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Comparison of hearing impairment in neonates born to mothers with presentational diabetes and gestational diabetes: A prospective observational study

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Abstract:
Maternal diabetes may adversely affect fetal auditory development, but the comparative risk of neonatal hearing impairment between pregestational and gestational diabetes remains inadequately defined. Therefore, it is of interest to evaluate the hearing outcomes in 50 neonates born to mothers with pregestational diabetes 18 or gestational diabetes 32 using otoacoustic emission screening followed by brainstem evoked response audiometry for abnormal screening results. Neonates of mothers with pregestational diabetes showed a higher frequency of abnormal otoacoustic emission findings and confirmed hearing impairment on brainstem evoked response audiometry, with a significant association between maternal diabetic status and neonatal hearing outcomes ($p < 0.05$). Prolonged maternal hyperglycemia before conception was associated with a greater risk of neonatal auditory dysfunction than diabetes developing during pregnancy. Thus, data shows the importance of optimal maternal glycemic control and targeted neonatal hearing screening to facilitate early detection and intervention for hearing impairment.

Keywords: Gestational diabetes mellitus (GDM), pregestational diabetes, neonatal hearing loss, otoacoustic emission (OAE), brainstem evoked response audiometry, maternal hyperglycemia

Background:
Hearing plays a fundamental role in speech acquisition, language development, cognitive growth and social interaction during infancy and childhood. Congenital hearing loss remains one of the most common sensory impairments worldwide, affecting approximately 1–3 per 1000 live births, with higher prevalence among neonates possessing identifiable risk factors **[1]**. Early detection and intervention significantly improve language development and educational outcomes, making newborn hearing screening programs an essential component of neonatal healthcare. Maternal metabolic disorders have increasingly been recognized as important contributors to adverse neonatal outcomes, including hearing dysfunction **[2]**. Diabetes mellitus during pregnancy represents one of the most prevalent endocrine disorders affecting pregnant women globally. Maternal diabetes may exist as pregestational diabetes, including type 1 or type 2 diabetes diagnosed before conception, or gestational diabetes mellitus (GDM), which develops during pregnancy due to increasing insulin resistance **[3]**. The prevalence of GDM has risen considerably owing to increasing maternal age, obesity, sedentary lifestyle and changing dietary patterns. Recent epidemiological studies estimate that nearly 14–18% of pregnancies worldwide are complicated by some form of hyperglycemia **[4]**. Maternal hyperglycemia influences fetal development through several mechanisms including oxidative stress, chronic inflammation, vascular dysfunction and altered placental transport of nutrients. Persistent exposure to elevated glucose levels during embryogenesis may interfere with organogenesis and neural maturation **[5]**. The developing auditory system is particularly vulnerable because cochlear structures and auditory neural pathways undergo critical stages of differentiation during fetal life. Hyperglycemia-induced microangiopathy and oxidative damage may impair cochlear hair cell development, spiral ganglion maturation and auditory brainstem pathway formation **[6]**. Several studies have showed associations between maternal diabetes and neonatal complications such as macrosomia, neonatal hypoglycemia, respiratory distress syndrome, hyperbilirubinemia and congenital malformations **[7]**. However, comparatively fewer investigations have focused on auditory outcomes among infants of diabetic mothers. Recent research utilizing otoacoustic emissions (OAE) and auditory brainstem response (ABR/BERA) testing has suggested higher rates of hearing screening failure among neonates born to diabetic mothers **[8]**. Pregestational diabetes is believed to carry greater fetal risk than gestational diabetes because fetal exposure to hyperglycemia begins during the earliest stages of organ development. In contrast, gestational diabetes typically develops after the first trimester when major organogenesis has already occurred **[9]**. Consequently, neonates born to mothers with pregestational diabetes may demonstrate a higher incidence of auditory dysfunction compared with those born to mothers with gestational diabetes **[10]**. Universal newborn hearing screening programs commonly employ OAE as an initial screening tool due to its simplicity, rapidity and non-invasive nature. Neonates who fail OAE screening undergo confirmatory evaluation with Brainstem Evoked Response Audiometry (BERA), which assesses auditory pathway integrity and hearing thresholds. These techniques permit early identification of congenital hearing deficits and facilitate timely intervention **[11]**. Although recent literature suggests a relationship between maternal diabetes and neonatal hearing impairment, comparative data between diabetic and non-diabetic pregnancies using objective neonatal hearing screening remain limited in Indian populations **[12, 13]**. Therefore, it is of interest to compare hearing impairment among neonates born to mothers with pregestational diabetes and gestational diabetes using OAE and BERA screening methods and to evaluate the influence of maternal diabetic status on neonatal auditory outcomes.

Materials and Methods:

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The present prospective observational study was conducted in the Departments of Pediatrics, Obstetrics and Gynecology and ENT at Atal Bihari Vajpayee Government Medical College, Vidisha and Madhya Pradesh. The study was carried out over a period of four months from March 2025 to June 2025 after obtaining institutional ethical committee approval and informed parental consent. A total of 50 neonates born to mothers with documented diabetes mellitus during pregnancy were included in the study. The mothers were categorized into two groups:

[1] Pregestational diabetes group: 18 mothers
[2] Gestational diabetes group: 32 mothers

Inclusion criteria:

[1] Neonates born to mothers with documented pregestational or gestational diabetes mellitus.

Exclusion criteria:

[1] Neonates with congenital anomalies or syndromic disorders.
[2] Birth asphyxia.
[3] Maternal exposure to ototoxic drugs or radiation.
[4] Maternal TORCH infections or systemic illnesses receiving steroid therapy.

Screening methodology for maternal diabetes:

Gestational diabetes mellitus was diagnosed using Oral Glucose Tolerance Test (OGTT) and/or Glycated Hemoglobin (HbA1c) according to standard obstetric guidelines. Pregestational diabetes was confirmed in mothers with documented diabetes mellitus before conception and elevated HbA1c levels.

Hearing assessment protocol:

All neonates underwent initial hearing screenings using Otoacoustic Emission (OAE) testing within the neonatal period.
OAE results were classified as:

[1] Pass
[2] Refer

Neonates with OAE refer status underwent Brainstem Evoked Response Audiometry (BERA).
Hearing loss was defined as:

[1] BERA threshold >25 dB HL in one or both ears, or
[2] Abnormal auditory waveform morphology, predominantly involving Wave V abnormalities.

Statistical analysis:

Data were entered into Microsoft Excel and analyzed using SPSS version 26.0. Chi-square test was applied to compare categorical variables between groups. A p-value <0.05 was considered statistically significant.

Results:

A total of 50 neonates born to diabetic mothers were evaluated. The majority of mothers included in the study had gestational diabetes mellitus (64%), while pregestational diabetes accounted for 36% of cases. This reflects the increasing prevalence of gestational diabetes among pregnant women attending tertiary healthcare institutions **(Table 1).** Among neonates born to mothers with pregestational diabetes, 44.4% showed OAE refer status compared to 15.6% among neonates born to mothers with gestational diabetes. The difference was statistically significant (p=0.026), indicating a higher prevalence of cochlear dysfunction in neonates exposed to maternal diabetes before conception **(Table 2).** BERA-confirmed hearing loss was observed in 33.3% of neonates born to mothers with pregestational diabetes compared with 6.2% among neonates born to mothers with gestational diabetes. The difference was statistically significant (p=0.013), suggesting that prolonged maternal hyperglycemia before pregnancy may adversely affect fetal auditory pathway development **(Table 3).**

Table 1: Distribution of study population

Maternal Diabetes Type	Number	Percentage
Pregestational Diabetes	18	36.0%
Gestational Diabetes	32	64.0%
Total	50	100%

Table 2: Comparison of OAE screening results among study groups

OAE Result	Pregestational Diabetes n (%) (n=18)	Gestational Diabetes n (%) (n=32)	Total (n=50)	p value
Pass	10 (55.6%)	27 (84.4%)	37 (74.0%)	
Refer	8 (44.4%)	5 (15.6%)	13 (26.0%)	
Total	**18 (100%)**	**32 (100%)**	**50 (100%)**	**0.026***

Chi-square = 4.92; p = 0.026 (Statistically Significant)

Table 3: Comparison of BERA-confirmed hearing loss among study groups

Hearing Status	Pregestational Diabetes n (%) (n=18)	Gestational Diabetes n (%) (n=32)	Total (n=50)	p value
Normal BERA	12 (66.7%)	30 (93.8%)	42 (84.0%)	
Hearing Loss	6 (33.3%)	2 (6.2%)	8 (16.0%)	
Total	**18 (100%)**	**32 (100%)**	**50 (100%)**	**0.013***

Chi-square = 6.14; p = 0.013 (Statistically Significant)

Discussion:

Maternal diabetes mellitus has emerged as one of the most common metabolic disorders complicating pregnancy and is increasingly recognized as a significant contributor to adverse neonatal outcomes. The effects of maternal hyperglycemia extend beyond metabolic disturbances and congenital malformations, influencing fetal neurodevelopment and sensory organ maturation. The present prospective observational study

compared hearing outcomes among neonates born to mothers with pregestational diabetes and gestational diabetes mellitus (GDM) and demonstrated significantly higher rates of abnormal OAE and BERA findings among neonates exposed to pregestational diabetes. The overall prevalence of BERA-confirmed hearing loss in the present study was 16%, which is considerably higher than that reported in healthy neonatal populations undergoing universal hearing screening. This finding supports the recommendation of the Joint Committee on Infant Hearing (JCIH), which identifies infants with specific perinatal risk factors as requiring closer audiological surveillance beyond routine newborn screening **[11]**. Furthermore, the World Report on Hearing emphasized the importance of early identification and intervention in neonatal hearing loss to prevent long-term deficits in language, communication and cognitive development **[10]**.The observed association between maternal diabetes and neonatal hearing impairment may be explained by several biological mechanisms. Maternal hyperglycemia is known to induce oxidative stress, endothelial dysfunction, chronic inflammation and placental vascular abnormalities, all of which may interfere with normal fetal organogenesis and neural maturation **[4, 9]**. Since the auditory system begins developing during early embryogenesis, prolonged exposure to elevated glucose levels may adversely affect cochlear hair cells, spiral ganglion neurons and auditory brainstem pathways. These mechanisms provide a plausible explanation for the higher incidence of hearing abnormalities observed among infants born to diabetic mothers. In the present study, 44.4% of neonates in the pregestational diabetes group showed OAE refer status compared with 15.6% in the gestational diabetes group. This difference was statistically significant, indicating that maternal diabetes existing before conception may exert a greater detrimental effect on fetal auditory development than diabetes diagnosed during pregnancy. Similar findings were reported by Zhou *et al.*, who showed a significant association between maternal gestational diabetes and abnormal neonatal hearing screening outcomes, suggesting that hyperglycemia may influence cochlear function during fetal development **[5]**. Likewise, Yıldız *et al.* reported higher hearing screening failure rates among neonates born to mothers with gestational diabetes compared with those born to non-diabetic mothers, reinforcing the importance of maternal metabolic status in determining neonatal auditory health **[6]**. The higher prevalence of abnormal OAE findings among neonates of mothers with pregestational diabetes observed in the present study may be attributed to the timing and duration of fetal exposure to hyperglycemia. In pregestational diabetes, elevated glucose levels are present during the earliest stages of embryogenesis when the cochlea and auditory neural pathways are undergoing critical differentiation. In contrast, gestational diabetes generally develops after the first trimester, when major organogenesis has largely been completed **[9]**. Consequently, fetuses exposed to pregestational diabetes may experience more profound structural and functional alterations within the auditory system. An important finding of the present study was that BERA-confirmed hearing loss occurred in 33.3% of neonates born to mothers with pregestational diabetes compared with only 6.2% among neonates born to mothers with gestational diabetes. These results are consistent with observations reported by Padmadasan *et al.*, who found a higher prevalence of hearing impairment among neonates of diabetic mothers and emphasized the importance of objective audiological assessment in this high-risk population **[8]**. These findings are further supported by Halder *et al.*, who reported hearing impairment in 8.9% of infants born to diabetic mothers and found a significantly higher prevalence among infants of mothers with pregestational diabetes than among those with gestational diabetes (19.5% vs 6.1%). They also observed a higher prevalence among infants of mothers with uncontrolled diabetes, highlighting the potential influence of both the type of maternal diabetes and glycemic control on neonatal auditory outcomes **[14].** Similarly, Amrutha *et al.* showed significantly increased auditory abnormalities among neonates born to diabetic mothers and proposed that prolonged fetal exposure to hyperglycemia may have neurotoxic effects on the developing auditory system **[1]**. Recent studies have further strengthened the evidence linking maternal diabetes and neonatal hearing dysfunction. Samanth *et al.* reported significant alterations in neonatal distortion product otoacoustic emissions among infants born to mothers with gestational diabetes and preeclampsia, suggesting subtle cochlear dysfunction even in clinically asymptomatic newborns **[7]**. Gopinath *et al.* also documented hearing abnormalities among infants of mothers with gestational diabetes and advocated routine audiological screening in this population **[12]**. More recently, Zhang *et al.* reported elevated hearing thresholds among high-risk children born to diabetic mothers, indicating that auditory deficits may persist beyond the neonatal period and potentially affect later developmental outcomes **[15]**. The findings of the present study are also supported by the systematic review conducted by Aggarwal and Ravi, which concluded that gestational diabetes mellitus is associated with increased neonatal hearing screening referral rates and may constitute an independent risk factor for congenital hearing impairment **[2]**. The authors highlighted the need for enhanced collaboration between obstetricians, neonatologists and otolaryngologists to ensure timely identification and management of affected infants. Another noteworthy observation in the present study was the difference between OAE referral rates and BERA-confirmed hearing loss. Although 13 neonates were referred after OAE screening, only 8 showed confirmed hearing impairment on BERA. Similar discrepancies have been reported in previous neonatal hearing screening programs and are generally attributed to transient middle-ear fluid, vernix obstruction, environmental noise, or technical factors affecting OAE recordings **[11, 16]**. This finding reinforces the importance of a two-stage screening protocol utilizing OAE followed by confirmatory BERA to improve diagnostic accuracy and reduce false-positive results. The strengths of the present study include its prospective design, use of objective audio logical assessment methods and direct comparison between pregestational and gestational diabetes. However, certain limitations should be acknowledged. The

sample size was relatively small, the study duration was limited and maternal glycemic control was not stratified according to HbA1c levels. Additionally, long-term follow-up of affected infants was not performed, limiting assessment of delayed-onset or progressive hearing loss. Despite these limitations, the present study provides important evidence indicating that maternal diabetes, particularly pregestational diabetes, is associated with a significantly increased risk of neonatal hearing impairment. These findings emphasize the importance of strict glycemic control before and during pregnancy, universal newborn hearing screening and continued audio logical surveillance among infants born to diabetic mothers. Early diagnosis and intervention remain essential to minimize the long-term consequences of hearing impairment on speech, language, educational achievement and overall quality of life.

Conclusion:

Neonates born to mothers with pregestational diabetes had significantly higher rates of abnormal otoacoustic emission findings and brainstem evoked response audiometry-confirmed hearing impairment than those born to mothers with gestational diabetes. Chronic maternal hyperglycemia before conception appears to have a greater adverse effect on fetal auditory development than diabetes developing during pregnancy. Thus, data support strict maternal glycemic control and early neonatal hearing screening to enable timely intervention and reduce the burden of congenital hearing impairment.

References:

[1] Amrutha P *et al. Indian J Otolaryngol Head Neck Surg.* 2024 **76**:1741. [PMID: 38566699]
[2] Aggarwal K & Ravi R. *Ann Otol Rhinol Laryngol.* 2025 **134**:87. [PMID: 39356544]
[3] Li X *et al. Int J Pediatr Otorhinolaryngol.* 2024 **184**:112056. [PMID: 39121684]
[4] Swaminathan G *et al. JAMA Netw Open.* 2020 **3**:e2025074. [PMID: 33165611]
[5] Zhou JH *et al. Diabetes Metab Syndr Obes.* 2021 **14**:2879. [PMID: 34234485]
[6] Yıldız EG *et al. J Matern Fetal Neonatal Med.* 2022 **35**:10152. [PMID: 36093841]
[7] Samanth R *et al. Ann Otol Rhinol Laryngol.* 2022 **131**:1. [PMID: 36200796]
[8] Padmadasan S *et al. Indian J Otolaryngol Head Neck Surg.* 2022 **74**:541. [PMID: 36032821]
[9] https://pubmed.ncbi.nlm.nih.gov/29370047/
[10] Chadha S *et al. Bull World Health Organ.* 2021 **99**:242. [PMID: 33953438]
[11] https://www.infanthearing.org/nhstc/docs/Year%202019%20JCIH%20Position%20Statement.pdf
[12] Gopinath S *et al. Bengal J Otolaryngol Head Neck Surg.* 2023 **31**:74. [DOI: 10.47210/bjohns.2023.v31i2.939]
[13] Chithra SC *et al. Int J Reprod Contracept Obstet Gynecol.* 2024 **13**:3102. [DOI: 10.18203/2320-1770.ijrcog20243158]
[14] Halder AL *et al. BIRDEM Med J.* 2026 **16**:52. [DOI: 10.3329/birdem.v16i2.91511]
[15] Zhang J *et al. Lin Chuang Er Bi Yan Hou Tou Jing Wai Ke Za Zhi.* 2025 **39**:202. [PMID: 40049633]
[16] Kumar GA *et al. Cureus.* 2024 **16**:e69521. [PMID: 39416529]

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