</b>		
Mother just keeps talking to child	2	15.3
Mother tries to make signs to child	3	23.1
Mother talks to child at close range	1	7.7
Unspecified	7	53.9

## DISCUSSION

The prevalence of hearing loss among children with neurologic disorder in the present study was 26.5%. There was a mild male preponderance similar to other studies where males were found to have more neurologic disorders compared to females.<sup>9,40</sup> The age range, 1 year to 10 years were the most affected with the age 1 to 5 years comprising the majority. Similarly, other researchers found an average age of 2.1 years in their study of meningitis in children.<sup>9,40</sup> While Zeeshan et al found most to be below 5 years in their own study.<sup>10</sup>

In the present study, about 57.1% of the children attend normal school but it is of note however, that about 35.7% were reported not to be doing well in school. In addition, even though a good percentage could talk, about 42.9% among these could not talk well for age and majority having delay in developmental milestone. These delays were also noted by some researchers.<sup>37,40</sup>

The commonest disorder noted in the present study was childhood epilepsy seen in 55.1% of the children similarly, another study found epilepsy and seizure disorders in 11.29 per 1000 children in Africa.<sup>2</sup> Cerebral palsy was the second commonest in this study similar to other researchers and autism was also commonly seen.<sup>17,38</sup> Others were microcephaly, attention deficit hyperactivity disorder while central nervous system infections and sequelae such as meningitis was very low in prevalence in the present study. This could be attributed to possible better immunization coverage.

Hearing loss was found most among the children with cerebral palsy where 50% had hearing loss. This is similar to the finding of some researchers that had 39% of hearing loss in their study of paediatric patients with cerebral palsy while in contrast others had more of autism spectrum as a major cause of hearing loss and yet some found hearing loss a common complication of meningitis.<sup>21,38,40</sup> It was also found that sensorineural hearing loss was the commonly type of loss found in these children. In the present study however objective tests were not carried out so the type of loss was not ascertained. Even though childhood epilepsy was the highest disorder seen in the study, only about 15.4% had record of hearing loss. This was in contrast to other researchers that found most patients with temporal lobe epilepsy having difficulty in discriminating sound and all the children with EAST Syndrome was found to have sensorineural hearing loss as one of the components.<sup>8</sup> On the other hand, autistic spectrum disorder and autism was seen in six children and 50% of them had hearing loss. In the present study, only a child was seen with Down's syndrome in contrast to other studies.<sup>41</sup> There were only two children recorded to have had meningitis, one of them (50%) was recorded as having hearing loss. It is known that hearing loss is a major complication of meningitis. Jawaid et al had a hearing loss prevalence of 22% following meningitis while an even lower



prevalence was recorded by another researcher.<sup>9,40</sup> In contrast to other studies, disorders such as ADHD and Down syndrome were very few in numbers and did not record any hearing loss, possibly because of very few of these patients seen.

The age of onset of neurological disorders in these patients was very important. It was found that majority was from around age 1 to 2 years. This represents the period of language acquisition which is dependent on good hearing therefore they affect the educational as well social development of the children.<sup>19,42</sup> In the present as study, age of onset of neurological disorder was found to be statistically significant with hearing loss in these children with a p value = 0.020 while gender was not found significant. It was also noted that though hearing loss was noted in an appreciable percentage of the children with delayed milestone and those with behavioural abnormality, it was not significant statistically.

Maternal factors studied showed that among the mothers that had antenatal care, few; 27.7% of their children had hearing loss but this was not significant. However, those that had illness during pregnancy showed statistical significance with hearing loss in their children with p value=0.045. The presence of neonatal illness was also significantly related to hearing loss in the children with p value of 0.009. This shows importance of proper antenatal care as well as good neonatal care for the children so as to avoid some of the preventable disorders.

In the present study, the children that was reported to have hearing loss, about 46.2% of them the parents /guardians had not sought any kind of care concerning the hearing loss while about 61.5% has not had any form of formal assessment done. Most of the children have not received any form of treatment or any form of hearing amplification done. In over all, there is limited information on audiologic interventions and treatment in these children.<sup>40,41</sup> This could be due to poverty as well as ignorance. It is also known that often, children with hearing problems have parents that are hearing and has no prior experience whatsoever on how to deal with or raise a child with hearing deficit.<sup>36,37</sup> The parents and caregivers themselves need a lot of educating on how to raise these children for family support is very relevant if these children will be properly integrated into the society. Majority of the mothers devise their own diverse ways of communicating with the children with some of them not verbally stimulated often times. They have no formal way of communicating with them and this could lead to frustration to both the children and the parents.<sup>37,42</sup>

## CONCLUSION

Neurological disorders were found mainly among age 1-5 years which corresponds to the age in which hearing is very important. Childhood epilepsy was the commonest type of neurologic disorder seen while cerebral palsy had

the highest hearing loss point prevalence. The age of onset of disorder was significant with hearing loss. Maternal illness and neonatal illness were all significant with hearing loss in the children. Majority of parents/caregivers did not seek medical care concerning the hearing loss neither were there any form of treatment given to the children.

## Recommendations

That the public be enlightened on the need for proper antenatal care and prompt and proper treatment of any illness during this period. Parents and care givers should be educated on the need to seek proper care especially for their children as soon as they notice any sign of hearing deficit and not leave it with the hope that it will self-resolve later. The primary physicians are to also insist on audiological assessment for these children by the otolaryngologist as part of their evaluation. The need for health insurance cannot be overemphasized to reduce out of pocket expenses so as to encourage the parents to take better care of the children with special needs. The sample size was small therefore may affect extrapolation of findings from the study to the general population.

This study has following limitation: The lack of objective hearing assessment could have led to possible loss of some patients with some mild loss and the degrees of hearing loss could not be ascertained because of this.

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