Original Article

Hearing impairment in infants of diabetic mothers: report from a tertiary care hospital in Bangladesh

Halder AL[a], Mollah AH[b], Baki MA [c], Khan S[d], Mohsin F [e], Nahar J [f], Ferdous F [g]

ABSTRACT

Background: *This study aimed to determine the prevalence of hearing impairment (HI) in infants of diabetic mothers (IDM) and to investigate its association with maternal diabetes type and maternal glycemic control.*

Methods: *In this prospective hospital-based observational cohort study, infants born to mothers with either pregestational diabetes (PGDM) or gestational diabetes (GDM) were classified as IDM. We screened 474 IDM over 1 year (January to December, 2021) for HI using Distortion Product Otoacoustic Emissions (DPOAE) in two steps. The first screening was conducted before the infants were 30 days old, and a second test was administered two weeks later for those who did not pass the initial screening. Infants who failed both DPOAE tests underwent further evaluation with Auditory Brainstem Response Audiometry (ABR) at three months to confirm the presence of HI. All the tests were performed in required ideal environment and with expert technician.*

Results: *After all the tests, 42 (8.9%) IDM were discovered as having HI. Among them 34 (81%) had unilateral and 8 (19%) had bilateral HI. The prevalence of HI was significantly higher (p < 0.00) in infants with pre-gestational diabetic mothers (19, 19.5%) than in GDM (23, 6.1%). Infants of mothers with uncontrolled (HbA1c >6.1%) blood glucose had a significantly higher rate (p 0.04) of HI than that of well-controlled diabetic mother (HbA1c <6.1%).*

Conclusion: *The prevalence of HI in IDM was 8.9% in our study. It was significantly higher in infants of mothers with pre-gestational diabetes and with uncontrolled blood sugar.*

Key words: *neonatal hearing screening, hearing impairment, infants of diabetic mother, maternal diabetes.*

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Author information

a. Amrita Lal Halder, Associate Professor, Department of Pediatrics and Neonatology, BIRDEM General Hospital (Women and Children), Dhaka, Bangladesh.

b. Md. Abid Hossain Mollah, Professor, Department of Pediatrics and Neonatology, BIRDEM General Hospital (Women and Children), Dhaka, Bangladesh.

c. Md. Abdul Baki, Associate Professor, Department of Pediatrics and Neonatology, BIRDEM General Hospital (Women and Children), Dhaka, Bangladesh.

d. Shareen Khan, Assistant Professor, Department of Pediatrics and Neonatology, BIRDEM General Hospital (Women and Children), Dhaka, Bangladesh.

e. Fauzia Mohsin, Professor, Department of Pediatrics and Department of Pediatric Endocrinology and Metabolism, BIRDEM General Hospital (Women and Children), Dhaka, Bangladesh.

f. Jebun Nahar, Professor, Department of Pediatrics and Pediatric Neurology, BIRDEM General Hospital (Women and Children), Dhaka, Bangladesh.

g. Fatheha Ferdous, Assistant Professor, Department of Gynecology and Obstetrics, BIRDEM General Hospital (Women and Children), Dhaka, Bangladesh.

Address of correspondence: Amrita Lal Halder, Associate Professor, Department of Pediatrics and Neonatology, BIRDEM General Hospital (Women and Children), Dhaka, Bangladesh. Email: amrita_antak@yahoo.com

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INTRODUCTION

Hearing is essential for speech and language development, communication, and learning, so hearing impairment (HI) in the infantile period can deleteriously affect a child's psychosocial, scholastic, and socio-emotional development. The Centers for Disease Control and Prevention (U.S.), CDC's Hearing Screening and Follow-up Survey (HSFS) estimates that the prevalence of hearing loss in 2020 was 1.8 per 1,000 babies screened for hearing loss.[1] In one study done in a tertiary care hospital in Bangladesh, 32.7% of neonates had HI in the first screening.[2] There are some well-accepted risk factors for HI, defined mainly by the Joint Committee on Infant Hearing (JCIH).[3] Although maternal diabetes (Type1, Type2, and Gestational) may cause congenital complications and malformations that also include HI, it is not generally considered a risk factor for HI. However, it is expected that these maternal metabolic disturbances will have the potential to adversely affect the newborn's overall health, including the development of the auditory system. According to the International Diabetes Federation (IDF) (2021) report, 21.1 million (16.7%) live births were affected by hyperglycemia due to pre-gestational and gestational diabetes mellitus (GDM).[4] Several conditions and complications common to diabetic pregnancy are also known risk factors for neonatal HI, which means infants of diabetic mothers (IDM) have to face numerous risk factors for HI.[5] Given the high risk of hearing impairment (HI) in infants of diabetic mothers (IDM), this study was designed to determine the prevalence of HI in IDM and to examine its association with the type of maternal diabetes and maternal glycemic control.

METHODS

This prospective hospital-based observational cohort included 474 infants of diabetic mothers (IDM) and was conducted from January 2021 to December 2021 at BIRDEM General Hospital, Dhaka. BIRDEM is a 600-bed tertiary care hospital specializing in diabetic care, with a dedicated 150-bed campus for women and children that provides comprehensive diabetic pregnancy and neonatal services. The high prevalence of diabetes among pregnant women in Bangladesh makes this setting particularly relevant for the study. Ethical approval was obtained from the institutional ethics committee, and written informed consent was secured from all parents, ensuring adherence to ethical research standards. An IDM was diagnosed if its mother was already known to have type 1, type 2, and other specific types of diabetes or found to have hyperglycemia at any point of the pregnancy period (GDM). For the screening for GDM, an oral glucose tolerance test (OGTT) with 75 gm oral glucose was done for all pregnant women at the first antenatal visit and/or between the 24th and 28th week of gestation and then again at 32–34 weeks if previous values were normal. The diagnosis was confirmed if it met the diagnostic criteria advocated by the International Association of the Diabetes and Pregnancy Study Groups (IADPSG)/WHO.[6] Fasting Blood Sugar(FBS); 5.1mmol/L or more and/or blood sugar 2 Hours After Glucose drink (2HAG); 8.5 mmol/L or more were considered GDM. HbA1c defined maternal glycemic control. According to the NICE guidelines for Diabetes in Pregnancy (Clinical Guideline 63), an HbA1c result of 6.1% or more was considered uncontrolled. [7]

All the IDM born in our hospital during the study period were evaluated for any risk factor for HI, like family history of hereditary childhood hearing loss, intrauterine infections (TORCHS), craniofacial anomalies, birth weight <1500 gram, APGAR scores of <4 at 1 min or <6 at 5 min, stigmata or other findings associated with a syndrome known to include sensorineural and/or conductive hearing loss. They were also followed up throughout the hospital course for developing any risk factor, like hyperbilirubinemia at a serum level requiring exchange transfusion, getting ototoxic medications, bacterial meningitis, and needing mechanical ventilation for more than 5 days. IDM who had multiple or moribund congenital anomalies or died before completion of hearing screening were excluded from the study.

A routine ear, nose, and throat (ENT) examination was done to inspect the pre- and post-aural regions and the pinna for any morphological abnormalities. An otoscopic examination of the external auditory canal and the tympanic membrane was done using Heine 3000 series Otoscope. Any vernix or fluid in the external ear canal was removed.

We used Distortion Product Otoacoustic Emissions (DPOAE) as a screening test for HI, as because, in one study, it was estimated that the DPOAE is a good screening test for neonatal hearing screening with high sensitivity (88.9%) and specificity (92.2%).[8] ABR (Auditory Brain-stem Response Audiometry) was used

to confirm HI. The machine used for the DPOAE and ABR test was a GSI AUDIOscreener, Part Number 2205-0100 Rev A, GrasonStadler, 7625 Golden Triangle Drive, suite F, Eden Prairie, MN55344, Made in Denmark. The first stage of screening was employed by the age of 30 days. The result of "Pass" or "Refer" was recorded. Here, "Pass" indicates normal functioning of outer hair cells up to the periphery, and "Refer" suggests the baby may have a HI; further test is warranted. After two weeks, a second DPOAE was done for those who failed to pass the first screening. A two steps screening procedure was applied to minimize the false positive cases. ABR was performed at three months to confirm the HI for those who failed to pass both DPOAE. Children with normal ABR were declared ecologically sound and no further evaluation was suggested. Infants proven to suffer substantial hearing impairment in one or both ears were referred to an ear, nose, and throat specialist for further evaluation and rehabilitation.

The study was conducted under the guidance of a full-time qualified audiologist, who was responsible for the design and implementation of the hearing screening process, a skilled doctor working in the neonatology department, who provided medical oversight and interpretation of the results, and an experienced audiology technician, who assisted in the technical aspects of the screening. Their collective expertise and knowledge in audiology and neonatology, along with the controlled environment in which the hearing screening was applied, ensured the accuracy and reliability of the study's findings.

Statistical analysis

The data collected were meticulously analyzed using SPSS software. The prevalence of HI was calculated for all IDM and separately for mothers with pre-gestational diabetes, GDM, and controlled and uncontrolled diabetes. The numerical data were expressed as percentages. The significance of the association was calculated using the Chi-square test, a widely accepted statistical method. We also calculated the known risk factors for HI in our population and their association with HI. A p-value of 0.05 was considered statistically significant.

RESULTS

A total of 474 IDM were screened for HI (1st DPOAE). Among them, 216 (45.6%) were males, and 258 (54.4%) were females. Gestational diabetes was predominant (377, 79.5%) over pre-gestational diabetes (97, 20.5%). Glycemic control during pregnancy was adequate in the majority of mothers, with 305 (64.3%) demonstrating HbA1c levels below 6.1%.

In IDM, the risk factors for hearing impairment observed in our study included low birth weight (<1500 g) in 96 infants (20.2%), low Apgar scores (<4 at 1 min or <6 at 5 min) in 31 infants (6.5%), hyperbilirubinemia requiring exchange transfusion in 34 infants (7.2%), exposure to ototoxic medications (aminoglycosides >5 days) in 152 infants (32.1%), and prolonged mechanical ventilation (>5 days) in 37 infants (7.8%) (Table I).

Of 474 IDM, 49 (10.3%) had abnormal DPOAE on 1st screening. 2nd DPOAE reevaluated this 49, and 43 (9.1%) failed the test. At ABR, 42 (8.9%) were discovered as having HI. Unilateral HI was found in 34 (81%) infant and that of bilateral in 8 (19%) infant. (Figure 1) Male infants (25, 60%) were more affected than females (17, 40%).

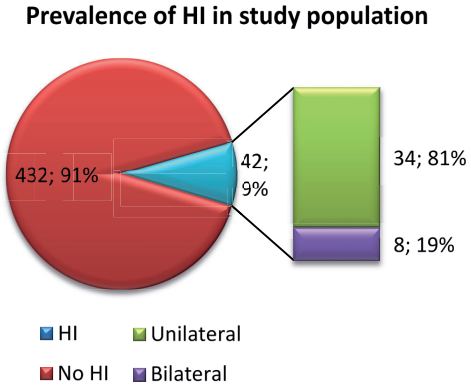

Figure 1. Prevalence of HI in the study population (N=474)

In our study, 168 (35.4%) IDM had at least one known risk factor for hearing impairment, with some infants having multiple risk factors. Among these 168 infants, 18 (10.7%) were diagnosed with hearing impairment. Of all the risk factors analyzed, only prolonged mechanical ventilation (>5 days) was significantly associated with hearing impairment (p = 0.02) (Table I).

The prevalence of HI was significantly higher (p 0.00) in infants with pre-gestational diabetic mothers (19, 19.5%) than in GDM (23, 6.1%). (Table II) Uncontrolled blood glucose (HbA1c >6.1%) during the pregnancy period is also alarming, as infants of uncontrolled diabetic mothers had a significantly higher rate (p 0.04) of HI than that of well-controlled diabetic mothers (HbA1c <6.1%). (Table II)

IDM, which had one or more known risk factors for HI (168), was the sufferer (18, 10.7%) in comparison with IDM, which had no risk factors (24, 7.8%). However, it is not statistically significant (p 0.29). (Table II)

Table I. Distribution of HI about the known risk factors

Risk factors	n	HI (%)	p-value
Birth weight <1500 grams	96	11 (11.4%)	0.31
APGAR (<4 at 1 or <6 at 5 min	31	4 (12.9%)	0.41
Hyperbilirubinemia	34	4 (11.7%)	0.53
Getting ototoxic medications	152	14 (9.2%)	0.85
Needing mechanical ventilation	37	7 (18.9%)	0.02

*One infant might have more than one risk factor.

Table II. Distribution of HI about the type of diabetes, the status of glucose control during the pregnancy period and the presence or absence of known risk factors in association with maternal diabetes (N=474)

Variables	n	HI (%)	p-value
Type of Diabetes			
Pre-gestational	97	19 (19.5%)	0.00
GDM	377	23 (6.1%)	
Status of Glucose control			
Uncontrolled (HbA1c >61%)	169	21 (12.4%)	0.04
Controlled (HbA1c<6.1%)	305	21 (6.9%)	
Infants of Diabetic Mother			
With known risk factors	168	18 (10.7%)	0.29
Without known risk factors	306	24 (7.8%)	

DISCUSSION

According to the CDC's Hearing Screening and Follow-up Survey (HSFS), the prevalence of HI among all babies screened for HI was only 0.18%.[1] But this number was manifoldly increased in our study, and the prevalence of HI in IDM was 8.9%. In another study, it was 4.16%.[9] So, it is evident that HI is much more common among the IDM. There are many studies in which diabetes in pregnancy is a statistically significant risk factor for the development of HI. [9, 10, 11]

In our study, the prevalence of HI was significantly higher (p 0.00) in infants with pre-gestational diabetic mothers than in GDM. Padmadasan et al. and Sharma et al. also found similar findings.[9, 12] This can be explained by the more prolonged exposure of the fetus to the more severe hyperglycemic environment in the case of pre-gestational diabetes, where the mother has hyperglycemia even before pregnancy. As the ear development will be completed by the second trimester, there is less chance of defective organogenesis in the case of GDM.

In our study, infants of uncontrolled diabetic mothers had a significantly high rate (p 0.04) of HI. Another study also concluded that there was a statistically significant association between diabetic control and neonatal HI.[9] Al Nemri et al., in their research, say that poor diabetes control during pregnancy is positively associated with increased perinatal morbidity and mortality.[13]

Low birth weight (<1500 grams), perinatal asphyxia, hyperbilirubinemia, ototoxic medications, and mechanical ventilation are well-defined risk factors.[3] We also found that these risk factors were prevalent in our study. It was also observed that needing mechanical ventilation for more than 5 days was significantly associated with HI (p 0.02). The same finding was also observed in one of our previous studies.[14]

IDM, which had one or more known risk factors for HI, suffered more (10.7%) than IDM, which had no risk factors (7.8%). The presence of risk factors in IDM may create an extra influence to destroy the hearing system. However, it is statistically insignificant (p 0.29), proving that only diabetes during pregnancy can rise to HI. Many other studies also observed the same findings.[9-11,15, 16] Lee JA et al. observed that the IDM were at significant risk for the development of HI (OR 1.66, 95%CI 1.28–2.17).[10] Maternal diabetes was identified as one of the potential risk factors for HI by Kountakis et al. [15] In a study by Angeli C. Carlos-Hiceta et al., it was found that the 'refer' result of a baby born to a diabetic mother is 2 times higher when compared with the results of a baby born to a nondiabetic mother.[16] This finding is similar to the observations of the present study. Some other studies also have opposite observations. [17, 18] A retrospective study by Fatih Mehmet Hanege et al. showed no difference between the hearing screening (OAE) results of infants born to healthy women and women with GDM.[17] In a prospective institutional-based study by Gangadhara K. S. et al., it was observed that six neonates born out of 44 GDM pregnancies failed the screening test. However, this result was not significant statistically when compared to the controls (p-value = 0.181).[18] Our present study was conducted in a single-center that did not represent the whole country. In addition to maternal diabetes, some known risk factors for HI were present in 35.4% of IDM. So, there might be confounding results. However, the difference was not statistically significant (p 0.29).

Conclusion

The prevalence of HI in IDM was 8.9% in our study. It was significantly higher in mothers with pre-gestational diabetes and with uncontrolled blood sugar.

Authors' contribution: ALH, AHM: Conceived and designed the study; ALH, MAB, SK, FM, JN, FF: Patient's management; ALH: Data collection; ALH, AHM, MAB, SK, FM, JN, FF: Analysis of the data; ALH, SK: Draft of manuscript; AHM, FM, MAB, JN, FF: Revision of manuscript; All authors approved the final manuscript.

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REFERENCES

1. CDC. Summary of Diagnostics Among Infants Not Passing Hearing Screening [Internet]. Centers for Disease Control and Prevention. 2022. Available from: https://www.cdc.gov/ncbddd/hearingloss/2020-data/06-diagnostics.html
2. Mannan M, Choudhury S, Dey A, Dey S, Naher B, Shahidullah M. Newborn hearing screening: what are we missing? Bangladesh Medical Research Council Bulletin. 2014 Sep 4;40(1):1–5.
3. Joint Committee on Infant Hearing. Year 2007 Position Statement: Principles and Guidelines for Early Hearing Detection and Intervention Programs. PEDIATRICS. 2007 Oct 1;120(4):898–921.
4. Magliano D, Boyko EJ. IDF Diabetes Atlas. International Diabetes Federation; 2021.
5. Ornoy A, Becker M, Weinstein-Fudim L, Ergaz Z. Diabetes during Pregnancy: A Maternal Disease Complicating the Course of Pregnancy with Long-Term Deleterious Effects on the Offspring. A Clinical Review. International Journal of Molecular Sciences [Internet]. 2021 Mar 15;22(6). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7999044/
6. International Association of Diabetes and Pregnancy Study Groups Consensus Panel; Metzger BE, Gabbe SG, Persson B, Buchanan TA, Catalano PA, Damm P, Dyer AR, Leiva Ad, Hod M, Kitzmiler JL, Lowe LP, McIntyre HD, Oats JJ, Omori Y, Schmidt MI. International association of diabetes and pregnancy study groups recommendations on the diagnosis and classification of hyperglycemia in pregnancy. Diabetes Care. 2010 Mar;33(3):676-82. doi: 10.2337/dc09-1848. PMID: 20190296; PMCID: PMC2827530.
7. National Institute for Health and Care Excellence (NICE). Diabetes in pregnancy: management from preconception to the postnatal period | Guidance | NICE [Internet]. Nice.org.uk. NICE; 2020. Available from: https://www.nice.org.uk/guidance/ng3
8. Halder A L, Mollah M A H, Baki M A, Khan S, Nahar J, Jasim S. The Sensitivity and Specificity of DPOAE (Distortion Product Otoacoustic Emission) Compared with ABR (Auditory Brain Stem Response Audiometry) in Neonatal Hearing Screening. Pediatr Oncall J. 2023;20: 48-50. doi: 10.7199/ped.oncall.2023.22
9. Shalu Padmadasan, Mathew M, Ravi Arodiyil. Prevalence of Hearing Impairment in Neonates of Mothers with Diabetes Mellitus: A Cross Sectional Study. Indian Journal of Otolaryngology and Head & Neck Surgery [Internet]. 2021 Jan 19 [cited 2024 Oct 24];74(S1):541–4. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC9411283/
10. Lee JA, Mehta CH, Nguyen SA, Meyer TA. Hearing outcomes in children of diabetic pregnancies. International

journal of pediatric otorhinolaryngology. 2020 May 1;132:109925–5.

11. A Selcuk, Terzi H, U Turkay, Kale A, S Genc. Does gestational diabetes result in cochlear damage? The Journal of Laryngology & Otology. 2014 Nov 1;128(11):961–5.
12. Sharma K, Mehta N, Kalita R. The Effect of Gestational Diabetes Mellitus on Hearing of Neonates in a Tertiary Healthcare Centre. Indian Journal of Otolaryngology and Head & Neck Surgery. 2023 Mar 18;75(S1):620–7.
13. Al-Nemri AM, Alsohime F, Shaik AH, El-Hissi GA, Al-Agha MI, Al-Abdulkarim NF, et al. Perinatal and neonatal morbidity among infants of diabetic mothers at a university hospital in Central Saudi Arabia. Saudi Medical Journal [Internet]. 2018 Jun 1 [cited 2021 Jan 11];39(6):592–7. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6058745/
14. Halder AL, Mollah MAH, Baki MA, Khan S, Nahar J. Hearing Impairment among the High-Risk Neonates: Findings from a Hospital-Based Targeted Screening. Mymensingh Med J. 2025 Apr;34(2):400-407. PMID: 40160057.
15. Kountakis SE, Skoulas I, Phillips D, Chang CYJoseph. Risk factors for hearing loss in neonates: A prospective study. American Journal of Otolaryngology. 2002 May;23(3):133–7.
16. Carlos-Hiceta AC, Reyes-Quintos MRT. Maternal Diabetes: A Potential Risk Factor of Congenital Hearing Loss. Acta Medica Philippina. 2021 Feb 24;55(1).
17. Hanege FM, Yýlmaz Hanege B, Çelik S, Göçmen A, Kalcýoðlu M. Is gestational diabetes a risk factor for neonatal hearing loss?. Arch Clin Exp Med. 2019;4(1):29-32.
18. S GK, Bhat AV, Nagaraj M. Does gestational diabetes mellitus affect the hearing of the baby? International Journal of Otorhinolaryngology and Head and Neck Surgery [Internet]. 2021 Dec 23;8(1):74–4. Available from: https://www.ijorl.com/index.php/ijorl/article/view/3336