INSIGHTS-JOURNAL OF
LIFE AND SOCIAL SCIENCES

INSIGHTS-JLSS
Insights-Journal of Life and Social Sciences

COMPARATIVE STUDY OF HEARING ASSESSMENT IN NORMAL AND HIGH RISK INFANTS BY NEWBORN HEARING SCREENING

Original Article

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Conflict of Interest: None

Grant Support & Financial Support: None

ABSTRACT

Background: Early identification of hearing impairment in neonates is essential for timely intervention, which can profoundly affect speech, language, and cognitive development. High-risk infants are more susceptible to hearing loss due to factors like prematurity, low birth weight, and exposure to ototoxic medications. This study aims to assess hearing outcomes in normal and high-risk infants using newborn hearing screening methods, promoting early detection and intervention to enhance developmental outcomes.

Objective: To compare the incidence and screening outcomes of hearing assessments in normal and high-risk infants using Otoacoustic Emissions (OAE) and Auditory Brainstem Response (ABR) tests and evaluate their effectiveness in identifying hearing impairment.

Methods: This comparative case-control study was conducted at Superior University, Lahore, with data collected from Hameed Latif Hospital, Lahore. A sample of 292 infants, including normal and high-risk groups, was calculated based on a 95% confidence interval. Newborns underwent OAE screening within the first 24 hours of life, with follow-up screenings at one and two months if the initial result was "refer." Infants who failed both OAE screenings were subsequently evaluated with ABR testing for diagnostic confirmation of hearing impairment.

Results: The study found a significantly higher incidence of hearing impairment in high-risk infants, with 63.1% (94/149) of high-risk infants referred after the first OAE test compared to 32.2% (46/143) of normal infants. In the second screening, 62.5% of high-risk infants were referred, whereas the normal group showed a refer rate of only 22.4%. Final ABR testing confirmed hearing impairment, showing the OAE and ABR combined protocol to be effective in early detection and confirmation, with notable improvements in developmental outcomes for infants receiving early intervention.

Conclusion: Newborn hearing screening is crucial for the early detection of hearing impairment, particularly in high-risk infants. A protocol combining OAE and ABR testing offers a reliable method for identifying infants who require early intervention, thereby preventing delays in treatment and supporting optimal developmental outcomes. Universal newborn hearing screening programs are recommended to ensure timely identification and intervention for hearing loss.

Keywords: Auditory Brainstem Response, Hearing Impairment, High-Risk Infants, Infant, Newborn, Newborn Hearing Screening, Otoacoustic Emissions.

INTRODUCTION

Hearing is an essential human sense that plays a critical role in a child's early development, particularly in language and speech acquisition. Auditory stimuli that children encounter contribute significantly to their ability to communicate, engage socially, and maintain a quality of life that supports growth and development. Early exposure to sounds helps infants interact, laugh, play, and develop the necessary foundations for language acquisition (1). Conversely, hearing impairments can result in delayed speech and language development in children, making early detection and intervention crucial for neonates who are at risk of hearing impairment. Pediatricians play an essential role in identifying infants who may be at risk of hearing deficits, enabling timely diagnosis and intervention that can facilitate normal language development (2).

Hearing impairment is globally prevalent. According to the United Nations' World Health Organization (WHO), around 3% of the global population experiences significant hearing impairment, defined as hearing loss of 40 dB or more in the better ear for adults and 30 dB or more in children (3). Congenital hearing loss, particularly prevalent in regions like South Asia, the Asia-Pacific, and Sub-Saharan Africa, affects neonates at an estimated incidence rate of 1.3 to 5.7 per 1,000 live births. Common causes include maternal diabetes, high blood pressure during late pregnancy, low birth weight, jaundice, anoxia, and hypoxia (5,6).

Congenital hearing loss, present from birth, stems from the ear's impaired ability to convert mechanical sound vibrations into electrical impulses. The type of hearing loss varies by the lesion's site. Conductive hearing loss occurs when the outer or middle ear is affected, obstructing sound waves' travel into the ear. Sensorineural hearing loss results from issues in the inner ear or auditory pathways, which may involve damage to outer hair cells or the auditory nerve, a condition known as auditory neuropathy. Mixed hearing loss encompasses both conductive and sensorineural characteristics (7,8). Visual observation is insufficient for detecting hearing impairment; thus, specialized screening and diagnostic assessments are essential. Early detection through newborn hearing screening is vital for preventing speech and language development delays (9). Newborn hearing screening programs have been widely implemented globally to enable early detection and intervention, thereby mitigating the adverse effects of undiagnosed hearing loss on children's language, cognitive skills, and social development (10). Such programs often follow the 1-3-6 guideline: screening by one month of age, diagnostic evaluation by three months, and initiation of treatment by six months, if needed (11). In Pakistan, where hearing impairment is a common health issue, detection is often delayed until 19 to 24 months of age, unlike developed regions where it is more common to identify hearing impairments within the first six months (12).

Clinically, two primary methods are used for hearing assessment in neonates: otoacoustic emissions (OAE) and auditory brainstem response (ABR) audiometry. OAE testing, which includes transient evoked otoacoustic emissions (TEOAEs) and distortion product emissions, is a rapid screening method. A probe with a microphone is placed in the infant's ear canal to deliver stimuli (clicks or tone bursts), eliciting responses from the cochlear hair cells. The result is indicated as "pass" if normal and "refer" if potential hearing impairment is detected, possibly due to fluid, vernix, or other obstructions in the ear. Ideally, OAE should be performed before hospital discharge or within 72 hours after birth. If the initial screening is unsuccessful, a follow-up is conducted after one month. If the subsequent screening is normal, hearing is deemed normal; if not, ABR testing is recommended for further diagnosis and management (13). The objective of this study is to conduct a comparative analysis of hearing assessment outcomes in normal and high-risk infants using newborn hearing screening, underscoring the importance of early detection for effective intervention and improved developmental outcomes.

METHODS

This study employed a comparative case-control design to assess hearing in normal and high-risk infants. Conducted at Superior University within the Department of Rehabilitative Sciences, data were gathered from Hameed Latif Hospital in Lahore, adhering to a sample size of 292, determined by a 95% confidence interval. The calculation followed the formula n=z2(1−d/2)pq/d2n = z^2 (1 - d/2) pq / d^2n=z2(1−d/2)pq/d2, ensuring a statistically robust sample size. A non-probability convenient sampling technique was used to select participants, and the study spanned 6 to 12 months following the approval of the research synopsis. The inclusion criteria allowed for the participation of all newborns, regardless of gender, while newborns with congenital anomalies such as anotia, microtia, atresia, or stenosis of the external canal were excluded to prevent confounding factors in the assessment of hearing.

Upon obtaining ethical clearance, a formal permission letter was addressed to the institutional head overseeing data collection. Once institutional consent was secured, the researcher approached subjects who met the inclusion criteria, contacting them and obtaining

parental consent. Parents were informed about the purpose of the study, and their written consent was collected prior to data collection. General information, including the neonate's name, age, and relevant medical and audiological history, was recorded as part of the initial assessment. The data collection process began with otoscopy, followed by a transient evoked otoacoustic emission (TEOAE) test within the first 24 hours post-birth. In cases where the initial screening showed a "refer" result, indicating potential hearing impairment, follow-up screenings were conducted in an outpatient setting at one and two months of age. This sequence allowed for comprehensive comparative analysis between normal and high-risk neonates by examining the results across all screening stages.

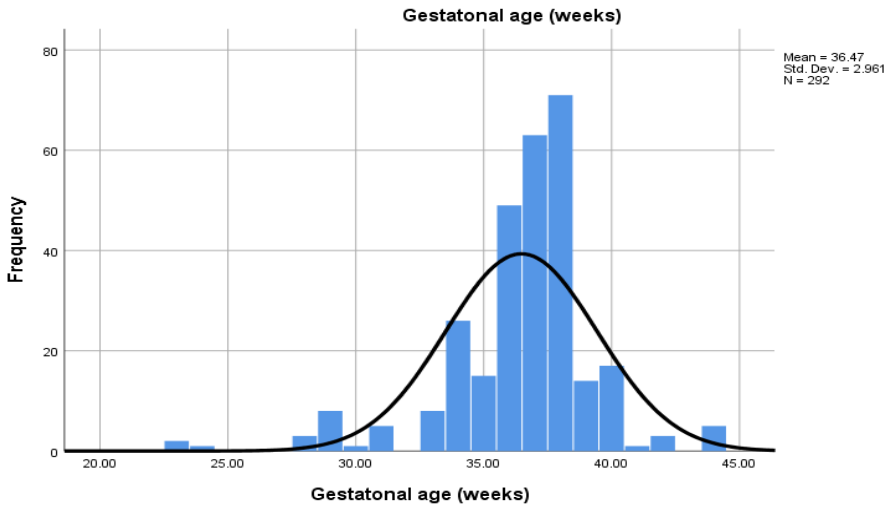
An otoacoustic emission (OAE) machine served as the primary tool for hearing assessment. A pre-designed questionnaire complemented the OAE, facilitating the systematic collection of data relevant to each participant's hearing status and any associated risk factors (32). Initial OAE screening was conducted within the first 24 hours of life, with follow-up screenings scheduled at one and two months for infants with a "refer" result on the initial test. The cumulative results were compared to ascertain the incidence of hearing impairment among study groups, delineating the differences in hearing outcomes between risk and non-risk infants. Data analysis was conducted using SPSS Version 21.0. The results for qualitative variables were measured using frequency and percentage, while quantitative data were summarized using mean and standard deviation. Statistical tests were applied to assess the differences in hearing outcomes between the risk and non-risk groups, with significance set at a level of $p \leq 0.05p \leq 0.05p \leq 0.05$, ensuring that findings were statistically meaningful.

RESULTS

The results of this study provide a detailed analysis of gestational age, gender distribution, and hearing screening outcomes across multiple assessment stages among a sample of 292 infants. The average gestational age was calculated as 36.47 weeks with a standard deviation of 2.96 weeks, showing a moderate variation around the mean. The gestational ages in this population ranged widely from a minimum of 23 weeks to a maximum of 44 weeks, reflecting a diverse group in terms of gestational development.

Table 1: Statistics of gestational age

Statistics of Gestational age (weeks)	
N	292
Mean	36.4726
Std. Deviation	2.96067
Minimum	23.00
Maximum	44.00



In terms of gender distribution, 60.6% (177 infants) of the sample were male, while 39.4% (115 infants) were female. This distribution indicates a predominance of male participants within the study cohort, although both genders were well-represented. The primary outcome measure involved the Otoacoustic Emission (OAE) screening tests conducted in three sequential rounds to identify potential hearing impairment. In the first round of screening, all 292 infants underwent OAE assessment. Among the normal-risk group, 67.8% (97 infants) achieved a "pass" result, while 32.2% (46 infants) were "referred" for further evaluation. The high-risk group exhibited a lower pass rate, with only 36.9% (55 infants) passing the test, whereas 63.1% (94 infants) were referred. These results highlighted a clear disparity in initial hearing outcomes between normal and high-risk infants. The second OAE screening was conducted for 140 infants who had shown a refer result in the initial test. In this phase, the normal-risk group demonstrated a pass rate of 77.6% (59 infants) and a refer rate of 22.4% (17 infants), suggesting a high success rate upon re-evaluation. However, the high-risk group had a considerably lower pass rate, with only 37.5% (24 infants) passing and 62.5% (40 infants) referred, indicating a persistent risk of hearing impairment among high-risk infants.

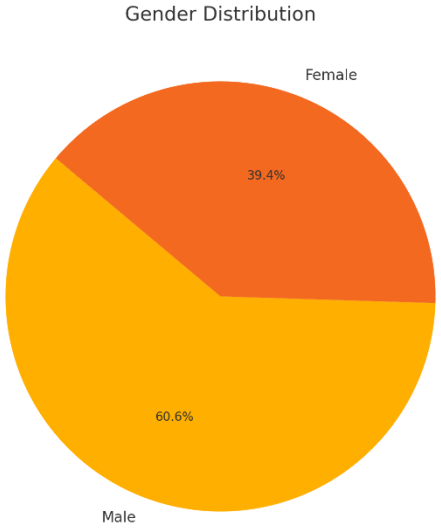


Table 2: Cross Tabulation

First OAEs	Normal	High Risk	Total
Pass	97	55	152
Refer	46	94	140
Total	143	149	292
2nd OAEs			
Pass	59	24	83
Refer	17	40	57
Total	76	64	140
3rd OAES			
Pass	19	13	32
Refer	9	16	25
Total	28	29	57

In the third and final OAE screening, conducted for 57 infants who remained under review, results continued to reflect differential outcomes. In the normal-risk group, the pass rate further decreased to 67.9% (19 infants), with a refer rate of 32.1% (9 infants). In contrast, the high-risk group showed a slight improvement, achieving a pass rate of 44.8% (13 infants) compared to a refer rate of 55.2% (16 infants). This final round confirmed that high-risk infants had consistently higher rates of hearing impairment, with fewer infants achieving a "pass" status across sequential screenings compared to their normal-risk counterparts.

DISCUSSION

The findings of this study underscore the critical importance of newborn hearing screening in identifying hearing impairment early, especially among high-risk infants. Results revealed that high-risk infants exhibited a significantly higher prevalence of hearing impairment compared to their normal-risk counterparts, aligning with previous studies that have demonstrated similar trends. Research by Falerina in 2023 observed increased hearing impairment among high-risk infants, with follow-up screenings showing a reduced need for referrals, reinforcing the benefit of continued monitoring (33). This study supports the existing literature by highlighting risk factors like low birth weight, prematurity, and exposure to ototoxic medications as major contributors to hearing loss in infants (34).

The application of Otoacoustic Emissions (OAE) and Auditory Brainstem Response (ABR) testing proved effective in screening and diagnosing hearing impairments, with OAE offering a reliable, non-invasive, and efficient initial assessment tool and ABR serving as a confirmatory method for those requiring further evaluation (35). The substantial referral rate in the high-risk group indicates the necessity of universal newborn hearing screening, aligning with the "1-3-6" guideline that emphasizes screening by one month, diagnosis by three months, and intervention by six months. Early detection facilitates timely intervention, essential in preventing delays in speech, language, and cognitive development. The study advocates for the integration of universal screening, particularly for high-risk populations, to enhance early diagnosis and treatment rates, ultimately allowing for interventions such as hearing aids or cochlear implants that can significantly mitigate developmental impacts (36). This study contributes to the body of research by reinforcing the effectiveness of a dual-tiered screening process that employs both OAE and ABR testing. This approach not only minimizes the likelihood of false positives but also ensures a thorough follow-up for infants needing further examination. It emphasizes that clinicians must consider factors like vernix or middle ear effusion, which can interfere with OAE outcomes, and should interpret results within a broader clinical context (37).

Compared to prior research, this study substantiates the heightened incidence of hearing impairment in high-risk infants and validates the role of OAE and ABR as complementary screening methods. Research consistently indicates that high-risk infants, particularly those admitted to Neonatal Intensive Care Units (NICUs), are more likely to experience hearing loss, supporting the need for focused screening protocols in these populations. This study further enriches the understanding of newborn hearing screening efficacy by offering a detailed comparison between normal and high-risk infants within a specified cohort, emphasizing the need for evidence-based screening practices tailored to infants with elevated risk profiles (38). Strengths of this study include its large sample size and the use of a standardized screening protocol, enhancing the reliability and applicability of findings. However, limitations exist, including potential biases due to the non-randomized sampling technique and the exclusion of certain demographic variables that might influence hearing outcomes. Additionally, factors like the availability of equipment, screening environment, and follow-up adherence could impact results and should be considered when interpreting outcomes. Despite these limitations, this research reinforces the utility of newborn hearing screening and provides strong evidence supporting the early identification and management of hearing impairment in high-risk infant populations, offering implications for healthcare policy and practice.

CONCLUSION

In summary, this study highlights the essential role of newborn hearing screening in the early detection of hearing loss, especially among high-risk infants. The integrated use of OAE and ABR screening methods provides a comprehensive approach to identifying hearing impairments, facilitating timely interventions that can greatly enhance developmental outcomes in affected infants. The findings underscore the importance of implementing universal hearing screening programs, ensuring that all infants benefit from early detection and intervention, thereby supporting healthier developmental trajectories and improved quality of life for those at risk of hearing impairment.

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