



Research Article

Association of Maternal Factors with Hearing Loss in Newborns Assessed by Otoacoustic Emission: A Prospective Observational Study.

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Abstract: **Introduction:** Hearing loss in newborns significantly affects speech, language, and cognitive development. Early detection using Otoacoustic Emission (OAE) plays a crucial role in timely intervention. **Objective:** To evaluate the association between maternal factors and hearing loss in newborns using OAE screening. **Methods:** A prospective observational study was conducted on 1000 newborns at a tertiary care center from April 2023 to July 2024. OAE screening was performed within 1–3 days of birth. Maternal factors including age, parity, BMI, medical history, and mode of delivery were analyzed. **Results:** Out of 1000 newborns, 4 (0.4%) failed the first OAE test. A statistically significant association was observed between mode of delivery and OAE failure ($p = 0.018$), with higher failure in cesarean section deliveries. No significant association was found with maternal age, parity, socio-economic status, or medical conditions. **Conclusion:** Mode of delivery is a significant maternal factor influencing initial OAE results. Universal newborn hearing screening remains essential for early detection and intervention.

Keywords: Otoacoustic emission, newborn hearing screening, maternal factors, neonatal hearing loss, cesarean section

INTRODUCTION

Scrotal emergencies represent a critical group of Hearing is a fundamental sensory modality essential for the development of speech, language, communication, and cognitive abilities in children. Early auditory input plays a critical role during the first few years of life, often referred to as the “critical period” for language acquisition. Any disruption in auditory function during this period may lead to delayed speech development, poor academic performance, and long-term social and psychological consequences [1].

Permanent childhood hearing impairment (PCHI) is defined as a bilateral hearing loss of ≥ 40 dB HL in the

better ear and affects approximately 0.5–5 per 1000 live births globally, with higher prevalence reported in

developing countries [2,3]. In India, the burden of neonatal hearing loss remains significant due to limited awareness, inadequate screening coverage, and high prevalence of risk factors such as maternal infections, low birth weight, and perinatal complications [4].

To address this issue, Universal Newborn Hearing Screening (UNHS) has been recommended by the American Academy of Pediatrics and the Joint Committee on Infant Hearing since 1999, advocating screening of all newborns before hospital discharge [5,6]. The goal is to ensure identification of hearing loss

by 3 months of age and initiation of intervention by 6 months, thereby improving language and cognitive outcomes [7].

Among available screening modalities, Otoacoustic Emission (OAE) testing is widely used due to its non-invasive, rapid, cost-effective, and objective nature. OAEs are low-intensity sounds generated by the outer hair cells of the cochlea in response to acoustic stimulation, reflecting cochlear integrity [8,9]. However, OAE results can be influenced by transient factors such as vernix in the ear canal, middle ear fluid, and perinatal physiological changes.

Several maternal and perinatal factors have been implicated in neonatal hearing impairment. These include maternal age, infections during pregnancy (e.g., cytomegalovirus, rubella), metabolic conditions such as diabetes and anemia, drug exposure, and obstetric factors like mode of delivery [10,11]. Notably, cesarean section has been associated with higher initial OAE failure rates, possibly due to delayed clearance of middle ear fluid [12].

Despite multiple studies, the association between maternal factors and neonatal hearing outcomes remains inconsistent, particularly in the Indian population. Therefore, this study aims to evaluate the relationship between maternal factors and hearing loss in newborns assessed using OAE screening, thereby contributing to improved screening strategies and early intervention policies.

RESULTS

In our study 545 individuals were identified as being 2 days old. This indicates that more than half of the sample falls into this age category. In contrast, a slightly smaller proportion of the sample, comprising 455 individuals, were observed to be 3 days old. 502 were identified as female, making up 50.2% of the sample population.

Table 1: Demographic Characteristics of Newborns

Variable	Category	Frequency	Percentage
Age (days)	2 days	545	54.5%
	3 days	455	45.5%
Sex	Male	498	49.8%
	Female	502	50.2%

Table 2: Birth Parameters

In contrast, 445 individuals were observed to have a height greater than 50 centimetres, accounting for 44.5% of the sample. The findings indicated that 346 individuals had a weight of less than or equal to 2.5 kg, representing 34.6% of the total sample. The mean weight of the individuals was calculated to be 2.8 kg, with a standard deviation of 0.34 kg.

Parameter	Category	Frequency	Percentage
Weight	≤2.5 kg	346	34.6%
	>2.5 kg	654	65.4%
Length	≤50 cm	555	55.5%
	>50 cm	445	44.5%

The data showed that 103 individuals had an APGAR score of 8, representing 10.3% of the sample. A larger proportion, consisting of 331 individuals, had an APGAR score of 9, making up 33.1% of the total sample. The mean APGAR score was found to be 9.46 with a standard deviation of 0.674

MATERIALS AND METHODS

Study Design- Prospective observational study

Study Setting- Department of Otorhinolaryngology, tertiary care hospital, Raigarh, India

Sample Size- 1000 newborns

Inclusion Criteria

- Full-term newborns
- Institutional deliveries

Exclusion Criteria

- Preterm neonates
- Congenital anomalies
- NICU admissions
- Syndromic babies

Procedure

OAE performed within 1–3 days of birth

Fail cases re-evaluated

Maternal history recorded

Statistical Analysis

Chi-square test

$p < 0.05$ considered significant

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Table 3: Maternal Characteristics

The data revealed that a significant majority of the sample, specifically 735 individuals, were younger than 30 years old. Conversely, 265 individuals were aged 30 years or older, accounting for 26.5% of the sample. The mean age of the individuals was calculated to be 24.2 years, with a standard deviation of 4.00 years. The majority, accounting for 54.5%, had a normal Body Mass Index (BMI) ranging from 18.5 to 24.9 kg/m². The average BMI for the group was 24.7 kg/m², with a standard deviation of 3.0 kg/m².

Variable	Category	Frequency	Percentage
Age	<30 years	735	73.5%
	≥30 years	265	26.5%
BMI	Normal	545	54.5%
	Overweight	390	39%
	Obese	65	6.5%

Table 4: Mode of Delivery vs OAE Outcome

Normal delivery, representing 75.6% of the total sample. On the other hand, 244 deliveries were carried out via C-section, accounting for 24.4% of the sample. This distribution underscores the predominance of normal deliveries.

Mode of Delivery	Fail	Pass	Total
C-section	3	241	244
Normal	1	755	756

Chi-square = 5.574, p = 0.018 (Significant)

Maternal Medical Conditions

The highest proportion of mothers reported having no medical issues (Nil), accounting for 310 cases (31.0%). This was followed by anaemia, which affected 300 mothers (30.0%), making it the most common medical condition observed.

Hyperemesis (excessive vomiting during pregnancy) was reported by 198 mothers (19.8%), and sickling was noted in 119 cases (11.9%). Hypertensive disorders of pregnancy were less common, reported by 70 mothers (7.0%). The least common condition was gestational diabetes mellitus, with only 3 cases (0.3%).

The chart highlights the significant prevalence of anaemia and hyperemesis among pregnant women in the study, as well as the relatively low occurrence of more serious metabolic conditions like gestational diabetes.

- **Anaemia (30%)**
- **Hyperemesis (19.8%)**
- **Sickling (11.9%)**

DISCUSSION

This study evaluated the association between maternal factors and neonatal hearing outcomes using Otoacoustic Emission screening in a cohort of 1000 newborns.

The overall failure rate of the first OAE test in this study was 0.4%, which is relatively low compared to previously reported rates ranging from 1% to 10% [13]. This variation may be attributed to differences in study populations, timing of screening, and exclusion of high-risk neonates in the present study.

A key finding of this study is the statistically significant association between mode of delivery and OAE outcomes (p = 0.018). Newborns delivered via cesarean section demonstrated a higher rate of OAE failure compared to those delivered vaginally. This finding is

consistent with studies by Xiao et al. and Smolkin et al., who reported significantly higher failure rates among cesarean-delivered infants [14,15]. The probable explanation lies in the retention of amniotic fluid in the middle ear cavity due to the absence of thoracic compression during cesarean delivery, which normally facilitates fluid clearance during vaginal birth.

However, some studies, such as those by Al-Balas et al., have reported contradictory findings, indicating higher failure rates in vaginal deliveries [16]. These discrepancies highlight the multifactorial nature of neonatal hearing screening outcomes and suggest that environmental and procedural factors may also play a role.

In the present study, maternal age did not show a significant association with neonatal hearing outcomes.

This aligns with findings from Bener et al. and Al-Balas et al., who also reported no significant correlation between maternal age and OAE results [16,17]. Although advanced maternal age has been linked to adverse perinatal outcomes, its direct impact on neonatal hearing remains inconclusive.

Similarly, parity and socio-economic status were not significant

ly associated with OAE outcomes. These findings suggest that demographic factors alone may not be strong predictors of neonatal hearing impairment in low-risk populations.

Maternal medical conditions such as anemia, hypertensive disorders, and hyperemesis were prevalent in the study population; however, none demonstrated a statistically significant association with OAE failure. This is consistent with findings by Karaca et al., who reported no significant relationship between maternal systemic conditions and hearing screening outcomes [18]. Nevertheless, other studies have identified conditions such as gestational diabetes, infections, and ototoxic drug exposure as potential risk factors [19].

Interestingly, low birth weight (<2.5 kg), although commonly considered a risk factor, did not show a significant association in this study. This contrasts with studies by Olusanya et al., which identified low birth weight as a significant predictor of hearing loss [20]. The discrepancy may be due to the exclusion of high-risk neonates and NICU admissions in the present study.

The findings emphasize that initial OAE failure does not necessarily indicate permanent hearing loss, as transient conductive factors may influence results. Therefore, adherence to a two-step or three-step screening protocol (OAE followed by repeat OAE or ABR) is essential to reduce false positives and ensure accurate diagnosis.

Strengths of the Study

- Large sample size (n = 1000)
- Prospective design
- Focus on maternal factors in a low-risk population

Limitations

- Single-center study
- Exclusion of high-risk neonates
- Lack of long-term follow-up with ABR confirmation
- Possible recall bias in maternal history

CONCLUSION

- OAE is an effective screening tool for neonatal hearing loss
- Mode of delivery significantly affects initial OAE outcomes
- No association found with maternal age, parity, or medical history

- Universal screening is essential for early intervention

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