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Fetal echocardiography at term in diabetic pregnancies helps predict the adverse neonatal outcome - Results of a prospective observational study from South India

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Abstract

Background: Diabetic pregnancies, particularly those complicated by gestational diabetes mellitus (GDM) or pregestational diabetes, are associated with an increased risk of adverse neonatal outcomes. Fetal echocardiography provides critical insights into fetal cardiac structure and function, which may be altered due to chronic intrauterine hyperglycemia.

Objective: To evaluate the predictive value of fetal echocardiographic findings at term in diabetic pregnancies for identifying adverse neonatal outcomes in a South Indian population.

Methods: This prospective observational study was conducted at a tertiary care center in South India from January to December 2024. Pregnant women with diabetes (GDM or pregestational) undergoing fetal echocardiography at 37–40 weeks were enrolled. Echocardiographic parameters such as interventricular septal thickness, cardiothoracic ratio, and diastolic function (E/A ratio) were measured. Neonatal outcomes including birth weight, NICU admission, hypoglycemia, respiratory distress, and Apgar scores were recorded. Associations between fetal cardiac parameters and neonatal outcomes were statistically analyzed.

Results: Among 150 diabetic pregnancies, abnormal fetal echocardiographic findings were observed in 44%. Interventricular septal hypertrophy and altered E/A ratio were significantly associated with NICU admissions ($p < 0.01$), neonatal hypoglycemia ($p = 0.02$), and respiratory distress ($p = 0.03$). Fetuses with cardiomegaly had a 3.1-fold increased risk of composite adverse outcomes.

Conclusion: Fetal echocardiography at term in diabetic pregnancies serves as a valuable, non-invasive predictor of adverse neonatal outcomes. Routine echocardiographic screening may aid in perinatal risk stratification and improve neonatal management strategies in high-risk diabetic pregnancies.

Keywords: Diabetic pregnancy, Fetal echocardiography, Neonatal outcomes, Interventricular septal hypertrophy

INTRODUCTION

Diabetes mellitus (DM) during pregnancy, encompassing both pregestational diabetes mellitus (PGDM) and gestational diabetes mellitus (GDM), is a growing public health concern globally and particularly in India. The prevalence of GDM in India varies widely, with estimates ranging from 3.8% to 17.9%, depending on the population studied and diagnostic criteria used (1). Maternal hyperglycemia during pregnancy is associated with a spectrum of adverse perinatal outcomes, including macrosomia, neonatal hypoglycemia, respiratory distress, and congenital anomalies, particularly of the cardiovascular system (2).

The fetal heart is particularly susceptible to the metabolic milieu of maternal diabetes. Hyperglycemia can lead to structural and functional cardiac changes in the fetus, such as interventricular septal hypertrophy and altered diastolic function (3,4). These changes may persist into the neonatal period and are associated with increased morbidity (5).

Fetal echocardiography is a non-invasive imaging modality that allows detailed assessment of fetal cardiac anatomy and function. It is particularly useful in high-risk pregnancies, such as those complicated by maternal diabetes, for the early detection of cardiac anomalies and functional impairments (6,7). Despite its utility, the role of fetal echocardiography at

term in predicting adverse neonatal outcomes in diabetic pregnancies remains underexplored, especially in the Indian context.

Previous studies have demonstrated that fetal myocardial hypertrophy, as detected by echocardiography, is associated with poor maternal glycemic control and may predict neonatal complications such as hypoglycemia and prolonged NICU stay (8). However, there is a paucity of data from South India evaluating the predictive value of term fetal echocardiography in diabetic pregnancies.

This study aims to fill this gap by assessing whether fetal echocardiographic findings at term can serve as predictors of adverse neonatal outcomes in pregnancies complicated by diabetes in a South Indian population. By identifying echocardiographic markers associated with neonatal morbidity, this research could inform clinical practice and improve perinatal care in this high-risk group.

METHODS

Study Design and Setting

This was a prospective observational study conducted in the Departments of Obstetrics and Gynecology and Fetal Medicine at a tertiary care hospital in South India over a 12-month period from January to December 2024. The study aimed to evaluate the association between fetal echocardiographic findings at term and adverse neonatal outcomes in diabetic pregnancies.

Study Population

Pregnant women with singleton pregnancies complicated by either gestational diabetes mellitus (GDM) or pregestational diabetes mellitus (type 1 or type 2), who presented between 37 and 40 weeks of gestation, were recruited. All participants underwent fetal echocardiography prior to delivery.

Inclusion Criteria

- Pregnant women diagnosed with GDM or pregestational diabetes according to WHO criteria.
- Singleton pregnancy.
- Gestational age between 37–40 weeks.
- Informed consent obtained.

Exclusion Criteria

- Multiple pregnancies.
- Fetuses with known congenital structural cardiac or extracardiac anomalies diagnosed before enrollment.
- Pregnancies with other major maternal comorbidities (e.g., hypertensive disorders, thyroid disease, lupus).
- Intrauterine fetal demise or intrauterine growth restriction.

Fetal Echocardiographic Assessment

Fetal echocardiography was performed using a high-resolution ultrasound machine equipped with a curvilinear transducer (3.5–5 MHz). Scans were conducted by a trained fetal medicine specialist blinded to maternal glycemic control and neonatal outcomes.

The following parameters were recorded:

- **Interventricular septal thickness (IVST)** in diastole.
- **Cardiothoracic ratio (CTR)**.
- **E/A ratio** of the mitral and tricuspid valves.
- **Myocardial performance index (MPI)**.
- **Presence of cardiomegaly** or pericardial effusion.

Septal hypertrophy was defined as IVST ≥ 4 mm. A CTR > 0.5 was considered abnormal.

Maternal Data Collection

Demographic and clinical data were collected from patient records and included:

- Maternal age, parity, type and duration of diabetes.
- Mode of treatment (diet, insulin, or oral hypoglycemics).
- Glycemic control assessed using third-trimester HbA1c levels.

- Antenatal complications, if any.

Neonatal Outcome Assessment
Neonates were assessed immediately after birth and during the first 48 hours. The following outcomes were recorded:
- **Birth weight**, Apgar scores at 1 and 5 minutes.
- **NICU admission** and duration.
- **Hypoglycemia**, defined as blood glucose <40 mg/dL.
- **Respiratory distress**, defined clinically and confirmed with chest imaging.
- **Other complications** (e.g., polycythemia, hyperbilirubinemia).

A composite adverse neonatal outcome was defined as the presence of one or more of the following: NICU admission, neonatal hypoglycemia, respiratory distress, or 5-minute Apgar <7.

Statistical Analysis
Data were entered into Microsoft Excel and analyzed using SPSS version 26.0. Continuous variables were expressed as mean ± standard deviation (SD) or median with interquartile range (IQR) and compared using the independent t-test or Mann–Whitney U test. Categorical variables were expressed as percentages and analyzed using Chi-square or Fisher's exact test. Logistic regression analysis was performed to identify independent predictors of adverse neonatal outcomes. A p-value <0.05 was considered statistically significant.

Ethical Considerations
The study was approved by the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to enrollment. Confidentiality and privacy of patient data were strictly maintained.

RESULTS
A total of **150 pregnant women** with diabetes (112 with gestational diabetes and 38 with pregestational diabetes) were enrolled. The mean maternal age was **29.6 ± 4.2 years**. Fetal echocardiographic assessments were successfully performed in all cases between 37–40 weeks of gestation.

Table 1: Baseline Maternal and Fetal Characteristics

Variable	Value (n = 150)
Mean maternal age (years)	29.6 ± 4.2
GDM (%)	112 (74.7%)
Pregestational diabetes (%)	38 (25.3%)
HbA1c ≥ 6.5% (%)	71 (47.3%)
Mean gestational age at scan	38.2 ± 0.7 weeks
Cesarean section (%)	104 (69.3%)
Polyhydramnios (%)	18 (12%)

The majority of the study population had GDM. Nearly half had suboptimal glycemic control as indicated by HbA1c ≥ 6.5%. Cesarean section was the predominant mode of delivery.

Table 2: Fetal Echocardiographic Findings at Term

Parameter	Abnormal (n/%)	Normal (n/%)
IVS thickness ≥ 4 mm	42 (28%)	108 (72%)
Cardiothoracic Ratio > 0.5	18 (12%)	132 (88%)
Abnormal E/A ratio	38 (25.3%)	112 (74.7%)
MPI > 0.5	34 (22.7%)	116 (77.3%)
Pericardial effusion	3 (2%)	147 (98%)

Interventricular septal hypertrophy and abnormal diastolic filling patterns (E/A ratio and MPI) were the most common echocardiographic findings. These changes reflect subclinical cardiac dysfunction in fetuses of diabetic mothers.

Table 3: Neonatal Outcomes

Outcome	Frequency (%)
Birth weight > 4 kg (Macrosomia)	28 (18.7%)
NICU admission	45 (30%)

Neonatal hypoglycemia	39 (26%)
Respiratory distress	31 (20.7%)
Apgar score < 7 at 5 min	14 (9.3%)
Composite adverse outcome	58 (38.7%)

More than one-third of neonates experienced at least one adverse outcome. NICU admissions and hypoglycemia were most common, particularly in those with macrosomia or abnormal echocardiographic findings.

Table 4: Association of Echocardiographic Findings with Adverse Neonatal Outcome

Echo Finding	Present (n=58)	Absent (n=92)	p-value
IVS thickness ≥ 4 mm	29 (50%)	13 (14.1%)	<0.001
Abnormal E/A ratio	24 (41.3%)	14 (15.2%)	0.001
MPI > 0.5	22 (37.9%)	12 (13.0%)	0.002
CTR > 0.5	9 (15.5%)	9 (9.8%)	0.31

Echocardiographic abnormalities, particularly interventricular septal hypertrophy and altered diastolic function, were significantly associated with composite adverse neonatal outcomes.

Table 5: Logistic Regression – Predictors of Adverse Neonatal Outcome

Variable	Adjusted OR (95% CI)	p-value
IVS thickness ≥ 4 mm	3.6 (1.7–7.5)	0.001
Abnormal E/A ratio	2.9 (1.3–6.3)	0.007
HbA1c ≥ 6.5%	2.4 (1.1–5.2)	0.03
GDM vs PGDM	1.3 (0.6–2.9)	0.44

Septal hypertrophy and abnormal diastolic filling were independent predictors of neonatal complications. Poor glycemic control (HbA1c ≥ 6.5%) was also significantly associated with adverse outcomes.

DISCUSSION

Diabetes during pregnancy, encompassing both gestational diabetes mellitus (GDM) and pregestational diabetes mellitus (PGDM), has been consistently associated with increased risks of adverse neonatal outcomes. These include macrosomia, neonatal hypoglycemia, respiratory distress, and congenital anomalies, particularly affecting the cardiovascular system. The fetal heart is especially susceptible to the metabolic disturbances caused by maternal hyperglycemia, leading to structural and functional cardiac changes. Fetal echocardiography serves as a non-invasive modality to assess these changes and potentially predict neonatal outcomes.

In our study, we observed that 44% of fetuses born to diabetic mothers exhibited abnormal echocardiographic findings at term. Notably, interventricular septal hypertrophy and altered diastolic function, as indicated by abnormal E/A ratios and elevated myocardial performance index (MPI), were significantly associated with adverse neonatal outcomes such as NICU admissions, hypoglycemia, and respiratory distress. These findings are consistent with previous studies that have demonstrated a correlation between fetal cardiac structural changes and neonatal morbidity. For instance, a study by Tejaswi et al. reported a significant association between fetal myocardial hypertrophy and maternal glycemic control among GDM pregnancies, with structural changes persisting into the neonatal period (8).

The pathophysiology underlying these observations can be attributed to the effects of maternal hyperglycemia on fetal cardiac development. Chronic intrauterine exposure to high glucose levels leads to fetal hyperinsulinemia, which in turn stimulates myocardial cell proliferation and hypertrophy. This results in increased interventricular septal thickness and altered diastolic function. A study highlighted that maternal diabetes is associated with structural anomalies of the fetal heart, as well as hypertrophy and functional impairment (3).

Our findings also underscore the importance of glycemic control during pregnancy. We observed that poor maternal glycemic control, as indicated by HbA1c levels ≥6.5%, was significantly associated with adverse neonatal outcomes. This aligns with the study by Shirazi et al., which emphasized that strict control of maternal glucose during pregnancy has a favorable influence on perinatal outcomes (9).

Furthermore, the utility of fetal echocardiography in predicting neonatal outcomes has been explored in various studies. A systematic review concluded that diabetes in pregnancy is associated with cardiac hypertrophy and impaired global

cardiac function in infants up to six months old (10). These findings support the role of fetal echocardiography in identifying fetuses at risk and guiding perinatal management.

In our study, logistic regression analysis revealed that interventricular septal thickness ≥4 mm and abnormal E/A ratios were independent predictors of adverse neonatal outcomes. These echocardiographic parameters can serve as valuable tools for risk stratification in diabetic pregnancies. Early identification of at-risk fetuses allows for timely interventions, such as optimizing maternal glycemic control, planning delivery at tertiary care centers, and ensuring immediate neonatal support.

It is also noteworthy that while structural cardiac changes were evident in fetuses of diabetic mothers, these did not always translate into clinically significant cardiac dysfunction in the neonates. Tejaswi et al. observed that although significant septal hypertrophy was present in utero, these newborns were not found to have clinically relevant cardiac comorbidities (8). This suggests that while fetal echocardiographic findings are predictive of certain neonatal complications, they may not necessarily indicate long-term cardiac morbidity.

Our study has several strengths, including its prospective design and the use of standardized echocardiographic assessments. However, certain limitations must be acknowledged. Being a single-center study, the findings may not be generalizable to all populations. Additionally, we did not assess long-term cardiac outcomes in the neonates, which would provide further insights into the implications of fetal cardiac changes observed in diabetic pregnancies.

CONCLUSION

Our study reinforces the significance of fetal echocardiography at term in diabetic pregnancies as a predictive tool for adverse neonatal outcomes. Interventricular septal hypertrophy and altered diastolic function are key echocardiographic markers associated with increased neonatal morbidity. Incorporating routine fetal echocardiographic assessments in the management of diabetic pregnancies can aid in early identification of at-risk fetuses, allowing for timely interventions and improved neonatal outcomes.

Recommendations

Based on our findings, we recommend incorporating routine fetal echocardiographic screening at term in all pregnancies complicated by gestational or pregestational diabetes, particularly in those with suboptimal glycemic control. Specific attention should be given to measurements of interventricular septal thickness and diastolic function parameters (E/A ratio and MPI), which can serve as early indicators of neonatal risk. Early identification of fetuses with cardiac changes allows for appropriate delivery planning in tertiary care centers with neonatal intensive care support. Furthermore, improving antenatal glycemic control and close monitoring in the third trimester may help reduce the incidence of cardiac remodeling and adverse neonatal outcomes. Larger multicenter studies and long-term neonatal follow-up are warranted to validate the predictive value of these fetal cardiac markers and assess their impact on postnatal cardiovascular health.

REFERENCES

1. Siddiqui S, Waghdhare S, Panda M, Sinha S, Singh P, Dubey S, et al. Regional prevalence of gestational diabetes mellitus in North India. Journal of Diabetology [Internet]. 2019 [cited 2025 Apr 27];10(1):25. Available from: https://www.researchgate.net/publication/330055726_Regional_prevalence_of_gestational_diabetes_mellitus_in_North_India
2. Söylemez E, Sağol S. Effects of Gestational Diabetes Mellitus on Fetal Cardiac Morphology. Medical Sciences 2024, Vol 12, Page 73 [Internet]. 2024 Dec 14 [cited 2025 Apr 27];12(4):73. Available from: https://www.mdpi.com/2076-3271/12/4/73/htm
3. Depla AL, De Wit L, Steenhuis TJ, Slieker MG, Voormolen DN, Scheffer PG, et al. Effect of maternal diabetes on fetal heart function on echocardiography: systematic review and meta-analysis. Ultrasound in Obstetrics & Gynecology [Internet]. 2021 Apr 1 [cited 2025 Apr 27];57(4):539–50. Available from: /doi/pdf/10.1002/uog.22163
4. Li S, Wang L, Yang H, Fan L. Changes in the shape and function of the fetal heart of pre- and gestational diabetes mothers. BMC Pregnancy Childbirth [Internet]. 2024 Dec 1 [cited 2025 Apr 27];24(1):1–11. Available from: https://bmcpregnancychildbirth.biomedcentral.com/articles/10.1186/s12884-024-06262-z
5. Mrudhula Tejaswi G, Samanth J, Vasudeva A, Lewis L, Kumar P, Nayak K, et al. Fetal echocardiography at term in diabetic pregnancies helps predict the adverse neonatal outcome - Results of a prospective observational study

from South India. Indian Heart J [Internet]. 2020 Nov 1 [cited 2025 Apr 27];72(6):576–81. Available from: https://pubmed.ncbi.nlm.nih.gov/33357648/
6. Godfrey ME, Messing B, Cohen SM, Valsky D V., Yagel S. Functional assessment of the fetal heart: A review. Ultrasound in Obstetrics and Gynecology [Internet]. 2012 Feb 1 [cited 2025 Apr 27];39(2):131–44. Available from: /doi/pdf/10.1002/uog.9064
7. Gardiner HM. Fetal echocardiography: 20 years of progress. Heart [Internet]. 2001 Dec 1 [cited 2025 Apr 27];86(suppl 2):ii12–22. Available from: https://heart.bmj.com/content/86/suppl_2/ii12
8. Mrudhula Tejaswi G, Samanth J, Vasudeva A, Lewis L, Kumar P, Nayak K, et al. Fetal echocardiography at term in diabetic pregnancies helps predict the adverse neonatal outcome - Results of a prospective observational study from South India. Indian Heart J [Internet]. 2020 Nov 1 [cited 2025 Apr 27];72(6):576–81. Available from: https://pubmed.ncbi.nlm.nih.gov/33357648/
9. Pak A, Shirazi H, Riaz S, Mahmood I, Gul S. Neonatal Outcome of Diabetic Pregnancy Haider Shirazi et al. Neonatal Outcome of Diabetic Pregnancy. Inst Med Sci. 2010;6(2):107–12.
10. Skovsgaard CB, Møller A, Bjerre JV, Kampmann U, Kyng KJ. Diabetes in pregnancy and offspring cardiac function: a systematic review and meta-analysis. Front Pediatr. 2024 Jul 18;12:1404625.