Original Article

Patterns in Audiological and Demographic Findings of Children with Hearing Loss below 3 Years of Age: A Retrospective Study

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Abstract

Introduction: Early identification of infants with hearing loss and initiating intervention by 6 months has been proven to have positive impacts on children. Understanding the demographic and audiologic factors influencing early identification and intervention of children with hearing loss will be valuable to professionals, implementing authorities, and stakeholders for effective service delivery. The aim of this study was to understand the patterns observed in the demographic and audiological findings of children with hearing loss below 3 years of age. **Methods:** A retrospective method was adopted to collect the audiological and demographic information from 143 case files of children below 3 years of age, registered in audiology diagnostics at the Institute in the period from January 2017 to December 2017. Descriptive statistics and Pearson's correlation were used to report the findings in various demographic and audiological factors. **Results:** The mean age of identification (AOI) was found to be 1.38 years (standard deviation [SD] ± 1.07); mean age of amplification was 1.54 years (SD ± 0.766); and age of intervention was 1.59 years (SD ± 0.83). There was a significant positive correlation (0.694) between AOI of hearing loss and age of amplification. The number of children who have been lost to follow-up after diagnosis was 55.2%. **Conclusions:** The findings from this retrospective data can help professionals to understand how well protocol for young children with hearing loss comply with universal standards and to take necessary steps to heighten quality health-care service.

Keywords: Age of identification, age of intervention, demographic findings, lost-to-follow up

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Introduction

Hearing loss in the pediatric population is one of the leading disabilities globally. It is estimated that 6.3% of the population report have hearing impairment in India. Four in every 1000 children among 100,000 babies are born with hearing deficiency every year and have been identified with severe to profound hearing loss. The prevalence of childhood onset deafness is estimated to be 2%.[1] According to the census of India 2011, among the various identified disability in children, 23% of the children have hearing loss.

Hearing loss, being an invisible condition has chances of being unidentified in children. The earlier the hearing loss occurs in a child's life, the more serious effects it has on the child's development. When hearing loss is left undetected in infants and children, it has deleterious impacts on speech and language acquisition, academic achievement and social, cognitive and emotional development. Hearing loss affects children by causing a delay in the development of receptive and expressive speech and language skills, which in turn results in reduced academic achievement, social isolation and poor self-concept, and an impact on vocational selections.[2] This desires the need for early identification and intervention of hearing loss in children, which will help reduce the impact hearing loss has on children. It is a recognized fact that language development is positively and considerably affected by age of identification (AOI) of hearing loss and age of initiation of intervention services.[3,4]

Best practices in Early Hearing Detection and Intervention (EHDI) specifies timeline for Universal New-born Hearing Screening, diagnosis, and intervention as the 1:2:3

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rule where every new-born is screened for hearing loss at 1 month of age, diagnosis is confirmed by 2 months of age, and intervention is initiated by 3 months of age (Joint Committee on Infant Screening [JCIH], 2019). Development of such standardized programs has ensured that every child born with a permanent hearing loss is identified before 2 months of age and provided with timely and appropriate intervention services by 3 months of age. However, it has shown that only 54% of babies who are screened subsequently receive the recommended hearing evaluation (JCIH, 2007).

Early identification of infants with a hearing loss and initiating intervention at the earliest, i.e., by at least 6 months has been proven to have positive impacts on children and their families worldwide. These children are found to attain language development in par with hearing peers[5] and better social emotional development.[6] Intervention is designed based on child's needs as dictated by the several factors such as age of the child, age of onset of the hearing loss, the age at which the hearing loss was identified, the severity of the hearing loss, the type of hearing loss, the extent of hearing loss, and the age at which amplification was introduced.[7] There have been frequent variables that have been shown to influence the performance outcomes observed in children with hearing loss such as early diagnosis of the hearing loss,[8] proper audiological management,[9-12] familial support, and appropriate aural rehabilitation.[12] Specifically, the age of onset of hearing loss, age of receiving cochlear implantation, duration of hearing loss, communication mode chosen, and duration of implant use have been significant.[13] Many children with hearing loss have the potential to develop language commensurate with their age-matched hearing peers, provided they are given opportunity for appropriate medical, therapeutic, and educational management. Hence, early identification and timely intervention with support from both the family and the community as a whole are crucial for the best outcomes.[14]

India is one of the fastest developing countries in the world with a growing disability rights movement and progressive policy frameworks. However, the implementation is affected due to large variability in factors not restricted to socio-economic profiles, attitudes, and accessibility of services. All the states do not have strict protocols for hearing screening or intervention programs; hence, the Government of India launched a program known as the National Program for the Prevention and Control of Deafness (NPPCD) in 2007. This program functions with the aim of early identification, diagnosis, and rehabilitation of hearing loss and deafness has been expanded to 192 districts of 20 States or Union Territories.[15] Kerala is a southernmost state of India, which has shown keen interest in the early detection of hearing loss and cochlear implantation for children below 5 years of age. As part of the State initiative of disability, Kerala has also upgraded the early detection program into the "Comprehensive Life Cycle Approach for Hearing impairment" by following 1-3-6-18-42 principle;[16] where apart from the 1:2:3 rule proposed by JCIH, significance is given to cochlear implantation in one/both ears by 18 months of age and mainstream education by 42 months of age. Due to the influence of medical model toward the management of hearing loss, still prevailing in the country such initiatives do not reach expected outcomes.

Retrospective databases usually provide access to large specific study populations and is considered as a relatively inexpensive and convenient approach for answering research questions.[17] In this study, retrospective data pertaining to children was collected as it has been known that various demographic and audiological factors have influence on the process of early identification and intervention. Demographic factors such as parental education and socioeconomic status (SES) have shown to have undue impact on the AOI and intervention.[18-20] Furthermore, the variability in the audiological factors, namely time taken for diagnosis, type and degree of hearing loss, and age of amplification have direct impact on the intervention procedures.[21-24] It will be thus valuable to professionals, implementing authorities as well as stakeholders to know the various factors and their trends observed during identification and intervention of children with hearing loss in developing country like India. The knowledge of current trends in audiological management can lead way to identifying factors that needs modification for improvising service delivery.

Aim of the study

The aim of this study is to understand the patterns observed in the demographic and audiological findings in children with hearing loss below 3 years of age reported to Audiology clinic of National Institute of Speech and Hearing in the year 2017.

The research questions for the study were:

1. What are the patterns observed in demographic findings in children with hearing loss below 3 years of age?
2. What are the patterns observed in audiological findings, namely AOI, degree and type of hearing loss, age of amplification, and intervention in children with hearing loss below 3 years of age?
3. Is there any correlation between the demographic findings and AOI of hearing loss and age of intervention?

Methods

A retrospective method was adopted for the study.

Participants

The demographic and audiologic details of 143 children were used to find answers to the research questions. The inclusion criteria set for selecting participants were children with chronological age <3 years of age at the time of reporting to the department of audiology. Case files of children with a chronological age above 3 years of age and reporting for only speech language evaluation were excluded from the study.

Materials

Based on the inclusion criteria set for the study, case files were selected from the record room, and a checklist with the factors mentioned in Table 1 was used to collect the information.

Table 1: The list of demographic and audiological factors

Demographic factors	Audiological factors
Age of reporting	Age of identification
Gender	Sub-factors:
Parents' education (under matriculation, matriculation, graduation, post-graduation)	Time taken for confirming diagnosis
Parents' job (unskilled laborer, skilled laborer, Government servant, private job)	Type and degree of hearing loss
Socio economic status (SES)	Age of amplification
	Sub – factors:
	Type of hearing device used Hearing aids/ Cochlear implant
	Age of intervention
	Comorbid conditions

Procedure

Case files of children below 3 years of age, registered in audiology diagnostics at the Institute in the period from January 2017 to December 2017 were selected. Inconvenience sampling method was used to select 143 files from a total of 1717 case files of children registered in audiological diagnostics during this period. Information relating to demographic factors and audiological factors of each child was noted down from the case files.

The details of the different audiological factors were collected in the following way. The AOI of hearing loss was calculated by taking into consideration the age at diagnosis. The time taken for the diagnosis was calculated by subtracting the age of diagnosis from the age of reporting. A test battery approach was used for diagnostic evaluations including behavioral testing, auditory brainstem-evoked responses, oto-acoustic emissions, and immittance audiometry. The type of hearing loss was recorded as sensorineural, conductive, mixed, and whether the hearing loss was bilateral or unilateral. The degree of hearing loss was categorized according to Goodman's classification[25] and wherever the audiological diagnosis was not complete, a (?) hearing loss was used. The age of amplification/sensory management was reported by collecting the ages at which hearing aid or cochlear implant were fitted and the ear in which the device was worn. The intervention details of children that was documented in the case files were collected which included the age and type of intervention. SES of the participants were categorized based on the Modified Kuppuswamy Scale.[26] The scale consists of composite scores considering education, occupation of the head of the family, and monthly income of the family and classify participants into five SES categories, namely I – Upper, II – Upper Middle, III – Lower Middle, IV – Upper Lower, and V – Lower. Numbers from 1 to 5 were used to denote the categories of education of father/mother, occupation of father/mother, and SES, respectively, for ease of analysis.

Data analysis

Descriptive statistical analysis was used to report the findings in various demographic and audiological factors. Pearson's correlation was carried out to understand the relationship between demographic and audiological factors.

Results

The results are discussed in terms of findings observed for the three research questions.

Demographic factors

The mean age of reporting for 143 children was found to be 1.13 years (standard deviation ±0.848). In the year 2017, the age of reporting of children below 3 years of age was found to be in the range of 1 month to 1 year by 54.5% of children. The demographic details of the participants are depicted in Table 2. Among these children, 57.3% of the children were male and 42.7% were female. 44.1% of fathers had education of matriculation and majority of fathers (46.9%) of fathers were skilled laborers. 28.7% of mothers had an education below tenth standard and 78.3% of mothers were homemakers. Majority of the participants had an SES of "upper lower" class (69%).

Audiological factors

Among the 143 children, hearing loss was confirmed in only 127 children and rest of 16 children did not follow-up for confirmation of presence of hearing loss and were considered as "lost to follow-up (LTF)."

Age of identification

The mean age of 127 children whose diagnosis was confirmed was 1.38 years (±1.07). The mean time taken to arrive at an audiological diagnosis was found to be 4.44 months (±0.91).

Type of hearing loss

As shown in Figure 1, 53.84% of children exhibited sensorineural hearing loss (SNHL), followed by 35.66% having conductive hearing loss, followed by lesser percentage of children having mixed or unilateral conditions. Children who had asymmetry in terms of type of hearing loss in both ears were reported as asymmetrical hearing loss in Figure 1. It was also noted that the children who were LTF most often were children receiving a diagnosis of bilateral conductive hearing loss (47.5%), followed by SNHL (19.58%).

Degree of hearing loss

The degree of hearing loss was classified according to the Goodman's classification and percentage of children who exhibited with different degree of hearing loss is depicted in Figure 2. 52.4% had shown to have symmetrical hearing loss, whereas 47.6% had asymmetrical hearing loss. 78.3% of children exhibited bilateral hearing loss, whereas 21.7% had unilateral hearing loss. A total of 97 children were LTF, and their audiological details are shown in Table 3. Children with unilateral conductive HL were mostly LTF, followed by bilateral SNHL and bilateral conductive HL. 11.2% of children were LTF after initial visit, 55.2% of children were followed up until diagnosis was made, and 33.6% of children were followed up till fitting of amplification devices

Age of amplification

Out of the confirmed hearing loss in 127 children, only 48 children have shown to have been fitted with amplification

devices at our institute. The mean age of amplification for these 48 children was shown to be 1.54 years (±0.766). Among which 86.66% of children were shown to use bilateral hearing aids and 89.74% of children had SNHL with 76.92% children who received a diagnosis of severe-profound or profound SNHL.

Table 2: Demographic details of the participants

	n (%)
Gender of children (*n*=143)	
Male	82 (57.3)
Female	61 (42.7)
Education of fathers	
Below tenth	42 (29.4)
Matriculation	63 (44.1)
Postmatriculation	21 (14.7)
Graduation	5 (3.5)
Postgraduation	12 (8.3)
Education of mothers	
Below tenth	41 (28.7)
Matriculation	38 (26.6)
Postmatriculation	37 (25.9)
Graduation	5 (3.5)
Postgraduation	22 (15.4)
Occupation of fathers	
Unskilled	12 (8.4)
Skilled	67 (46.9)
Government employee	48 (33.6)
Private job	16 (11.2)
Occupation of mothers	
Unskilled	1 (0.7)
Skilled	2 (1.4)
Government employee	14 (9.8)
Private job	5 (3.5)
Homemaker	112 (78.3)
SES	
Upper middle class	4 (3)
Lower middle class	28 (20)
Upper lower class	98 (69)
Lower class	13 (9)

SES: Socioeconomic status

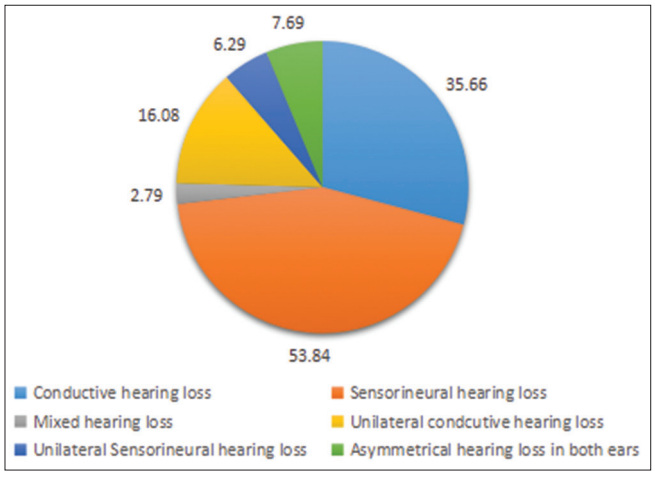

Figure 1: Type of hearing loss identified in children (in percentage)

Even though to a lesser degree (<2%), it was also seen that all degree and type of hearing loss received amplification. There was a significant positive correlation (0.694) between AOI of hearing loss and age of amplification

Age of intervention

Out of 48 children who were fitted with amplification devices at our institute, only 22 children are documented/reported to be attending early intervention program at the institute. Intervention details of other 26 children could not be tracked from the case files. Based on the information collected from case files of these 22 children, the mean age of intervention was observed to be 1.59 years (±0.83) and the mean duration of attending intervention is around 10.86 months (±4.37). Two children have underwent bilateral cochlear implant and two children are bimodal users with hearing aid in one ear and cochlear implant in other ear. All these children have been attending early intervention programme with aural-oral or auditory-verbal approach of training as documented in files.

As depicted in Table 4, there is a significant correlation between father's education and the AOI of hearing loss. Both are negatively correlated (−0.167) which implies that if the father has achieved higher education then chances of identification of hearing loss in child was more at a very young age. Father's education also had significant correlation with mother's education and SES, as shown in Table 5.

The number of children who have been LTF after diagnosis was found to be 55.2%. That is, after receiving a diagnosis of hearing loss, they have not reported back for hearing aid fitting or intervention procedures. 33.6% of children have been LTF after fitting of amplification devices (that is, before the intervention stage).

Discussion

This retrospective study was done by reviewing and collecting the audiological and demographic details from 143 case files of children below 3 years of age, registered in audiology diagnostics at the Institute in the period from January 2017 to December 2017. The results revealed that for the children who were identified early, intervention could be warranted without much delay. The AOI of hearing loss was found to be 1.38 years (±1.07), and the average time taken for confirming diagnosis from time of reporting was around 4.44 months.

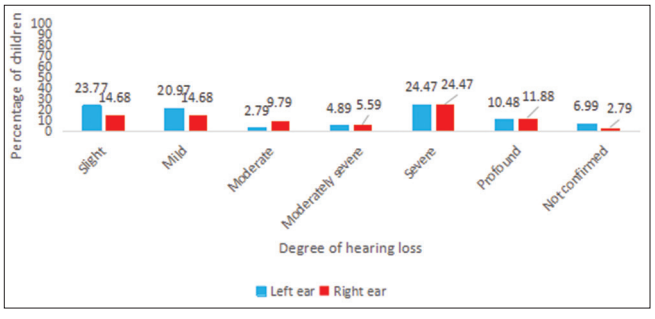

Figure 2: Degree of hearing loss in the left and right ear

Table 3: Details of number of children lost to follow-up

Degree of HL	Type and laterality of HL				
	Bilateral SNHL (*n*=27)	Unilateral SNHL (*n*=10)	Bilateral CHL (*n*=17)	Unilateral CHL (*n*=34)	Bilateral mixed HL (*n*=5)
Mild	9	1	11	20	5
Moderate	0	2	4	3	
Moderately severe	1	1	3	7	
Severe	1	3			
Severe-profound	4	0			
Profound	5	2			
Asymmetrical	5		5		
Unconfirmed	2	1	4	4	

HL: Hearing loss; SNHL: Sensorineural HL; CHL: Conductive HL

Table 4: Correlation between audiological and demographic factors

Audiological factor	Statistic	SES	Mothers education	Mothers occupation	Fathers education	Fathers occupation
Age at diagnosis (*n*=143)	Pearson correlation	−0.130	0.115	−0.023	−0.167*	−0.008
	Significant (two-tailed)	0.121	0.172	0.792	0.047	0.927
Age of amplification (*n*=48)	Pearson correlation	−0.124	−0.061	0.064	−0.194	−0.010
	Significant (two-tailed)	0.395	0.675	0.678	0.182	0.945

*Correlation is significant at the 0.05 level (two-tailed). SES: Socioeconomic status

Table 5: Correlation among the variables in demographic factors

Demographic factor	Statistic	Mothers education	Mothers occupation	SES	Fathers occupation
Fathers education	Pearson correlation	0.234**	−0.105	0.478**	0.477**
	Significant (two-tailed)	0.005	0.228	0.000	0.000

**Correlation is significant at the 0.01 level (two-tailed); SES: Socioeconomic status

There are literature that complies with findings of average age of AOI being 18 months[27] and a range of 11.5–32 months, depending on degree of hearing loss,[28] but which is still much higher than the position statement put forth by JCIH 2007. Even though the AOI has been found to be 27.77 months in Mumbai,[29] there is a scarcity in the literature to understand the trends in developing country like India, so as to warrant necessary actions. The results from the rural areas are even more disturbing, showing the mean age of suspicion of hearing loss in children to be 1.5 years and consulted doctors only by an age of 2.4 years.[30] It was also seen that father's education having correlation with the AOI, mothers education and SES suggesting as the education and SES of family is better, the process toward early identification and intervention taken place at younger ages.[18]

The age of amplification was found to be 1.54 years (±0.766) and intervention was 1.59 years (±0.83) and had significant correlation with AOI (0.694). The average age of enrolling into intervention has shown to be 22 months in the literature.[27] Since there is a decrease in the average AOI of hearing loss in children, the timely fitting of appropriate amplification was possible, which is often a major challenge.[21,22] There are numerous literature on added benefits of early identification and intervention in children on the outcomes.[5,7,8,31,32]

However, it was seen that 55.2% of children were LTF at some point of service delivery. Children who did not receive or complete the recommended diagnostic or intervention process are been recognized as LTF.[33] Infants were categorized in "No documented diagnosis/Undetermined" and "No intervention services" due to reasons like infants who are in process, who died, whose parents declined services, who are nonresidents, who moved out of jurisdiction, who cannot be contacted, whose parents are unresponsive and who have no documented diagnosis for unknown reasons by the Centers for the Disease Control and Prevention in 2012. Hence, this study also strongly directs attention to focus on identifying contributing factors for LTF. In the present study, the LTF was found to be high for children receiving a diagnosis of bilateral conductive hearing loss (47.5%), and similar reports have been reported in the literature.[34] With respect to the degree of hearing loss, LTF in the left ear was maximum for slight hearing loss (23.7%); mostly after confirmation of diagnosis. In the right ear, LTF rates were maximum for severe to profound hearing loss (20.9%) and among which 13.9% were found to LTF after fitting of amplification devices. As all the clients could not be contacted, we assume that these children are availing early intervention services at some other habilitation centers within the state. Hence, future investigation by directly contacting parents of children subjected to LTF is needed to conclude the assumption.

When considering identification and diagnosis of hearing loss, the contributing factors for LTF in this scenario is found to be lack of a common entry point for all children who are being referred by different hospitals or different professionals to the institute. Hence, this report advocates the need for a single point EHDI system in place which can streamline and track all young children until appropriate habilitation. Children are lost to both short-term and long-term follow-up when we do not have adequate systems to track them.[35] In India, the barriers to timely identification and intervention could be factors such as gender bias, poor SES, lack of awareness of family, inadequate referrals from professionals, and dearth of testing facilities, especially in the rural areas of the state.[29] The findings from the study thus highlight the need for identifying the contributing factors related to LTF to take necessary steps to prevent them. Reducing LTF is a social responsibility and requires collective involvement of professionals dealing with hearing loss, the parents and family members and even the Government officials in the field of disability. The steps have to be taken with respect to increasing follow-up strategies, expanded parental education, comprehensive data management, and tracking systems.[36] There is a need for a system that can constantly track and follow-up each client until they are enrolled appropriately into intervention. This can be complimented by expanded parental education given by the professionals so that parents understand the need for adequate follow ups. In India, there is also need for an integrated data management and tracking system available in programs like NPPCD that will help better communications between health-care providers, family members, and screening programs for successful follow-up. These steps can expand effective service delivery to young children with hearing loss and their families. This retrospective data can also help professionals to understand how well the protocol followed for diagnostic evaluation and management of young children with hearing loss comply with universal standards. Hence, it is the need of the hour to monitor the reasons for children subjected to LTF by periodically keeping track of individuals who are receiving early intervention.

Limitations of the study

The participants who were LTF could not be contacted to collect the details of audiological diagnosis and intervention. Further study is warranted to identify the factors that contributed to LTF by contacting these participants. Since this study was retrospective in nature, only the patterns in audiological and demographic findings could be identified. Further prospective studies in this regard would give more insights into the factors contributing to LTF.

Conclusions

Globally, the amount of disabling hearing loss is rising, and the consequences of it on young children are even more devastating. The timeline for early identification and intervention has been reaching standards proposed by JCIH position statement worldwide. Hence, if we understand current trends in our state, better health care services can be implemented. The findings from the retrospective data will not only help professionals, but also policy-makers and society as a whole in implementing state of the art diagnostic and management services effectively.

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Conflicts of interest

There are no conflicts of interest.

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