

EARLY DETECTION OF HEARING IMPAIRMENT IN HIGH-RISK NEWBORNS

Dr. Aatika Aftab^{*1}, Dr. Maliha Akhtar², Dr Saad Hameed³^{*1,3}Post Graduate Trainee (FCPS Pediatrics), KRL Hospital, Islamabad.²Consultant Pediatrician / Deputy Chief Medical Officer, KRL Hospital, Islamabad.^{*1}aatikaftab1996@gmail.comDOI: <https://doi.org/10.5281/zenodo.18374554>**Keywords**

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Corresponding Author: *

Dr. Aatika Aftab

Abstract

Background: High-risk newborns, including those with low birth weight, prematurity, hyperbilirubinemia, or serious medical conditions, are at increased risk of hearing impairment. Due to varying reported frequencies, this study aimed to determine its occurrence using standardized screening.

Objective: To determine the frequency of early hearing impairment in high risk new-borns at a tertiary care hospital

Duration: Three months after approval of synopsis i.e. 23-03-2025 to 25-06-2025

Methodology: After approval from the hospital ethical review committee and study synopsis, 174 high-risk newborns admitted to KRL Hospital's NICU were enrolled following informed parental consent. Demographics were recorded, and BERA testing was performed using surface electrodes and auditory stimuli in a quiet, controlled environment.

Results: A total of 174 high-risk newborns were studied, with a mean age of 15.31 ± 8.34 days and mean birth weight of 2166.06 ± 198.48 grams. Hearing impairment was detected in 21.8% of participants, ranging from mild to severe, with no significant association found with risk factors like age, gender, or birth weight.

Conclusion: The study found that hearing impairment affects a significant proportion of high-risk newborns, regardless of specific risk factors such as birth weight or gestational age. Early screening using BERA is essential for timely diagnosis and intervention to prevent developmental delays in this vulnerable population.

INTRODUCTION

Hearing is one of the essential five senses and plays a fundamental role in the development of speech, language, and cognitive abilities in children.¹ It enables infants to recognize sounds, identify objects, and internalize abstract concepts during early development². Hearing loss, the most common pediatric sensory disability, requires timely identification and intervention to prevent long-term developmental delays.² Over 80% of hearing loss in

children is either congenital or occurs during infancy. Bilateral deafness has been reported in 1–3% of all live births and in approximately 2–4% of neonates admitted to intensive care units.³

Early detection and timely rehabilitation are key to improving hearing and communication outcomes in affected infants.⁴ The first six months of life are particularly critical for identifying hearing impairment and initiating appropriate interventions, which can significantly enhance language acquisition

and overall developmental outcomes. Newborn hearing screening serves as an effective tool in achieving this objective.⁴ Globally, there is an urgent need for universal hearing screening, especially since an estimated 7.5 million children require testing, with 80% residing in low- to middle-income countries.⁵

The severity of hearing loss is determined by assessing auditory thresholds in decibels (dB) at various frequencies. Normal hearing ranges from 0 to 20 dB, while hearing loss is categorized as mild, moderate, severe, or profound based on threshold values.⁶ If left undiagnosed and unmanaged, hearing loss not only hampers speech and language development but also imposes a substantial socioeconomic burden.⁷ It is also recognized as the most common congenital sensory impairment, with an estimated incidence of 1.5 per 1,000 live births.⁷

High-risk newborns include those exposed to prenatal, perinatal, or postnatal risk factors, such as prematurity, low birth weight, or neonatal complications, which may adversely affect neurodevelopment.⁸ In a study conducted by Joshi et al. in India, the frequency of hearing impairment among high-risk neonates was reported to be 13%.⁹

In light of the above study, it appeared essential to screen every high-risk newborn for hearing impairment to ensure early detection and timely intervention. However, some studies have reported lower frequencies. Siddique et al. reported a 2% frequency of hearing impairment in high-risk newborns, while Mandal et al. reported 4.61%.^{4,10} Given Pakistan's limited healthcare resources, it is vital to base screening policies on strong, conclusive evidence. As existing literature is limited and largely foreign-based, this study aimed to reconfirm findings and provide local evidence to help determine whether routine hearing screening should be implemented in high-risk newborns in future practice.

METHODOLOGY

This study was a descriptive cross-sectional study conducted at the Department of Paediatrics, KRL Hospital, Islamabad from 23-03-2025 to 25-06-2025. The sample size was calculated using the WHO calculator. A total of 174 high-risk newborns were included, based on a 95% confidence level and 5% margin of error, assuming an expected frequency of hearing impairment in high-risk newborns to be

13.0%.⁹ The sampling technique used was non-probability, consecutive sampling. The sample selection was based on specific inclusion and exclusion criteria. Inclusion criteria comprised high-risk newborns of both genders aged ≤ 28 days, as per operational definition. Exclusion criteria included any congenital infections known to be associated with hearing loss, newborns who had already undergone any hearing assessment based on history or medical record, and those with severe brain malformations or other conditions that could make hearing assessment unreliable. High-risk newborns were defined as infants with a birth weight of less than 2,500 grams, gestational age of less than 37 weeks, serum bilirubin level greater than 17 mg/dL (290 mol per L), or those requiring intensive care due to conditions such as respiratory distress, congenital abnormalities, or maternal factors like gestational diabetes or preeclampsia. This definition also included any infant requiring specialized medical interventions or monitoring within the first 28 days of life to manage life-threatening conditions or complications. Hearing impairment was defined and assessed using BERA (Brainstem Evoked Response Audiometry), a non-invasive test to evaluate hearing in high-risk newborns. In normal hearing, Wave V appeared at 20–30 dB with a latency of 5.5–6.5 milliseconds. Mild hearing impairment showed Wave V at 30–40 dB with slightly prolonged latency. Moderate impairment showed Wave V at 40–60 dB with more prolonged latency. Severe impairment showed Wave V only at high thresholds (60–90 dB) or absent at lower levels, with markedly prolonged latency. In cases of profound hearing loss, Wave V was absent even at maximum stimulus levels. After obtaining approval from the hospital ethical review committee, 174 high-risk newborns admitted to the NICU of KRL Hospital, Islamabad, who met the inclusion criteria, were enrolled in the study following informed written consent from their parents or guardians. Their demographic details were recorded on a predesigned proforma. The procedure began by ensuring that the neonate was stable and situated in a quiet environment to minimize any external noise. Once the neonate was adequately settled, surface electrodes were placed on the scalp, earlobes, and the nape of the neck. These electrodes were connected to a recording device to capture auditory neural responses.

Auditory stimuli such as clicks or tone bursts were delivered through earphones or speakers placed near the neonate's ears. These stimuli evoked electrical activity along the auditory pathway from the cochlea to the brainstem. The BERA device recorded these responses as waveforms, which reflected the timing and integrity of the auditory nerve and brainstem's reaction to sound. A single senior consultant analysed the recorded waveforms to detect any abnormalities in the auditory pathway, and hearing impairment was labelled as per the operational definition. All findings were recorded by the resident herself to minimize observer bias. Regardless of the findings, all patients received standard NICU treatment as per hospital protocol. Confounding variables were controlled through the application of exclusion criteria. All collected data were entered and analysed using SPSS version 26.0. Numerical variables including age, gestational age, birth weight, and serum bilirubin levels were presented as mean $\pm$ standard deviation. Categorical variables such as gender, presence of respiratory distress, chorioamnionitis, early hearing impairment, and severity of hearing impairment were presented in terms of frequency and percentage. The frequency of early hearing impairment was stratified for age, gender, and other risk factors to identify effect modifiers. Post-stratification, chi-square test was applied, considering a p-value of ≤ 0.05 as statistically significant.

RESULTS

A total of 174 high-risk newborns were enrolled in the study. The mean age of the participants was 15.31 ± 8.34 days, with 44.8% (n=78) aged between 1–14 days and 55.2% (n=96) between 15–28 days. Regarding gender distribution, 53.4% (n=93) were boys and 46.6% (n=81) were girls. The mean birth weight was 2166.06 ± 198.48 grams, with 23.0% (n=40) of the neonates weighing less than 2000 grams and 77.0% (n=134) between 2000 and less than 2500 grams. The

mean gestational age was 32.47 ± 2.36 weeks, with 34.5% (n=60) born between 28–31 weeks and 65.5% (n=114) between 32–36 weeks. The mean serum bilirubin level was 20.11 ± 2.01 mg/dl; of these, 58.6% (n=102) had bilirubin levels ranging from 17.1–20 mg/dl, while 41.4% (n=72) had levels greater than 20 mg/dl. Respiratory distress was observed in 28.7% (n=50) of the newborns, whereas 71.3% (n=124) did not exhibit any respiratory distress. A maternal history of chorioamnionitis was present in 15.5% (n=27), while 84.5% (n=147) had no such maternal risk factor. Data is given in Table 1.0. Among the 174 high-risk newborns included in the study, hearing impairment was detected in 21.8% (n=38), whereas 78.2% (n=136) did not exhibit any hearing impairment. Among the 38 newborns diagnosed with hearing impairment, 50.0% (n=19) had mild hearing impairment, 31.6% (n=12) had moderate hearing impairment, and 18.4% (n=7) were found to have severe hearing impairment. Data is given in Table 2.0. Hearing impairment was present in 23.1% of newborns aged 1–14 days and 20.8% of those aged 15–28 days ($p = 0.722$). Among males, 21.5% had hearing impairment, compared to 22.2% of females ($p = 0.909$). Hearing impairment was observed in 25.0% of newborns with birth weight <2000 g and 20.9% with birth weight 2000 to <2500 g ($p = 0.581$). Among those with gestational age 28–31 weeks, 25.0% had hearing impairment, versus 20.2% in the 32–36 week group ($p = 0.464$). Hearing impairment occurred in 20.6% of newborns with elevated serum bilirubin and 23.6% without ($p = 0.635$). It was present in 26.0% of those with respiratory distress and 20.2% without ($p = 0.399$). In cases with maternal chorioamnionitis, hearing impairment was seen in 25.9%, compared to 21.1% without ($p = 0.576$). No statistically significant association was found between hearing impairment and any of the studied risk factors ($p > 0.05$) as shown in Table 3.0.

Table 1.0: Demographic Characteristics of High Risk Newborns Included in the Study

Characteristics	Total (n=174)
Age (days)	15.31 ± 8.34
● 1-14 days	78 (44.8%)
● 15-28 days	96 (55.2%)

Gender	
● Boy	93 (53.4%)
● Girl	81 (46.6%)
Birth Weight	2166.06±198.48
● <2000 g	40 (23.0%)
● 2000 to <2500g	134 (77.0%)
Gestational Age (weeks)	32.47±2.36
● 28-31 weeks	60 (34.5%)
● 32-36 weeks	114 (65.5%)
Serum Bilirubin (mg/dl)	20.11±2.01
● 17.1-20 mg/dl	102 (58.6%)
● >20 mg/dl	72 (41.4%)
Respiratory Distress	
● Yes	50 (28.7%)
● No	124 (71.3%)
Maternal Factor (Chorioamnionitis)	
● Yes	27 (15.5%)
● No	147 (84.5%)

Table 2.0: Frequency of Hearing Impairment in High Risk Newborns and Its Severity

Hearing Impairment	Frequency (n)	Percent (%)
● Yes	38	21.8%
● No	136	78.2%
Severity		
● Mild	19	50.0%
● Moderate	12	31.6%
● Severe	7	18.4%

Table 3.0: Stratification of Frequency of Hearing Impairment across Various Risk Factors

Study Variable	Hearing Impairment		p-value
	Yes	No	
Age (days)			
● 1-14 days	18 (23.1%)	60 (76.9%)	0.722
● 15-28 days	20 (20.8%)	76 (79.2%)	
Gender			
● Boy	20 (21.5%)	73 (78.5%)	0.909
● Girl	18 (22.2%)	63 (77.8%)	
Birth Weight			
● <2000 g	10 (25.0%)	30 (75.0%)	0.581
● 2000 to <2500g	28 (20.9%)	106 (79.1%)	
Gestational Age (weeks)			
● 28-31 weeks	15 (25.0%)	45 (75.0%)	0.464
● 32-36 weeks	23 (20.2%)	91 (79.8%)	

Serum Bilirubin (mg/dl)			
● Yes	21 (20.6%)	81 (79.4%)	0.635
● No	17 (23.6%)	55 (76.4%)	
Respiratory Distress			
● Yes	13 (26.0%)	37 (74.0%)	0.399
● No	25 (20.2%)	99 (79.8%)	
Maternal Factor (Chorioamnionitis)			
● Yes	7 (25.9%)	20 (74.1%)	0.576
● No	31 (21.1%)	116 (78.9%)	

Chi Square test, taking $p\text{-value} \leq 0.05$ as significant

DISCUSSION

High-risk newborns are those with a birth weight below 2,500 grams, gestational age under 37 weeks, serum bilirubin levels above 17 mg/dL, or those requiring intensive care for conditions such as respiratory distress, congenital anomalies, or maternal complications.^{3,11} These infants often need specialized medical care during the first 28 days of life.^{10,12}

Among this vulnerable group, hearing impairment is a significant concern, potentially leading to delayed speech and cognitive development.^{8,9,10} However, the frequency of hearing impairment in high-risk newborns remains controversial across studies. Therefore, this study was designed to determine its frequency using standardized screening.

In this study, a total of 174 high-risk newborns were enrolled, with a mean age of 15.31 ± 8.34 days and mean birth weight of 2166.06 ± 198.48 grams. Hearing impairment was detected in 21.8 percent of the newborns, ranging from mild to severe. Although some subgroups such as those with birth weight less than 2000 grams, gestational age 28 to 31 weeks, respiratory distress, or maternal chorioamnionitis showed higher frequencies of hearing impairment, none of these associations were statistically significant with p values greater than 0.05. This indicates that hearing impairment is prevalent across all high-risk groups without a significant link to specific risk factors.

The findings of the present study, which identified hearing impairment in 21.8% of high-risk newborns, can be better understood in light of existing literature. Various studies across different regions have explored the prevalence of hearing loss in neonates with comparable risk factors, though reported rates vary

due to population differences, screening methods, and timing of assessments.

Lower frequencies have been reported in several studies. Kunnath et al. in India observed a prevalence of only 0.5%, with an equal distribution between unilateral and bilateral impairment.¹³ Despite the low rate, they identified significant associations with multiple risk factors such as pregnancy-induced hypertension, preterm labor, low birth weight, respiratory distress, and congenital anomalies. Similarly, Siddique et al. in India reported a 2% rate of bilateral severe sensorineural hearing loss in neonates with high-risk features like prematurity, hyperbilirubinemia, neonatal infections, and extended NICU admissions.⁴

Studies from Iran and India have also shown relatively low prevalence. Keihani-Doust et al. reported a 3.6% rate of mild to moderate hearing loss in neonates, significantly linked to neonatal jaundice requiring phototherapy, respiratory distress syndrome, and low Apgar scores.¹⁴ Mandal et al. in India found hearing impairment in 4.61% of high-risk newborns, while Joshi et al. observed a 3.6% incidence and 13% overall prevalence in NICU neonates.^{10,9} Their findings emphasized that multiple concurrent risk factors, including low birth weight, prematurity below 32 weeks, and hyperbilirubinemia requiring exchange transfusion, increased the likelihood of hearing loss. Moderate frequencies were reported by Naqqash et al. in Pakistan and Regina et al., with hearing impairment rates of 6% and 6.76%, respectively.^{16,17} Both studies highlighted that although most high-risk neonates screened normal, a notable minority presented with definite hearing loss, justifying the inclusion of routine hearing assessments in neonatal care, especially in NICU settings.

In contrast, Labeka et al. in Nigeria reported more substantial rates.¹⁷ They found that 41.3% of high-risk neonates failed the initial hearing screening, 15.9% failed at discharge, and 9.5% continued to show impairment on follow-up. Most cases were bilateral and severe, underlining the persistence of undetected hearing loss in some high-burden environments.

Overall, while the frequency of hearing impairment varies, existing literature supports the importance of early screening in high-risk newborns. Findings across different studies consistently demonstrate that key perinatal and neonatal risk factors contribute to auditory dysfunction, warranting timely detection and intervention strategies.

CONCLUSION

The study found that hearing impairment affects a significant proportion of high-risk newborns, regardless of specific risk factors such as birth weight or gestational age. Early screening using BERA is essential for timely diagnosis and intervention to prevent developmental delays in this vulnerable population.

LIMITATIONS & RECOMMENDATIONS

This study's strength lies in its focused screening of high-risk newborns using standardized BERA testing, ensuring reliable detection of hearing impairment. A limitation is the lack of statistically significant associations, though some subgroups showed insignificantly higher frequencies, warranting further investigation with larger samples. Future studies should explore these trends in greater depth, potentially identifying subtle risk patterns. Expanding screening to broader populations and incorporating follow-up assessments may enhance early detection and long-term outcomes.

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Authors Contributions

Author 1

Substantial contributions to study design, acquisition of data, analysis, and interpretation of data, and manuscript writing & drafting.

Has given final approval of the version to be published.

Agrees to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Author 2

Substantial contributions to concept and study design.

Data analysis, manuscript writing, and critical review. Has given final approval of the version to be published.

Agrees to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Author 3

Substantial contributions to acquisition of data, analysis, and interpretation of data, and manuscript writing & drafting

Agrees to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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