



## An Epidemiological Study of Deafness in Children Below 5 Years Age Group Associated with Neurological Deficits - A Tertiary Hospital-Based Prospective Study Using Otoacoustic Emissions

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### Abstract

**Background:** Hearing impairment is a condition where the ability to detect certain frequencies of sound is completely or partially impaired. In the early years of life, hearing ability is critical for the development of speech, language, and cognition. The prevalence of hearing loss associated with neurological conditions in preschool children is poorly portrayed.

**Objective:** To assess the prevalence of hearing loss in children below 5 years of age associated with neurological deficits by doing Otoacoustic Emissions.

**Methodology:** A prospective study of preschool children from KLE'S Dr. Prabhakar Kore Hospital and Medical Research Centre, Belagavi was undertaken from December 2018 to December 2019. The children were subjected to distortion product evoked otoacoustic emission (DPOAEs). A total of 108 patients underwent the first screening, 8 patients lost for follow up at the end of 3 months and were excluded from the study.

**Results:** All the 100 children were divided into 3 age groups, as less than or equal to 2 years, 2 - 4 years and more than or equal to 4 years. 20 (20%) children were in the first group, 23 (23%) in the second group and majority 57 (57%) in the third group respectively. 6 children had a family history of hearing loss and 13 children had a history of consanguineous marriage. Bilateral hearing loss was detected in 10% of children with neurological deficits in the first screening. In the second screening, 4 children were confirmed to have hearing loss, hence the prevalence of hearing loss was estimated to be 4%.

**Keywords:** Hearing Impairment; Neurological Deficits; Otoacoustic Emission; Screening; Speech and Language Development

### Abbreviations

OAE: Otoacoustic Emissions; DPOAEs: Distortion Product Evoked Otoacoustic Emissions; TEOAEs: Transient Evoked Otoacoustic Emissions; OHCs: Outer Hair Cells; dB: Decibel; NO.: Number; SNHL: Sensorineural Hearing Loss; WHO: World Health Organization

### Introduction

Hearing impairment occurs when there is a reduction in auditory acuity [1]. It is second most common impairment globally affecting 1.33 billion (1.26 - 1.40 billion) people all over the world, among 16 million children according to World Health Organization (WHO) 2012 [2]. Children born in resource-rich countries compared to children born in resource-poor countries are nearly twice as likely to have hearing loss [1]. Children with moderate to severe hearing disorders are noticed early, as compared to children with a mild or unilateral hearing disorder. Parental education, family

livelihood, other social factors may influence the time of screening and treatment [1,2].

The early diagnosis of pre-lingual deafness is important to prevent the consequences of hearing impairment on language, speech, social-emotional development, and educational achievement [2-4]. Early diagnosis and intervention by the age of 6 - 12 months, enables the normal development of language and speech, regardless of the degree of hearing loss [5,6].

Recent studies find neonatal intensive care unit admission, low birth weight, metabolic disorders, parental consanguinity, syndromes, and postnatal infection as the risk factors for newborn hearing impairment [2,5]. Children with neurological illness can be associated with congenital or delayed-onset hearing impairment. Hearing impairment may involve peripheral auditory structures such as middle ear or cochlea or auditory nerve and central ner-

vous system [7]. Acquired Hearing loss in children is 60% preventable and 40% non-preventable. Out of preventable causes, infectious is 31%, birth-related causes are 17%, others 8%, ototoxic medication 4% [8].

Otoacoustic emissions are a marker of cochlear function [9,10]. OAE is an Electrophysiological, objective and non-invasive low-intensity sounds generated by the active movement of the outer hair cells (OHCs) of the cochlea used commonly for newborn screening and diagnostic testing of infants in the first 6 months of age [11-14]. They can also prove of value in children of any age when behavioral testing has failed to produce reliable results, in particular those with neurological disorders with severe learning or communication difficulties [13,14]. OAE is quick, minimally invasive and economical [15].

Distortion-product Otoacoustic emissions (DPOAEs) are generated by pure tones separated by a specific frequency difference. The two components are hypothesized to be generated by different mechanisms; the component from the overlap region is due to an outer hair cell-based nonlinear generation process and the component of the other form is linked to a process of coherent linear reflection and referred to as place fixed [16].

Hearing impairment can be associated with neurological deficits such as Down syndrome, microcephaly, macrocephaly, hemiplegia. Down syndrome is the most commonly occurring genetic abnormality involving nearly 1 in 700 births. Some studies show that mild hearing loss of less than 15dB hearing loss can also severely impact speech perception and development [17].

Abnormal head size in children classified into microcephaly and macrocephaly. The direct relation between sensorineural hearing loss and abnormal head size is rare in the literature in developing countries. Cause of sensorineural hearing loss in microcephaly may be due to the effect of chromosomal abnormalities, congenital and postnatal infection on the auditory system [18].

There is inadequate literature on hearing impairment associated with neurological conditions among preschool children (under five years age) as per Indian literature. This study is carried out to determine the prevalence, diagnosis, and management of hearing impairment due to neurological deficits using Otoacoustic emission.

## Materials and Methods

This was a prospective hospital-based study conducted for children less than 5 years of age with the neurological disorder at ENT OPD of KLE'S Dr. Prabhakar Kore Hospital and Medical Research Centre, Belagavi, India.

Duration of the study period from December 2018 to December 2019.

The children were examined for the presence of wax in the external auditory canal, Otitis media with effusion, retraction of the tympanic membrane and these conditions were treated. Only those children who had complete resolution of these confounding factors were included in this study.

After taking informed consent from the parents/guardians of children, they were subjected to DPOAEs at 2000 Hz, 4000 Hz and 6000 Hz.

They were subjected to DPOAEs in a quiet room to prevent any interference from noise. The results of the first screening were noted for both ears. All cases were labeled as either PASS or REFER depending on the result obtained on the OAE machine. A second screening was done after 3 months.

A total of 108 patients underwent the first screening. 8 patients lost for follow up at the end of 3 months and were excluded from the study hence final sample size was 100.

## Results

In the study out of 100 children evaluated 55 were males and 45 were females (Table 2). They were divided into 3 age groups as less than or equal to 2 years, 2 - 4 years and more than or equal to 4 years. 20 (20%) children were in the first group, 23 (23%) in the second group and the majority 57 (57%) in the third group. 6 children had a family history of hearing loss and 13 children had a history of consanguineous marriage.

During the first screening, bilateral hearing loss was diagnosed in 10 (10%) children with neurological deficits. During the second screening, hearing loss was diagnosed in 4 (4%) children. Out of which 2 (2%) cases were having cerebral palsy, other cases were Down syndrome and Hemiplegia each respectively. Hence the prevalence of hearing loss with neurological deficits was estimated to be 4% (male 3%, female 1%).

## Discussion

Theoretically, the period for the development of the auditory system and speech commences in the first 6 months of life and continues through 2 years of age. Hearing experience in the first 6 months of life, before meaningful speech begins, affects the perception of speech and their capacity to learn. Any hearing impairment in the first year of life is believed to compromise speech and language acquisition as well as cognitive and social development [1,3]. However, it is widely reported that targeted high-risk screening can

	Male	Female
No. of patients	55	45

**Table 1:** Distribution of male and female.

Age	< 2 Years	> 2 and < 4 Years	> 4 Years
No. of patients	20	23	57

**Table 2:** Age distribution.

	No. of patients
Family history of hearing loss	6
Consanguineous marriage	13

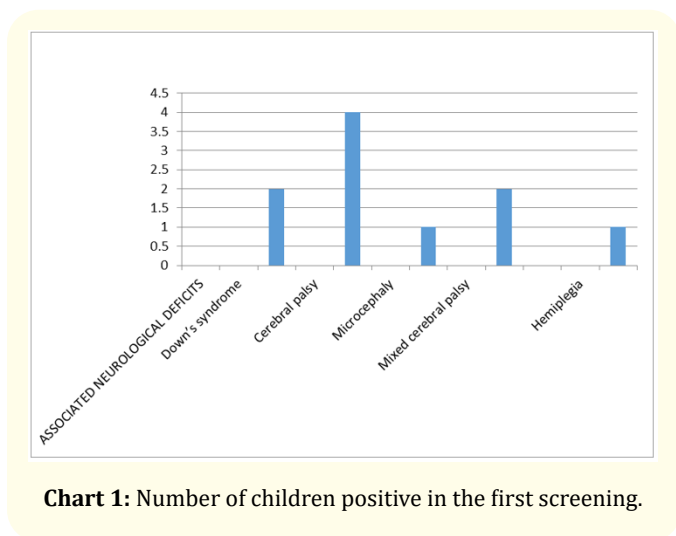
**Table 3:** Number of children with family history and parental consanguineous marriage.

	Right Ear	Left Ear	Right Ear	Left Ear
Pass	90	90	96	96
Refer	10	10	4	4

**Table 4:** Comparison of the first and second testing.

Associated neurological deficits	No. of patients
Down’s syndrome	2
Cerebral palsy	4
Microcephaly	1
Mixed cerebral palsy	2
Hemiplegia	1

**Table 5:** Number of children positive in the first screening.



**Chart 1:** Number of children positive in the first screening.

identify at best about 50% of children who have a significant pre-lingual hearing impairment [5].

The present study was undertaken to evaluate the hearing loss among the children below 5 years of age associated with neurological deficits in tertiary care hospital, using distortion product Otoacoustic emissions in two steps.

The present study revealed that the prevalence of hearing loss is more in children associated with neurological deficit, amongst which cerebral palsy was more prevalent. In a study done by E S Marlow., *et al.* cerebral palsy was predominantly seen with significant disability [24].

The study conducted by Bolajoko O Olusanya., *et al.* In 2013 showed microcephaly children were significantly at risk of sensorineural hearing loss [18]. It has been shown that hearing loss occurs more often in children with down syndrome; In literature, the incidence ranges from 38% to 82% [17] which can be correlated with our study.

In this study male preponderance was seen which can be comparable to studies done by Rout N., *et al.* most studies reported that hearing loss is more common in male children [19,20].

In this study, the majority of the children presented late after the age of 4 years. It may be due to lack of neonatal hearing screening centers or may be due to parental ignorance and poverty, as observed in some other studies [21-23].

### Conclusion

Hearing impairment with neurological deficits in preschool children is a burden to the parents, otorhinolaryngologist as well as pediatrician which leads to auditory morbidity. Our study showed a 4% prevalence in patients with neurological conditions. Otoacoustic emissions are sensitive, non-invasive, easy to perform and can be used for screening all preschool children. OAE helps in early diagnosis, management of hearing impairment and rehabilitation.

### Sponsorship and Financial Support

None.

### Conflict of Interest

There is no conflict of interest amongst authors.

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