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# Comparison of Hearing loss in Children 3 months to 3 years Old with and without Risk Factors

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**Abstract:** Background: Babies in newborn intensive care units (NICU) are more expected to experience hearing loss due to a wide range of risk factors, such as prematurity, low birth weight, and hyperbilirubinemia. Effects of hearing impairment among children include poor consequences in speech, linguistics, social interaction, education, intelligence abilities, and overall well-being of life. Aims & Objective: The purpose of our research was to find out the comparison of hearing loss in children 3 months to 3 years old, with and without risk factors. Methodology: Our study was conducted at the Audiology Centre, Lahore. Children age range from 3 months to 3 years; both male and female genders were included in our study. Detailed history-taking of patients was done. We did an audiological evaluation through TEOAEs, Immittance Audiometry, and Auditory Brainstem Response Audiometry in 98 children (49 in each group) with risk factors indicated by the Joint Committee on Infant Hearings (JCIH) (2007) and without risk factors. Every parent gave their consent to participate in the study. Results & Findings: The total number of children was 98; 59.6% were male and 39.4% were female. The mean age of the children was 1.86±0.73. In the risk factor group, 77.6% of children

had referred TEOAEs, while in the children without risk factor group, 34.7% of children had TEOAEs referred. In the risk factor group, 77.6% of children had hearing loss, while in the without risk factor group, 36.7% of children had hearing loss. The Wilcoxon Signed Ranks test reveals a statistically significant difference ($P < 0.05$) between the hearing impaired with and without risk factor groups. Conclusion: Our study reveals significant at-risk factors for childhood hearing impairment, including consanguinity, prematurity, NICU stays for more than 5 days, family history of hearing loss, meningitis, and low birth weight. This current study recommends mandatory neonatal hearing screening for early identification and management. Advances in technology and evidence-based public health approaches can help recognize, treat, and cure hearing loss.

**Keywords:** Hearing loss, Children, JCIH Risk factors, OAEs, ABR, Tympanometry, NICU.

## INTRODUCTION:

Based on studies on global data, 1-3 infants out of every 1000 are born with hearing loss (1). According to the World Health Organization (WHO), between 0.5 and 5 newborns and infants out of every 1000 have severe-to-profound hearing problems, or genetic or early childhood start sensorineural hearing loss (2).Worldwide, hearing loss counts as the fourth most common cause of years spent disabled. According to the most current data, there are half a billion people globally who have a significant hearing loss (3). 9% of individuals with hearing loss live globally (4).One of the most prominent hereditary impairments in children is hearing loss. Hearing is mandatory for communication and helps children learn to identify objects, events and awareness of sounds. Hearing is very essential for educational purposes, life event experiences, group activities, and social development. In children, hearing loss is common and can lead to harmful outcomes in schooling and social development. Effects of hearing impairment among children include poor consequences in speech, social interaction, education, intelligence abilities, and overall well-being of life (5). Hearing impairment can be acquired or congenital, with possible causes including hereditary infections, inherited disorders, non-syndromic causes, injury, and other things. Assessment of hearing deafness must be based on suspected diagnosis, degree and type of hearing loss, age of onset, and including additional variables. Hearing therapy for children with hearing loss may involve the use of cochlear implants, auditory devices, assistive listening devices, and bone-anchored devices. Early screening and assessment of hearing loss, as well as understanding its cause, may help with prediction and guidance for families (2).

Hearing problems must be diagnosed within three months after birth in order to get appropriate therapy. Early intervention should begin before six months of life, using the 1-3-6 early hearing diagnosis and treatment (EHDI) (6). As suggested by the Joint Committee on Infant Hearing (JCIH), hearing evaluations of all infants should be done within one month of age, and for infants whose referral assessment is required, a detailed audiological assessment must take place within three months of age, and infants with hearing impairments must get proper intervention at six months of age (7). The aim of preliminary hearing assessment and treatment is to help infants who are deaf develop their ability to read, write, and speak (8).The World Health Organization (WHO) estimates that primary, secondary, or tertiary intervention may avoid 50% of hearing loss (3). Children with Hearing impairment often show quiet disabilities, demanding active investigation for it (9). The JCIH recommendations include the following high-risk factors: A family history of sensorineural hearing impairment, birth weight under 1500 grams, hyperbilirubinemia over 15 mg/dL requiring blood transfusion, meningitis, NICU admission for more than five days, consanguinity, and premature birth (5).

According to JCIH, babies in newborn intensive care units (NICU) are more probably to develop hearing loss due to a wide range of risk variables, such as prematurity, low birth weight, and hyperbilirubinemia (10). Hearing loss was independently associated with the presence of at least one JCIH risk factor, admission to the NICU for longer than five days, birth weight, and age (11). The goal of our investigation was to find out the comparison of hearing loss in children 3 months to 3 years old, with and without risk factors. There are several significant benefits to studying the comparison of hearing loss in children between the ages of three months and three years, both with and without risk factors. Some of these advantages include early detection, at-risk population identification, prevalence estimation, assessment of impacts, and long-standing outcome evaluation. The results of these investigations will ultimately enhance the quality of life and chances for future achievement of young children with hearing impairments by improving the diagnosis, treatment, and outcomes of this condition.

## METHODOLOGY

This study employed a cross-sectional observational design and was conducted at the Audiology Centre in Lahore over a three-month period, from December 2023 to February 2024. The sample size was calculated to be 98 participants, with 49 individuals in each group, based on a 95% confidence level, 10% absolute precision, and expected proportions of hearing loss risk factors in the population 10% for those with risk factors and 96.3% for those without. The sampling method used was convenience sampling.

$$N=\frac{Z^2_{1-\alpha/2}\,[P_1\,(1-P_1)+P_2\,(1-P_2)]}{d^2}$$

$$Z_{1-\alpha/2} = Confidence\ level = 95\% = 1.96$$

$$P_1 = Population\ proportion\ I = 10\%$$

$$P_2 = Population\ proportion\ II = 96.3\%$$

d= Absolute precision=10%

Participants included in the study were children aged 3 months to 3 years, of both genders, and were categorized into two groups based on the presence or absence of hearing loss risk factors, as outlined by the Joint Committee on Infant Hearing (2007). Inclusion criteria encompassed children with specific risk factors such as premature birth, low birth weight (<1500 g), hyperbilirubinemia requiring exchange transfusion, NICU admission for more than 5 days, consanguinity, meningitis, delayed cry at birth, or a family history of hearing impairment. Children who met any of the following exclusion criteria were not included: presence of occlusive earwax, ear discharge, lack of parental consent for OAE/ABR testing, or congenital conditions like microtia, canal atresia, craniofacial anomalies, and syndromic illnesses.

The data collection involved a detailed history-taking from the participants, followed by comprehensive audiological evaluations. The audiological assessments included Transient Evoked Otoacoustic Emissions (TEOAEs), Immittance Audiometry, and Auditory Brainstem Response (ABR) Audiometry. The ABR testing, which serves as an objective assessment of auditory pathway function, was conducted while the children were either asleep or sedated. The ABR procedure involved electrode placement as follows: a positive electrode was positioned at the high forehead (Cz), with negative electrodes placed on the right and left mastoids or ear lobes (A1 and A2), and a ground electrode was placed on the lower forehead. Key measurements recorded during ABR testing included the absolute latencies, amplitudes, and interwave durations, particularly between waves I, III, and V, with wave V being the most clinically significant for detecting auditory thresholds. ABR Recording Parameters: The ABR testing was performed using the following parameters:

1. **Electrode Location:** Positive electrode at Cz (high forehead), negative electrodes at the right and left mastoids, and a ground electrode on the lower forehead.
2. **Stimulus Type:** Alternating polarity
3. **Stimulus Rate:** 44.1/s
4. **Amplifier Filters:** High frequency at 50 Hz and low frequency at 1500 Hz
5. **Window Length:** 15 ms
6. **Number of Sweeps:** 4000 click or CE chirp sweeps, with an artifact rejection level of ±5 µV
7. **Display:** Wave V response visualization

For statistical analysis, SPSS version 27.0 was employed. The quantitative data were expressed as mean ± standard deviation, and comparisons between groups were made using the Wilcoxon Signed Ranks Test. Statistical significance was considered at a p-value of <0.05.

## RESULTS & FINDINGS

Out of 98 children, 59.6% were male and 39.4% were female. The mean age of the children was 1.86±0.73. In the risk factor group, 77.6% of children had referred TEOAEs, while in the children without risk factor group, 34.7% of children had TEOAEs referred. In the risk factor group, 69.4% of children had normal tympanograms, while in the children without risk factor group, 85.7% of children had normal tympanograms. Demographics, TEOAEs, and Immittance Audiometry are shown in Table 1.

**Table 1: Demographic and Audiological Characteristics of Children with and without Risk Factors for Hearing Impairment**

| | Children with Risk Factors | | Children Without Risk Factors | | Total | |
|---|---|---|---|---|---|---|
| | **Frequency** | **Percentage (%)** | **Frequency** | **Percentage (%)** | **Frequency** | **Percentage (%)** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Age | | 1.69±0.73 | | 2.02±0.70 | | 1.86±0.73 | |
| Gender | Male | 26 | 53.1 | 33 | 67.3 | 59 | 59.6 |
| | Female | 23 | 46.1 | 16 | 32.7 | 39 | 39.4 |
| TEOAEs | Pass | 11 | 22.4 | 32 | 65.3 | 43 | 43.9 |
| | Refer | 38 | 77.6 | 17 | 34.7 | 55 | 56.1 |
| Immittance Audiometry | Type A | 34 | 69.4 | 42 | 85.7 | 76 | 77.6 |
| | Type As | 2 | 4.1 | 1 | 2.0 | 3 | 3.1 |
| | Type B | 12 | 24.5 | 5 | 10.2 | 17 | 17.3 |
| | Type C | 1 | 2.0 | 1 | 2.0 | 2 | 2.0 |

In the risk factor group, 18.4% of children had a history of premature birth, 4.1% had a history of delayed cry at birth, 6.1% had a history of hyperbilirubinemia requiring blood transfusion, 12.2% had a history of meningitis, 12.2% had a history of NICU stay for more than 5 days, 16.3% had a history of low birth weight, 42.9% had a family history of hearing loss, 79.6% had a history of consanguinity, and 24.5% had a history of delayed developmental milestones. The details of the risk factors are given in Table 2.

**Table 2: Distribution of Risk Factors Among Study Participants**

| RISK FACTORS | | | |
|---|---|---|---|
| | | **Frequency** | **Percentage %** |
| Birth History | Normal | 40 | 81.6 |
| | Premature | 9 | 18.4 |
| Delayed Cry at birth | No | 47 | 95.5 |
| | Yes | 2 | 4.1 |
| Hyperbilirubinemia requiring an exchange transfusion | No | 46 | 93.9 |
| | Yes | 3 | 6.1 |
| Meningitis | No | 43 | 87.8 |
| | Yes | 6 | 12.2 |
| NICU stay more than 5 days | No | 43 | 87.8 |
| | Yes | 6 | 12.2 |
| Low birth weight | No | 41 | 83.7 |
| | Yes | 8 | 16.3 |
| Family history of hearing loss | No | 28 | 57.1 |
| | Yes | 21 | 42.9 |
| Consanguinity | No | 10 | 20.4 |
| | Yes | 39 | 79.6 |
| Developmental Milestones | Normal | 37 | 75.5 |
| | Delayed | 12 | 24.5 |

In the risk factor group, 77.6% of children had hearing loss, while in the without risk factor group, 36.7% of children had hearing loss. In the risk factor, all children had SNHL. 63.3% of children in the risk factor had a profound degree of hearing loss, 6.1% had a severe degree of hearing loss, and 8.2% of children had a moderate degree of hearing loss. While in the children without risk factors group, 26.5% of children had a

profound degree of hearing loss. The details of the type and degree of hearing loss are given in Table 3.

**Table 3: Comparison of Hearing Loss Characteristics Between Children with and Without Risk Factors**

| | | Children with Risk Factors | | Children Without Risk Factors | |
|---|---|---|---|---|---|
| | | **Frequency** | **Percentage (%)** | **Frequency** | **Percentage (%)** |
| Hearing loss | No | 11 | 22.4 | 31 | 63.3 |
| | Yes | 38 | 77.6 | 18 | 36.7 |
| Degree of hearing loss | Moderate | 4 | 8.2 | 4 | 8.2 |
| | Severe | 3 | 6.1 | 1 | 2.0 |
| | Profound | 31 | 63.3 | 13 | 26.5 |
| Type of hearing loss | SNHL | 38 | 77.6 | 14 | 28.6 |
| | CHL | 0 | 0 | 3 | 6.1 |
| | MHL | 0 | 0 | 1 | 2.0 |
| BC ABR | No | 38 | 77.6 | 44 | 89.8 |
| | Yes | 11 | 22.4 | 5 | 10.2 |

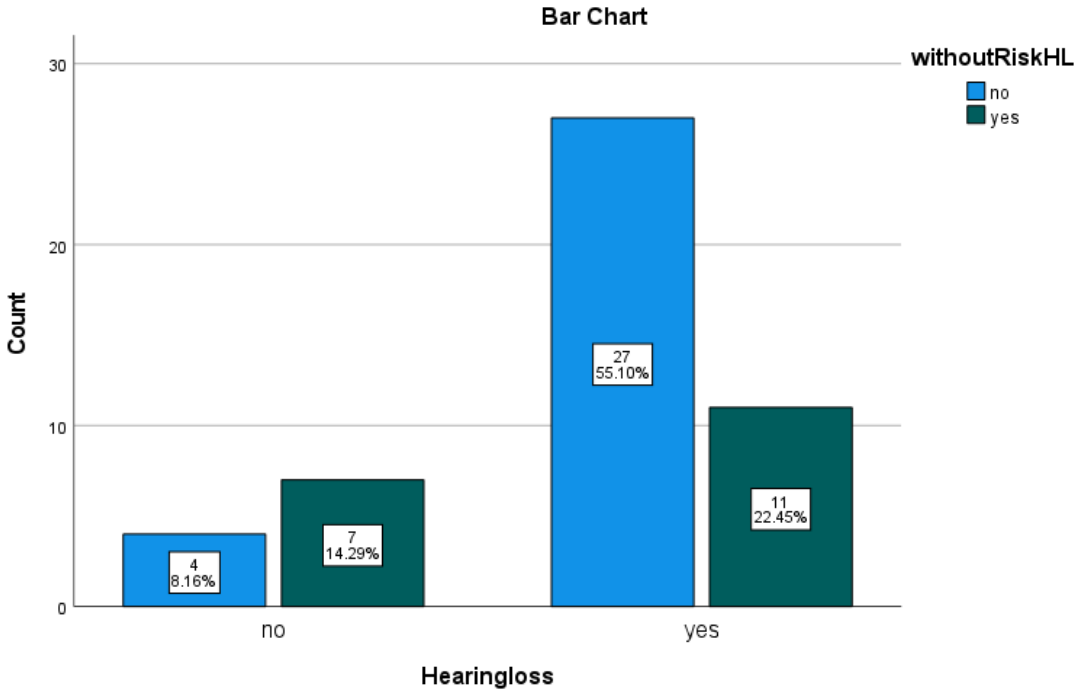
The Wilcoxon Signed Ranks Test was applied, which reveals a statistically significant relationship between hearing loss with and without risk factors ($P < 0.05$), as shown in Table 4.

**Table 4: Wilcoxon Signed Ranks Test**

| **Ranks** | | | | |
|---|---|---|---|---|
| | | N | Mean Rank | Sum of Ranks |
| withoutRiskHL - Hearingloss | Negative Ranks | 27[a] | 17.50 | 472.50 |
| | Positive Ranks | 7[b] | 17.50 | 122.50 |
| | Ties | 15[c] | | |
| | Total | 49 | | |
| a. withoutRiskHL < Hearingloss | | | | |
| b. withoutRiskHL > Hearingloss | | | | |
| c. withoutRiskHL = Hearingloss | | | | |

| **Test Statistics[a]** | |
|---|---|
| | Without Risk HL – Hearing loss |
| Z | -3.430[b] |
| Asymp. Sig. (2-tailed) | .001 |
| a. Wilcoxon Signed Ranks Test | |
| b. Based on positive ranks. | |

**Figure 1 shows a comparison of children with hearing loss with and without risk factors.**




## DISCUSSION

The goal of our investigation was to find the comparison of hearing loss in children 3 months to 3 years old, with and without risk factors. According to available research, impairment of hearing was more reported among children with risk factors. A number of researchers have suggested that genetic causes contribute to approximately fifty percent of childhood sensorineural hearing loss. Our study's findings are similar and comparable to those of that study of Abdulbari Bener, Amr A.M. Eihakeem et. al., which shows that those with impaired hearing were more inclined to have consanguineous parents (12). Another study found that the inherited cause of hearing disability provides information for clinical identification of hearing-related cases using the latest generation of sequencing in areas with a high number of consanguineous partnerships (13).

Depending on the level of hearing loss, the hearing needs of children may differ. The impact occurs more strongly in children who are developing language skills or getting educational experience (14). The study of Giorgia Girotto,Massimo Mezzavilla et. al., matches our study, which showed that hearing loss-affected individuals had a higher rate of paternal consanguinity than unaffected ones (15). According to the study of Barbara Leal, Ana Cristina, et al., parental consanguinity was linked to a greater risk of childhood deafness, and our study correlated with it (16). The study of Hossam Sanyelbhaa, Abdelmagied Kabel et al. also matches to our study, which showed that, as compared to non-consanguineous children, children of consanguineous marriages had 76% higher chance to develop SNHL (17). Another study also correlates to our study. This study showed that 70% of the deaf children were from parents who had cousin marriages (18). A study by Yacouba Dia et al. also relates to our study: 93% of the expected consanguinity rate tends to be correlated with an exceptionally high consanguinity proportion (19).

The study of Mercedes Valido Quintana et al. also coordinated with our study, which proved that having a family history of hearing loss was a risk factor (20).The study of Talite le Roux (2014) is also parallel to our study, which shows that the most common risks are preterm, family history of infant hearing damage, and NICU admission (21). Another study by Nermin Hrncic (2018) is also similar to ours. In this investigation, several major risk factors for hearing loss were discovered, including a family history of persistent childhood problems with hearing, being preterm, and hyperbilirubinemia (22). Another study showed that high sensorineural hearing loss rates were observed in children with hyperbilirubinemia, while in our study, only 6.1% of children had hyperbilirubinemia (23).

According to another study, being underweight at birth raises the possibility of SNHL (24). Another study correlates with ours, showing that the danger of loss of hearing was significantly greater in infants admitted to the NICU (25).The study of Carlos Fabian Martinez-Cruz,

Adrian Poblano, et. al., is similar to our study, which shows that as the primary risk factors for SNHL, low birth weight, prolonged NICU stays, and meningitis in high-risk infants require early management and hearing screening (26). A study by Hassan Boskabadi et al. showed that impairment of hearing was found to be about 10–50 percent higher in infants with severe jaundice. The bilirubin level provides the strongest estimation for an infant's hearing condition, while in our research, 6.1% of children had hyperbilirubinemia (27). Another study found that admission to the neonatal intensive care unit for longer than five days was a crucial indication for diminished hearing in infants (28). In our research, 16.3% of children had a history of low birth weight, which is similar to another study that showed that infant hearing impairment has been linked to low birth weight (29).

The study of Silvia A. Borkoski-Barreiro et. al. also correlates to our study. This study showed that, unexpectedly, a greater number of VLBW babies are receiving hearing loss diagnoses. Every infant with SNHL had one or two hearing risk factors linked to VLBW and had a quick diagnosis (30). A study by Xiadan Zhu et al. showed that loss of hearing is highly prevalent in infancy, especially in infants who are premature, and hyperbilirubin is a major reason (31). A study by L. Pan et al. showed that premature deliveries and very low birth weight could raise the chance of developing hearing loss (32). It has been discovered that children with meningitis frequently suffer from sensorineural hearing loss, which raises questions regarding the importance of an appropriate and rapid audiological diagnosis (33).

It is suggested that a hearing examination program should be undertaken for all infants admitted. To diagnose and treat hearing impairment quickly, a newborn hearing screening protocol must be established (34).Impairment of hearing inspection should be part of the routine physical examination (35). The chances that an infant may experience hearing impairment rise with the number of risk factors to which they are exposed. All newborns should have their hearing tested because a significant portion of them will have Sensorineural hearing impairment can occur even when there are no known risk factors(36).Early intervention is needed to enhance the social and intellectual abilities of the child and minimize the adverse effects of hearing impairment on interaction (37).

## CONCLUSION

The occurrence of hearing impairment among at-risk factors was discovered to be quite significant in our study. Consanguinity, prematurity, NICU stays for more than 5 days, a family history of hearing loss, low birth weight, and meningitis are important risk factors for childhood hearing impairments. All children with risk factors had bilateral profound sensorineural hearing loss. However, we suggest a newborn hearing screening program should be considered mandatory for the better quality of life of children with hearing loss. Hearing loss can be recognized and treated through the use of current advances in technology along with evidence-based public health approaches. The following method involves affordable measures and techniques, such as screening newborns and preschoolers for hearing difficulties, as well as the therapeutic treatment of ear challenges and the use of listening innovations, such as cochlear implant devices or hearing devices.

## CONFLICT OF INTEREST

The authors declare no conflicts of interest regarding this manuscript.

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