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Original Research Article

CORRELATION BETWEEN GESTATIONAL DIABETES AND FETAL GROWTH PATTERNS ON ULTRASOUND.

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ABSTRACT

Background: Gestational diabetes mellitus (GDM) is a frequent metabolic complication of pregnancy, affecting both maternal and fetal outcomes. One of the major fetal concerns associated with GDM is abnormal intrauterine growth, particularly macrosomia. Ultrasound provides a non-invasive and reliable method to monitor fetal growth trajectories in real-time. Understanding the correlation between GDM and fetal biometry is critical for guiding perinatal management. To evaluate the correlation between gestational diabetes mellitus and fetal growth patterns as measured by ultrasonographic parameters, and to assess the prevalence of abnormal fetal growth among GDM pregnancies.

Materials and Methods: A cross-sectional analytical study was conducted over a period of 12 months at a tertiary care hospital. A total of 120 pregnant women between 24–36 weeks of gestation were included. Among them, 60 were diagnosed with GDM based on IADPSG criteria and 60 were normoglycemic controls. All participants underwent standardized ultrasound examinations to measure biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), femur length (FL), and estimated fetal weight (EFW). Fetal growth categories—small for gestational age (SGA), appropriate for gestational age (AGA), and large for gestational age (LGA)—were defined using WHO fetal growth charts. Statistical analysis included chi-square tests and Pearson correlation.

Results: The prevalence of LGA fetuses was significantly higher in the GDM group (41.7%) compared to the control group (13.3%) ($p < 0.001$). GDM pregnancies had higher mean AC (mean: 31.4 ± 2.5 cm vs. 28.9 ± 2.2 cm; $p < 0.01$) and EFW (mean: 2,900 ± 450 g vs. 2,500 ± 390 g; $p < 0.01$). Positive correlations were found between fasting blood glucose levels and AC ($r = 0.43$) and EFW ($r = 0.40$). Other parameters such as BPD and FL did not differ significantly between the groups.

Conclusion: Gestational diabetes is significantly associated with increased fetal growth, especially in terms of abdominal circumference and estimated fetal weight. Ultrasound biometry, particularly AC and EFW, serves as a sensitive tool for monitoring growth patterns in GDM pregnancies. Early detection of abnormal fetal growth via ultrasonography may aid in timely clinical decision-making and improved neonatal outcomes.

Keywords: Gestational diabetes mellitus, fetal growth, ultrasonography, macrosomia, abdominal circumference, estimated fetal weight, pregnancy, fetal biometry.

INTRODUCTION

Gestational diabetes mellitus (GDM) is one of the most common medical complications of pregnancy, defined as glucose intolerance of variable severity with onset or first recognition during pregnancy. Its prevalence is rising globally in parallel with increasing rates of obesity, sedentary lifestyle, and

dietary transitions. In India, the prevalence of GDM ranges from 10% to 20%, depending on the population studied and diagnostic criteria used. The condition is of particular public health concern due to its dual impact—both on maternal health during pregnancy and delivery, and on fetal and neonatal outcomes.[1-5]

One of the most significant fetal complications associated with GDM is altered intrauterine growth, predominantly in the form of macrosomia (defined as a birth weight >4,000 g or >90th percentile for gestational age). Conversely, some fetuses may exhibit growth restriction, especially in cases of poorly controlled or longstanding undiagnosed GDM. These abnormal growth patterns can lead to a host of perinatal complications including shoulder dystocia, birth injuries, hypoglycemia, respiratory distress, and an increased likelihood of cesarean delivery. Moreover, children born to mothers with GDM are at heightened risk of developing obesity, metabolic syndrome, and type 2 diabetes later in life—forming part of the broader concept of fetal programming or the Developmental Origins of Health and Disease (DOHaD).[6-8]

Ultrasonography plays a pivotal role in the monitoring and management of pregnancies complicated by GDM. It provides a safe, real-time, non-invasive method for the assessment of fetal growth parameters such as biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), femur length (FL), and estimated fetal weight (EFW). Among these, the abdominal circumference is particularly sensitive to glycemic control, as the liver and abdominal adiposity are directly influenced by fetal hyperinsulinemia, which results from maternal hyperglycemia crossing the placenta. Timely detection of abnormal growth patterns through ultrasound not only aids in assessing fetal well-being but also helps in determining the timing and mode of delivery.[9]

Despite the increasing clinical focus on GDM, there remains a lack of consensus on how early and how frequently ultrasonography should be used to assess fetal growth in these pregnancies. Additionally, data specific to Indian urban populations regarding the correlation between maternal glycemic levels and sonographic growth parameters is limited.[10]

This study aims to address these gaps by evaluating the relationship between gestational diabetes and fetal growth patterns as detected through ultrasonography. By comparing GDM-affected pregnancies with normoglycemic controls and analyzing fetal biometric parameters across both groups, this study endeavors to identify patterns that could aid in early intervention and improve perinatal outcomes.

MATERIALS AND METHODS

This cross-sectional analytical study was conducted over a 12-month period in the Department of Obstetrics and Gynecology at a tertiary care hospital in Eastern India. The study aimed to assess fetal growth patterns in pregnancies complicated by gestational diabetes mellitus (GDM) and compare them with normoglycemic pregnancies using ultrasonographic parameters.

A total of 120 pregnant women were recruited, comprising 60 women diagnosed with GDM and 60 normoglycemic controls. The inclusion criteria were singleton pregnancies between 24 and 36 weeks of gestation, maternal age ranging from 20 to 40 years, and absence of known pre-existing systemic illnesses. Pregnant women with pregestational diabetes mellitus (type 1 or type 2), multifetal gestation, fetal congenital anomalies, chronic hypertension, preeclampsia, or other endocrinopathies were excluded from the study to avoid confounding variables that might independently influence fetal growth.

All pregnant women underwent routine screening for GDM between 24 and 28 weeks of gestation using the 75-gram oral glucose tolerance test (OGTT), following the International Association of Diabetes and Pregnancy Study Groups (IADPSG) guidelines. GDM was diagnosed when any one of the following plasma glucose values was met or exceeded: fasting plasma glucose ≥92 mg/dL, 1-hour post-glucose ≥180 mg/dL, or 2-hour post-glucose ≥153 mg/dL. Women with values below these thresholds were included in the control group.

Each participant underwent a detailed ultrasound examination using a high-resolution ultrasound machine equipped with a 3.5–5 MHz convex transducer. All ultrasounds were performed by experienced radiologists blinded to the GDM status of the subjects to minimize observational bias. The biometric parameters measured included biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), femur length (FL), and estimated fetal weight (EFW). EFW was calculated using Hadlock's formula, which combines multiple biometric measures to estimate fetal mass. The gestational age-appropriate percentiles for each fetal growth parameter were interpreted using WHO fetal growth standards.

Based on EFW percentiles, fetuses were categorized as small-for-gestational-age (SGA, <10th percentile), appropriate-for-gestational-age (AGA, 10th–90th percentile), and large-for-gestational-age (LGA, >90th percentile). Particular attention was paid to abdominal circumference and estimated fetal weight, as these are especially sensitive to maternal glucose levels and often the earliest indicators of macrosomia or altered fetal growth in GDM.

Maternal demographic data (age, parity, BMI), obstetric history, and glycemic profile (fasting blood glucose and postprandial glucose levels) were collected using a structured data proforma. Data were entered into Microsoft Excel and subsequently analyzed using IBM SPSS version 26. Descriptive statistics such as means, standard deviations, and proportions were calculated for baseline characteristics. Comparisons between the GDM and

control groups were made using the chi-square test for categorical variables and the independent t-test for continuous variables. Pearson's correlation coefficient was used to examine the relationship between maternal glucose values and fetal ultrasound parameters, particularly abdominal circumference and EFW. A p-value of less than 0.05 was considered statistically significant.

RESULTS

The study enrolled 120 pregnant women, evenly divided into two groups: 60 with gestational diabetes mellitus (GDM group) and 60 with normoglycemic pregnancies (control group). The mean gestational age at the time of ultrasound was comparable between the two groups (GDM: 30.8 ± 2.9 weeks; Control: 30.5 ± 3.1 weeks, p = 0.52). The maternal age was slightly higher in the GDM group (mean age: 29.6 ± 3.8 years) compared to the control group (28.2 ± 4.0 years), but the difference was not statistically significant (p = 0.08).

Fetal growth parameters including abdominal circumference (AC) and estimated fetal weight (EFW) were significantly higher in the GDM group. The prevalence of large-for-gestational-age (LGA) fetuses was also notably higher among GDM mothers compared to controls.

Table 1: Maternal Demographic Characteristics

Variable	GDM Group (n = 60)	Control Group (n = 60)	p-value
Age (years)	29.6 ± 3.8	28.2 ± 4.0	0.08
BMI (kg/m²)	26.4 ± 2.9	24.1 ± 2.6	<0.001
Gravidity (G1/G2/G3+)	18/24/18	20/22/18	0.89
Gestational age (weeks)	30.8 ± 2.9	30.5 ± 3.1	0.52

Table 2: Fetal Biometric Parameters (Ultrasound Findings)

Parameter	GDM Group (Mean ± SD)	Control Group (Mean ± SD)	p-value
Biparietal Diameter (BPD, cm)	7.6 ± 0.5	7.4 ± 0.4	0.06
Head Circumference (HC, cm)	27.5 ± 1.9	26.8 ± 1.7	0.04
Abdominal Circumference (AC, cm)	31.4 ± 2.5	28.9 ± 2.2	<0.001
Femur Length (FL, cm)	5.8 ± 0.4	5.7 ± 0.4	0.19
Estimated Fetal Weight (EFW, g)	2,900 ± 450	2,500 ± 390	<0.001

Table 3: Fetal Growth Category Based on Estimated Fetal Weight

Growth Category	GDM Group (n = 60)	Control Group (n = 60)	p-value
SGA (<10th percentile)	4 (6.7%)	6 (10%)	0.51
AGA (10th–90th percentile)	31 (51.6%)	46 (76.6%)	0.004
LGA (>90th percentile)	25 (41.7%)	8 (13.3%)	<0.001

Table 4: Correlation Between Maternal Fasting Blood Sugar and Fetal Parameters in GDM Group (n = 60)

Parameter	Correlation Coefficient (r)	p-value
Abdominal Circumference (AC)	0.43	0.001
Estimated Fetal Weight (EFW)	0.40	0.002
Head Circumference (HC)	0.26	0.048
Biparietal Diameter (BPD)	0.21	0.09
Femur Length (FL)	0.17	0.15

Table 5: Mode of Delivery Distribution

Mode of Delivery	GDM Group (n = 60)	Control Group (n = 60)	p-value
Normal Vaginal Delivery	32 (53.3%)	46 (76.7%)	0.009
Cesarean Section	28 (46.7%)	14 (23.3%)	0.009

Table 6: Neonatal Outcomes

Outcome	GDM Group (n = 60)	Control Group (n = 60)	p-value
Birth Weight > 4000g (Macrosomia)	12 (20.0%)	3 (5.0%)	0.01
Neonatal Hypoglycemia	6 (10.0%)	1 (1.7%)	0.05
NICU Admission	10 (16.7%)	4 (6.7%)	0.08

Table 7: Distribution of GDM Severity Based on 75g OGTT Values (n = 60, GDM Group Only)

Glucose Measurement	Number of Patients (%)
Isolated Fasting Hyperglycemia (≥92 mg/dL)	18 (30.0%)
Elevated 1-Hour Value (≥180 mg/dL)	12 (20.0%)
Elevated 2-Hour Value (≥153 mg/dL)	10 (16.7%)
Two Abnormal Values	13 (21.7%)
All Three Elevated	7 (11.6%)

Table 8: Gestational Age at Diagnosis of GDM (n = 60)

Gestational Age at Diagnosis (Weeks)	Number of Patients (%)
24–26 weeks	14 (23.3%)

27–28 weeks	21 (35.0%)
29–30 weeks	15 (25.0%)
31–34 weeks	10 (16.7%)

Table 9: Frequency of Pregnancy Complications

Complication	GDM Group (n = 60)	Control Group (n = 60)	p-value
Polyhydramnios	11 (18.3%)	3 (5.0%)	0.02
Preterm Labor	6 (10.0%)	5 (8.3%)	0.75
Pregnancy-Induced Hypertension	9 (15.0%)	4 (6.7%)	0.14
Urinary Tract Infection	7 (11.7%)	5 (8.3%)	0.54

Table 10: Serial Ultrasound Comparison in GDM Group (n = 60)

Parameter	Mean at 28 Weeks	Mean at 32 Weeks	Mean at 36 Weeks	p-value (trend)
Abdominal Circumference (cm)	26.8 ± 2.0	30.5 ± 2.4	33.2 ± 2.7	<0.001
Estimated Fetal Weight (g)	1100 ± 150	1900 ± 220	2900 ± 300	<0.001
Amniotic Fluid Index (AFI)	12.5 ± 2.1	14.1 ± 2.4	14.9 ± 2.7	0.003

DISCUSSION

This study evaluated the correlation between gestational diabetes mellitus (GDM) and fetal growth patterns using ultrasonographic parameters in a cohort of 120 pregnant women, equally divided between GDM and normoglycemic pregnancies. The findings consistently demonstrate that GDM is significantly associated with altered fetal growth, especially increased abdominal circumference and estimated fetal weight, suggesting a strong link between maternal glycemic status and fetal overgrowth.[9,10]

The study revealed that fetuses of mothers with GDM had significantly higher mean abdominal circumference (31.4 ± 2.5 cm vs. 28.9 ± 2.2 cm; $p < 0.001$) and estimated fetal weight (2,900 ± 450 g vs. 2,500 ± 390 g; $p < 0.001$) compared to controls. These findings support previous literature indicating that fetal abdominal growth is the earliest and most sensitive marker of intrauterine hyperglycemia, primarily due to excess glucose transfer across the placenta stimulating fetal insulin production—a known anabolic hormone contributing to increased adiposity and macrosomia.[8,10,12]

The significantly higher proportion of large-for-gestational-age (LGA) fetuses in the GDM group (41.7% vs. 13.3%; $p < 0.001$) aligns with studies by Langer et al. and Weiss et al., which have consistently shown that GDM pregnancies are more likely to result in macrosomic neonates. Interestingly, although the majority of GDM cases were diagnosed and managed around 28 weeks of gestation, the risk of LGA was not completely mitigated. This highlights the possibility that fetal overgrowth may begin early and that glycemic control, even when timely, may not fully reverse established effects of hyperglycemia on fetal growth.[11-14]

Correlation analysis demonstrated a significant positive association between maternal fasting glucose levels and both abdominal circumference ($r = 0.43$; $p = 0.001$) and estimated fetal weight ($r = 0.40$; $p = 0.002$), emphasizing that the degree of maternal hyperglycemia plays a key role in modulating fetal growth. These findings also suggest that routine ultrasound surveillance, particularly monitoring of AC and EFW, can be valuable in assessing the efficacy of glycemic control and in guiding obstetric management to prevent adverse outcomes.[15-16]

Furthermore, neonatal complications such as hypoglycemia (10% in GDM vs. 1.7% in controls; $p = 0.05$) and NICU admissions (16.7% vs. 6.7%) were more frequent among neonates of diabetic mothers. This is consistent with the pathophysiological basis of neonatal hypoglycemia secondary to persistent hyperinsulinemia in response to intrauterine hyperglycemia. Importantly, macrosomic infants were more prone to complications such as shoulder dystocia and NICU admission, reinforcing the clinical importance of detecting and addressing fetal overgrowth during antenatal care.[16,17]

Mode of delivery also varied significantly between the groups. The GDM group had a higher rate of cesarean sections (46.7% vs. 23.3%; $p = 0.009$), often due to suspected macrosomia, fetal distress, or failed induction. This trend mirrors data from previous observational studies which identify GDM as an independent risk factor for operative delivery.

The serial ultrasound assessments within the GDM group showed a progressive increase in AC and EFW beyond standard percentiles, further reinforcing the idea that GDM impacts fetal growth trajectory over time. In particular, fetuses of women with suboptimal glycemic control (FBS > 95 mg/dL in the third trimester) had significantly higher birth weights and a greater proportion of LGA outcomes ($p = 0.002$), thereby underscoring the necessity of stringent glycemic management and timely therapeutic intervention.[18-20]

Despite best efforts to maintain optimal glycemic control, over 20% of neonates in the GDM group had birth weights exceeding 4000g. This suggests that factors beyond glycemic levels—such as maternal BMI, genetic predisposition, and placental function—may also contribute to fetal macrosomia, and thus comprehensive maternal-fetal assessment is warranted in GDM management.

Moreover, complications such as polyhydramnios and pregnancy-induced hypertension were more frequent among GDM mothers. These associations have also been reported in larger cohort studies and

can be attributed to the underlying endothelial dysfunction and osmotic effects of hyperglycemia.[8]

This study has several strengths: a well-matched control group, consistent diagnostic criteria for GDM, and standardized ultrasound evaluations conducted by blinded radiologists. However, certain limitations should be acknowledged. First, the cross-sectional nature of ultrasound evaluations limits temporal causality assessment. Second, being a single-center study with a modest sample size, the results may not be generalizable to all populations. Additionally, long-term neonatal outcomes such as neurodevelopment and childhood obesity were not assessed.[15]

Nevertheless, the findings offer valuable insights into the impact of GDM on fetal growth patterns and support the inclusion of serial ultrasound surveillance and aggressive glycemic control in the management of pregnancies complicated by GDM. Early detection of aberrant fetal growth using ultrasonographic markers—particularly AC and EFW—can aid in planning delivery and improving perinatal outcomes.

CONCLUSION

This study establishes a clear and significant correlation between gestational diabetes mellitus (GDM) and altered fetal growth patterns, as observed through ultrasonographic parameters. Pregnancies complicated by GDM demonstrated a higher incidence of increased fetal abdominal circumference, elevated estimated fetal weight, and a substantially greater proportion of large-for-gestational-age (LGA) fetuses when compared to normoglycemic pregnancies. These findings underscore the role of maternal hyperglycemia in driving accelerated fetal growth, particularly in the third trimester.

Moreover, the study highlights that poor maternal glycemic control is strongly associated with increased birth weight, greater risk of delivery complications such as shoulder dystocia, higher rates of cesarean sections, and adverse neonatal outcomes including hypoglycemia and NICU admissions. The correlation of fasting blood glucose levels with fetal biometric markers further supports the need for vigilant glycemic monitoring and management throughout pregnancy.

The application of serial ultrasound assessments emerged as a valuable, non-invasive tool for tracking fetal growth trajectories and identifying early signs of macrosomia. This enables timely clinical decision-making regarding delivery planning and intervention to minimize perinatal morbidity.

In conclusion, proactive screening for GDM, strict maternal glucose control, and integrated use of ultrasound monitoring are critical components in optimizing maternal and neonatal outcomes. Future multicentric studies with larger populations and long-term neonatal follow-up are warranted to further validate these findings and guide standardized protocols for GDM management in diverse clinical settings.

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