Original Article
DOI: https://doi.org/10.70749/ijbr.v3i4.2040

INDUS JOURNAL OF BIOSCIENCE RESEARCH
https://ijbr.com.pk
ISSN: 2960-2793/ 2960-2807

Maternal and Fetal Outcome in Gestational Diabetes Mellitus

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ARTICLE INFO

Keywords: Gestational Diabetes Mellitus, Maternal Outcome, Fetal Complications, Preeclampsia, Low Birth Weight, Polyhydramnios, Hyperbilirubinemia.

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Declaration
Authors' Contribution
All authors equally contributed to the study and approved the final manuscript

Conflict of Interest: No conflict of interest.

Funding: No funding received by the authors.

Article History
Received: 19-01-2025 Revised: 23-03-2025
Accepted: 04-04-2025 Published: 30-04-2025

ABSTRACT

Background: Gestational diabetes mellitus is a frequent metabolic disorder of pregnancy, which is related to severe maternal and fetal complications. Despite the existence of documented worldwide data, inter-regional variations between populations, care access, and antenatal care policies require local investigations to clarify patterns of outcomes and to inform clinical decision-making. **Objective:** To determine the frequency of maternal and fetal outcome in patients with gestational diabetes mellitus. **Study Design:** Descriptive cross-sectional study. **Duration and Place of Study:** The study was conducted from April to October 2024 at the Department of Obstetrics and Gynecology, Ayub Teaching Hospital, Abbottabad. **Methodology:** A total of 139 pregnant women diagnosed with GDM after 20 weeks of gestation were enrolled. Maternal and neonatal outcomes including preeclampsia, polyhydramnios, low birth weight, respiratory distress, and hyperbilirubinemia were assessed. Demographic and clinical data were documented, and outcomes were stratified by age, BMI, parity, socioeconomic status, education, residence, and family history. **Results:** The mean maternal age was 30.60±6.03 years and BMI was 26.42±2.94 kg/m^2. The most frequent complications were preeclampsia (20.10%), low birth weight (13.70%), polyhydramnios (12.20%), respiratory distress (10.80%), and hyperbilirubinemia (9.40%). Significant associations were found between maternal age >30 years, BMI >25 kg/m^2, higher parity, and increased rates of complications. **Conclusion:** Gestational diabetes mellitus is associated with a high burden of maternal and fetal complications.

INTRODUCTION

Gestational diabetes mellitus (GDM) is a variable severity glucose intolerance that develops or is first identified during pregnancy.[1] It most commonly develops during the second or third trimester when the hormonal changes cause impaired function of the insulin, resulting in hyperglycemia.[2] Risk factors for GDM are obesity, advanced age, history of diabetes mellitus in the first-degree relative, polycystic ovarian syndrome, and prior delivery of a macrosomic infant.[3] Glucose tolerance testing to detect GDM early is very important since a large percentage of GDM carriers are asymptomatic.[4] Appropriate glycemic control through diet, physical activity, and intermittent insulin use is crucial to the risk minimization of mother and fetus.[5] GDM, when not adequately controlled, can impose numerous complications on both mother and fetus.[5] The maternal complications involve preeclampsia, polyhydramnios, and increased risk of cesarean delivery.[6] Failure to achieve proper glycemic control may further subject the mother to frequent urinary tract infection and future risk from type 2 diabetes mellitus.[7] The fetal complications involve from macrosomia, shoulder dystocia, and delivery trauma to neonatal hypoglycemia, respiratory distress syndrome, and jaundice.[8] Besides, exposure to prenatal hyperglycemia has been found to have long-lasting metabolic effects on the offspring.[9]

Maternal outcomes in pregnancies complicated by GDM are significantly influenced by the degree of glycemic control and the timeliness of intervention.[10] Women with GDM have a higher likelihood of operative delivery and are at increased risk for postpartum hemorrhage due to uterine atony associated with macrosomia.[11] Additionally, there is a notable recurrence rate of GDM in future pregnancies and an elevated lifetime risk of progressing to type 2 diabetes.[12] Postpartum follow-up and counseling are therefore integral parts of care to avoid these long-term risks. The fetal outcomes directly correlate to the maternal plasma glucose level during pregnancy. Macrosomia increases the risk of traumatic delivery injuries, and poor glycemic control leads to delayed maturation of fetal lungs, prematurity, and stillbirth on an extreme scale.[13] After delivery, newborn infants might develop metabolic derangements such as hypoglycemia and hypocalcemia.[14] The long-term effects include becoming more susceptible to obesity, resistance to insulin, and type 2 diabetes much further down the line in life.[15] Therefore, proper antenatal surveillance, individualized plans of management, and integrated

postpartum care are crucial to improve both maternal and fetal outcomes among GDM-affected pregnancies.[16]

A study conducted by Dudhwadkar AR et al. reported that among patients with gestational diabetes mellitus, preeclampsia was observed in 26% of cases, followed by polyhydramnios in 20%, low birth weight and respiratory distress each in 12%, while hyperbilirubinemia was noted in 10% of the neonates.[17]

There was a clear need to conduct this work to identify maternal and fetal outcomes among local populations with pregnancy complications from gestational diabetes mellitus. Though there was evidence internationally about risks, local variations between genes, access to care, and antenatal care protocols required identification on a population level. The aim was to provide usable clinical information to inform evidence-based decision-making and to improve earlier detection and intervention on GDM cases. The findings should improve existing protocol and inform future intervention to improve maternal and neonatal outcomes.

METHODOLOGY

This descriptive cross-sectional study was conducted from April to October 2024 in the Department of Obstetrics and Gynecology at Ayub Teaching Hospital, Abbottabad. A total of 139 pregnant women were included who had been diagnosed with gestational diabetes mellitus after 20 weeks of gestation. Diagnosis was based on laboratory findings showing either fasting plasma glucose levels exceeding 92 mg/dL, one-hour post-75g oral glucose tolerance test (OGTT) values above 180 mg/dL, or two-hour post-OGTT values over 153 mg/dL. Sample size was calculated using WHO sample size software, with a 95% confidence level, 5% margin of error, and an anticipated 10% frequency of hyperbilirubinemia in newborns.[17]

Women between 18 and 40 years of age with a singleton pregnancy and gestational age greater than 20 weeks by last menstrual period were eligible. Those with a known history of diabetes prior to pregnancy, chronic hypertension, hepatitis, HIV infection, or corticosteroid use were excluded to eliminate potential confounding factors. After approval from the hospital's ethics committee and obtaining informed consent, demographic and baseline clinical details such as maternal age, gestational age, parity, body mass index, family history of gestational diabetes, educational background, occupation, socioeconomic category, and place of residence were documented at the time of enrollment.

All enrolled women were monitored until delivery. Maternal complications assessed included elevated blood pressure greater than 140/90 mmHg accompanied by proteinuria of at least 300 mg in 24 hours, indicating preeclampsia. Excessive accumulation of amniotic fluid was identified on ultrasound when the amniotic fluid index exceeded 24 cm, representing polyhydramnios. Neonatal assessments were performed immediately after birth. Low birth weight was defined as neonatal weight below 2,500 grams measured using a standard digital weighing scale. Respiratory distress in the newborn was recognized clinically if the baby exhibited a respiratory rate above 60 breaths per minute along with nasal flaring and expiratory grunting. Hyperbilirubinemia was identified when total serum bilirubin levels exceeded 5 mg/dL, confirmed via laboratory testing. All outcomes were documented by the principal investigator using a predesigned data sheet.

Data analysis was performed using SPSS version 26. Frequencies and percentages were reported for categorical variables. For continuous variables results were expressed as mean ± standard deviation or median with interquartile range, depending on the normality of data distribution assessed by the Shapiro-Wilk test. Maternal and neonatal outcomes were further analyzed according to stratified risk groups including maternal demographics and clinical factors. Chi-square test or Fisher's exact test was applied where appropriate, and a p-value ≤0.05 was considered statistically significant.

RESULTS

In this study of gestational diabetes mellitus, the maternal demographics revealed a mean age of 30.60±6.03 years, gestational age of 37.92±0.79 weeks, and BMI of 26.42±2.94 kg/m^2 (as shown in Table-I). The majority of participants had middle socioeconomic status (52.5%), secondary education (41.0%), and urban residence (72.7%), while 23.0% had a family history of diabetes.

Table I

Patient Demographics

Demographics		Mean ± SD
Age (years)		30.60±6.03
Gestational Age (weeks)		37.92±0.79
BMI (Kg/m^2)		26.42±2.94
Parity		1.99±1.54
Socioeconomic Status	Poor n (%)	38 (27.3%)
	Middle n (%)	73 (52.5%)
	Rich n (%)	28 (20.1%)
Education	Uneducated n (%)	29 (20.9%)
	Primary n (%)	25 (18.0%)
	Secondary n (%)	57 (41.0%)
	Higher n (%)	28 (20.1%)
Residential Status	Rural n (%)	38 (27.3%)
	Urban n (%)	101 (72.7%)
Family History of Diabetes	Yes n (%)	32 (23.0%)
	No n (%)	107 (77.0%)

The most common maternal and fetal outcomes included preeclampsia (20.10%), low birth weight (13.70%), polyhydramnios (12.20%), respiratory distress (10.80%), and hyperalbuminuria (9.40%) (as shown in Table-II).

Table II

Maternal and fetal outcomes in gestational diabetes mellitus

Maternal and fetal outcomes	Frequency	% age
Preeclampsia	28	20.10%
Polyhydramnios	17	12.20%
LBW	19	13.70%
Respiratory Distress	15	10.80%
Hyperalbuminuria	13	9.40%

Stratified analysis demonstrated significant associations between maternal age >30 years and increased risk of preeclampsia (30.3% vs 7.9%, p=0.001), polyhydramnios (19.7% vs 3.2%, p=0.003), and hyperalbuminuria (14.5% vs 3.2%, p=0.037), while respiratory distress showed borderline significance (15.8% vs 4.8%, p=0.053) (as shown in Table-III). BMI >25 kg/m^2 was significantly associated with preeclampsia (32.9% vs 0.0%, p<0.001), polyhydramnios (17.6% vs 3.7%, p=0.016), and

hyperalbuminuria (15.3% vs 0.0%, p=0.002). Higher parity (>2) showed strong associations with preeclampsia (37.8% vs 11.7%, p<0.001), polyhydramnios (28.9% vs 4.3%, p<0.001), and hyperalbuminuria (17.8% vs 5.3%, p=0.028). Socioeconomic status demonstrated significant associations with most outcomes, with rich patients showing higher rates of preeclampsia (46.4%), polyhydramnios (32.1%), and hyperalbuminuria (28.6%) compared to poor patients (all 0.0%) (p<0.001 for preeclampsia, polyhydramnios, and hyperalbuminuria; p=0.013 for low birth weight). Educational level showed similar patterns, with higher education associated with increased preeclampsia (46.4%), polyhydramnios (32.1%), and hyperalbuminuria (28.6%) compared to uneducated patients (all 0.0%) (p<0.001 for preeclampsia and hyperalbuminuria; p=0.002 for polyhydramnios). Urban residence was significantly associated with higher rates of all complications except respiratory distress, with preeclampsia (27.7% vs 0.0%, p<0.001), polyhydramnios (16.8% vs 0.0%, p=0.007), low birth weight (18.8% vs 0.0%, p=0.004), and hyperalbuminuria (12.9% vs 0.0%, p=0.020). Family history of diabetes showed no significant associations with any of the studied outcomes, with p-values ranging from 0.075 to 1.000.

Table III

Association of maternal and fetal outcome with demographic factors

Demographic Factors		Preeclampsia		p-value	Polyhydramnios		p-value	LBW		p-value	Respiratory Distress		p-value	Hyperalbuminuria		p-value
		Yes n(%)	No n(%)		Yes n(%)	No n(%)		Yes n(%)	No n(%)		Yes n(%)	No n(%)		Yes n(%)	No n(%)	
Age (years)	≤30	5 (7.9 %)	58 (92.1 %)	0.001*	2 (3.2 %)	61 (96.8 %)	0.003*	7 (11.1 %)	56 (88.9 %)	0.467	3 (4.8 %)	60 (95.2 %)	0.053*	2 (3.2 %)	61 (96.8 %)	0.037*
	>30	23 (30.3 %)	53 (69.7 %)		15 (19.7 %)	61 (80.3 %)		12 (15.8 %)	64 (84.2 %)		12 (15.8 %)	64 (84.2 %)		11 (14.5 %)	65 (85.5 %)	
BMI (Kg/m^2)	≤25	0 (0.0 %)	54 (100.0 %)	<0.001*	2 (3.7 %)	52 (96.3 %)	0.016*	7 (13.0 %)	47 (87.0 %)	1.000	3 (5.6 %)	51 (94.4 %)	0.162*	0 (0.0 %)	54 (100.0 %)	0.002*
	>25	28 (32.9 %)	57 (67.1 %)		15 (17.6 %)	70 (82.4 %)		12 (14.1 %)	73 (85.9 %)		12 (14.1 %)	73 (85.9 %)		13 (15.3 %)	72 (84.7 %)	
Parity	≤2	11 (11.7 %)	83 (88.3 %)	<0.001*	4 (4.3 %)	90 (95.7 %)	<0.001*	9 (9.6 %)	85 (90.4 %)	0.063	7 (7.4 %)	87 (92.6 %)	0.082	5 (5.3 %)	89 (94.7 %)	0.028*
	>2	17 (37.8 %)	28 (62.2 %)		13 (28.9 %)	32 (71.1 %)		10 (22.2 %)	35 (77.8 %)		8 (17.8 %)	37 (82.2 %)		8 (17.8 %)	37 (82.2 %)	
Socioeconomic Status	Poor	0 (0.0 %)	38 (100.0 %)	<0.001*	0 (0.0 %)	38 (100.0 %)	<0.001*	0 (0.0 %)	38 (100.0 %)	0.013*	2 (5.3 %)	36 (94.7 %)	0.475*	0 (0.0 %)	38 (100.0 %)	<0.001*
	Middle	15 (20.5 %)	58 (79.5 %)		8 (11.0 %)	65 (89.0 %)		13 (17.8 %)	60 (82.2 %)		9 (12.3 %)	64 (87.7 %)		5 (6.8 %)	68 (93.2 %)	
	Rich	13 (46.4 %)	15 (53.6 %)		9 (32.1 %)	19 (67.9 %)		6 (21.4 %)	22 (78.6 %)		4 (14.3 %)	24 (85.7 %)		8 (28.6 %)	20 (71.4 %)	
Education	Uneducated	0 (0.0 %)	29 (100.0 %)	<0.001*	0 (0.0 %)	29 (100.0 %)	0.002*	0 (0.0 %)	29 (100.0 %)	0.076*	2 (6.9 %)	27 (93.1 %)	0.471*	0 (0.0 %)	29 (100.0 %)	<0.001*
	Primary	2 (8.0 %)	23 (92.0 %)		2 (8.0 %)	23 (92.0 %)		5 (20.0 %)	20 (80.0 %)		1 (4.0 %)	24 (96.0 %)		2 (8.0 %)	23 (92.0 %)	
	Secondary	13 (22.8 %)	44 (77.2 %)		6 (10.5 %)	51 (89.5 %)		8 (14.0 %)	49 (86.0 %)		8 (14.0 %)	49 (86.0 %)		3 (5.3 %)	54 (94.7 %)	
	Higher	13 (46.4 %)	15 (53.6 %)		9 (32.1 %)	19 (67.9 %)		6 (21.4 %)	22 (78.6 %)		4 (14.3 %)	24 (85.7 %)		8 (28.6 %)	20 (71.4 %)	
Residential Status	Rural	0 (0.0 %)	38 (100.0 %)	<0.001*	0 (0.0 %)	38 (100.0 %)	0.007*	0 (0.0 %)	38 (100.0 %)	0.004*	2 (5.3 %)	36 (94.7 %)	0.238*	0 (0.0 %)	38 (100.0 %)	0.020*
	Urban	28 (27.7 %)	73 (72.3 %)		17 (16.8 %)	84 (83.2 %)		19 (18.8 %)	82 (81.2 %)		13 (12.9 %)	88 (87.1 %)		13 (12.9 %)	88 (87.1 %)	
Family History of Diabetes	Yes	6 (18.8 %)	26 (81.3 %)	0.82	2 (6.3 %)	30 (93.8 %)	0.35	4 (12.5 %)	28 (87.5 %)	1.00	6 (18.8 %)	26 (81.3 %)	0.09	0 (0.0 %)	32 (100.0 %)	0.07

No	22 (20.6 %)	85 (79.4 %)	15 (14.0 %)	92 (86.0 %)	15 (14.0 %)	92 (86.0 %)	9 (8.4 %)	98 (91.6 %)	13 (12.1 %)	94 (87.9 %)

DISCUSSION

This study examined the maternal and fetal outcomes in gestational diabetes mellitus and their associations with various demographic factors. The findings indicated that advanced maternal age > 30 years, BMI > 25 kg/m^2, higher parity, better socioeconomic status, higher education, and urban residence were highly associated with higher complication rates such as preeclampsia, polyhydramnios, and hyperalbuminuria. The age-related complications are secondary to decreased insulin sensitivity and lowered vascular compliance that accompany advanced maternal age. The strong association between higher BMI and poor outcomes reflects the complex interaction between obesity-linked chronic inflammation and insulin resistance that catalyzes hyperglycemia and resultant fetal macrosomia. The paradoxical association between better socioeconomic status and higher education and complications most likely results from disparities in access to care and diagnostic workup, so that women benefiting from better socioeconomic status receive closer monitoring that translates to higher detection of complications. Similarly, the much higher complication rates among urban residents are secondary to disparities in lifestyle such as sedentary lifestyle and processed foods, and better access to care and resultant higher detection rates compared to their rural peers.

Our findings demonstrate that maternal age >30 years significantly increases the risk of preeclampsia (30.3% vs 7.9%, p=0.001), polyhydramnios (19.7% vs 3.2%, p=0.003), and hyperalbuminuria (14.5% vs 3.2%, p=0.037). This aligns closely with the study by Rajshree D & Adithi JP[17], which reported that 68% of GDM mothers were >30 years compared to 40% in controls, and with Qadir SY et al.[18], where 88% of GDM patients were >25 years with a mean age of 32.3 years. Similarly, Jani R et al.[19] reported a mean maternal age of 31.3 years in their GDM cohort. The consistency across studies from different geographical regions reinforces the established association between advanced maternal age and GDM complications, likely due to age-related insulin resistance and metabolic changes.

Our study revealed that BMI >25 kg/m^2 was significantly associated with preeclampsia (32.9% vs 0.0%, p<0.001), polyhydramnios (17.6% vs 3.7%, p=0.016), and hyperalbuminuria (15.3% vs 0.0%, p=0.002). While our mean BMI of 26.42±2.94 kg/m^2 was relatively lower than several comparative studies, the association patterns remain consistent. Van Zyl S & Levitt NS[20] reported much higher median booking BMI values: 34.8 kg/m^2 for T2DM, 34.5 kg/m^2 for GDM, and 32.8 kg/m^2 for IGT patients. Jani R et al.[19] found that 44.2% of their GDM patients were obese (BMI ≥30 kg/m^2), while Rajshree D & Adithi JP[17] reported that 16% of GDM mothers had pre-pregnancy BMI ≥30 kg/m^2 compared to only 2% in controls. The lower BMI in our cohort may reflect regional dietary patterns, genetic factors, or different population characteristics, yet the significant associations with complications persist even at lower BMI thresholds.

Our study identified preeclampsia as the most common maternal complication, affecting 20.10% of participants. This finding is consistent with multiple studies: Khan R et al.[21] reported pregnancy-induced hypertension in 22.3% of GDM patients versus 11.3% in controls (p=0.029), and preeclampsia in 16.5% versus 6.2% (p=0.027). Qadir SY et al.[18] documented preeclampsia in 12% of their GDM cohort, while Jani R et al.[19] reported pregnancy-induced hypertension in 46.1% of cases. The variation in rates may be attributed to different diagnostic criteria, population characteristics, and healthcare settings, but the consistently elevated risk across studies confirms the strong association between GDM and hypertensive disorders of pregnancy.

Polyhydramnios occurred in 12.20% of our patients, which is notably lower than several comparative studies. Jani R et al.[19] reported polyhydramnios in 38.4% of GDM patients, while Rajshree D & Adithi JP[17] found it in 28% of GDM cases versus 2% in controls. Qadir SY et al.[18] documented polyhydramnios in 18% of their cohort. The lower prevalence in our study might reflect better glycemic control, different diagnostic criteria for polyhydramnios, or population-specific factors. However, our stratified analysis confirmed significant associations with maternal age >30 years (p=0.003), BMI >25 kg/m^2 (p=0.016), and higher parity (p<0.001), supporting the established pathophysiology linking maternal hyperglycemia to fetal hyperinsulinemia and excessive amniotic fluid production.

Our study identified low birth weight in 13.70% of neonates, which contrasts with the macrosomia patterns reported in most comparative studies. Khan R et al.[21] found macrosomia in 28.2% of GDM neonates versus 10.3% in controls (p=0.001), while Rajshree D & Adithi JP[17] reported macrosomia >4 kg in 36% of GDM neonates versus 10% in controls, with mean birth weight of 3.43 kg versus 3.1 kg in controls. Qadir SY et al.[18] documented macrosomia in 36% of neonates, and Jani R et al.[19] reported macrosomia in 10.5% with mean birth weight increasing with HbA1c levels. The predominance of low birth weight in our cohort may indicate better glycemic control, different nutritional status, or the presence of other confounding factors such as preeclampsia or preterm delivery affecting fetal growth.

Respiratory distress affected 10.80% of neonates in our study, showing borderline significance with maternal age >30 years (p=0.053). This finding aligns with Jani R et al.[19], who reported prematurity in 16.3% of cases, and Khan R et al.[21], who found preterm labor in 25.2% of GDM patients versus 8.2% in controls (p=0.001). Van Zyl S & Levitt NS[20] reported preterm delivery rates of 34.9% for GDM patients, significantly higher than our findings. The relatively lower respiratory complications in our study may reflect better antenatal care, appropriate timing of delivery, or different criteria for respiratory distress diagnosis.

Our study uniquely demonstrated significant associations between socioeconomic status and GDM complications, with higher-income patients showing increased rates of preeclampsia (46.4% vs 0.0%, p<0.001), polyhydramnios (32.1% vs 0.0%, p<0.001), and hyperalbuminuria (28.6% vs 0.0%, p<0.001). Similarly, higher educational levels were associated with increased complications. This counterintuitive finding may reflect better healthcare access leading to more comprehensive diagnostic evaluation and detection of complications, different lifestyle factors, or selection bias in our patient population. Most comparative studies did not stratify results by socioeconomic status, limiting direct comparison of these novel findings.

While our study did not specifically report preterm birth rates, the mean gestational age of 37.92±0.79 weeks suggests some degree of preterm delivery. This aligns with Van Zyl S & Levitt NS[20], who reported preterm delivery before 38 weeks in 34.9% of GDM patients, and Khan R et al.[21], who found preterm labor in 25.2% of GDM cases. The consistency across studies reinforces the association between GDM and preterm birth, likely due to maternal complications necessitating early delivery or spontaneous preterm labor secondary to polyhydramnios and other complications.

This study has several limitations that should be acknowledged. Being a single-center study, the generalizability of findings may be limited to similar healthcare settings and populations. The relatively small sample size may have affected the statistical power to detect smaller but clinically significant associations. Additionally, the lack of long-term follow-up data prevents assessment of postpartum outcomes and future diabetes risk. The absence of detailed glycemic control parameters, such as HbA1c levels and glucose monitoring data, limits our ability to correlate outcomes with the degree of metabolic control. Furthermore, the study did not account for potential confounding factors such as medication adherence, dietary compliance, or the timing of GDM diagnosis during pregnancy, which could have influenced the observed outcomes.

CONCLUSION

Our study identified that gestational diabetes mellitus significantly increased the risk of adverse fetal and maternal outcomes, and its most common complications are preeclampsia, polyhydramnios, and low birth weight. High parity, older maternal age, and higher BMI became significant risk factors to develop such complications. Individually, socioeconomic status and level of education showed significant correlations to GDM outcomes, which mean that awareness and accessibility to healthcare significantly determine disease management.

Acknowledgments

We thanks the dedicated department staff, whose meticulous attention record management and patient documentation played a crucial role throughout this work.

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