

Assessment of Risk Factors and Their Impact on Maternal and Fetal Outcomes in Gestational Diabetes Mellitus

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Received: 10-11-2025 / Revised: 15-12-2025 / Accepted: 22-01-2026

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Conflict of interest: Nil

Abstract:

Background: Gestational diabetes mellitus (GDM) is defined as carbohydrate intolerance first recognized during pregnancy and is associated with significant maternal and neonatal morbidity.

Aim: To assess risk factors associated with GDM and evaluate their impact on maternal and fetal outcomes.

Methodology: A prospective observational study was conducted over 8 months in the Department of Obstetrics and Gynaecology at Nalanda Medical College and Hospital, Patna, Bihar, India. Sixty pregnant women diagnosed with GDM by 75 g OGTT (≥ 140 mg/dL) between 24–34 weeks were enrolled and followed until delivery. Women with overt diabetes were excluded. Data were analyzed using descriptive statistics and Chi-square test ($p < 0.05$ significant).

Results: Most women were aged 21–25 years (43.33%); 48.34% were overweight/obese and 33.33% had a family history of GDM. Maternal complications occurred in 38.33%, commonly polyhydramnios (13.33%) and pre-eclampsia (10%). Preterm delivery occurred in 25% and cesarean section in 40%. Neonatal complications included macrosomia (23.33%), NICU admission (15%), and hypoglycemia (10%). Significant correlations were observed between OGTT and gestational age ($R = -0.432$, $p = 0.001$), and between APGAR score and gestational age ($R = 0.681$, $p < 0.001$).

Conclusion: GDM significantly impacts maternal and fetal outcomes. Early detection, glycemic control, and timely intervention are crucial to improve perinatal outcomes.

Keywords: Gestational diabetes mellitus, risk factors, maternal outcomes, neonatal outcomes, macrosomia, OGTT.

DOI: 10.25258/Ijpqa.17.1.51

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Introduction

Gestational diabetes mellitus (GDM) is a term that is characterized as carbohydrate intolerance of unpredictable intensity that starts and is first identified during the current pregnancy. Practically, any new cases of diabetes identified in pregnancy are a type of transient diabetes type 2. A minimal percentage of cases of de novo diabetes are revealed to continue to exist post the pregnancy with the majority being type II diabetes mellitus (DM). But in very few cases, type I DM can occur during pregnancy, and this is just by coincidence [1]. This definition emphasizes the heterogeneity of glucose intolerance initially discovered in pregnancy and the necessity to pay close attention to the assessment and follow-up of the women affected.

GDM is regarded as a contentious clinical phenomenon and is generally perceived as the unveiling of an already compensated metabolic defect which is relative insulin deficiency and enhanced insulin resistance. Pregnancy per se is also a diabetogenic condition with modifications in the maternal metabolism that enhances insulin resistance, especially in the second and third trimester [2] in the condition. Several hormones (human placental lactogen, progesterone, cortisol, growth hormone) are also responsible of this insulin-resistant, which is necessary to guarantee satisfactory supply of glucose to the growing fetus. With a finite pancreatic β -cell reserve or a pre-existing state of metabolic vulnerability, this physiological insulin resistance can be beyond compensatory limits, leading to hyperglycemia and the clinical expression of GDM.

GDM is a special clinical case whereby possible negative consequences to the mother and fetus are paramount and have to be outlined. Maternal hyperglycemia has a direct impact on intrauterine environment culminating in cascade of metabolic changes that can impact on fetal growth and development [3]. Unmanaged GDM is linked to elevated maternal morbidity including preeclampsia, polyhydramnios, operative birth, as well as the development of overt diabetes in the future. In the case of the fetus, the problems might be macrosomia, birth trauma, neonatal hypoglycemia, respiratory distress syndrome, and long-term metabolic effects.

Although the notion of GDM has been acknowledged to be of clinical importance, the issue has not always been agreed upon. Jarrett [4] referred to the GDM as a non-entity whose sole clinical correlation is with an elevated risk of the mother later developing into a diabetic. This perspective implied that GDM may only be an indication of a tendency towards the future onset of diabetes and not a separate pathological process that influences the pregnancy outcomes. By contrast, Hunter and Milner have indicated that gestational diabetes is a diagnosis that is yet to find an aetiology thus suggesting that there is still a great degree of ambiguity as to its clinical implication and diagnosis criteria. Nonetheless, Beard and Hoet [5] have also concluded that GDM is a clinical entity, which is linked to high rates of maternal and fetal morbidity. They have based their observations on the growing clinical evidence that untreated or poorly treated GDM is a significant contributor to poor pregnancy outcomes.

Thereafter, research studies have established that perinatal and maternal morbidity of the women with GDM can be minimized by adopting a systematic method of identifying and managing the disease. Early prenatal screening, prompt diagnosis, proper management of glycemia in the form of diet and exercise in the case of diabetes, and close antenatal monitoring have been reported to make a significant difference in the outcome of the pregnancy. These observations support the essential role of considering GDM as a condition that has both clinical and biochemical significance to the mother and child [6] rather than being viewed as a biochemical abnormality.

There is also a wide range of epidemiology of GDM in that there are hereditary, environmental, and lifestyle factors. Indian statistics on GDM are limited and fail to paint the real image of its real prevalence and risk factors. India is a moderately high-risk category of diabetes, and due to the introduction of the western lifestyle with sedentary lifestyle, high caloric intake, and the rising prevalence of obesity, diabetes type II is becoming a runaway epidemic. As a result, the issue of women with GDM is also on the increase. This accumulating load highlights the pressing need to have region-specific data in order

to comprehend the scale of the issue and to implement viable screening and management protocols to suit the local population.

The risk factors that are usually linked to GDM are advanced maternal age, obesity, a history of diabetes in the family, a history of GDM, a history of macrosomic babies, an unexplained infant demise in the womb, polycystic ovarian syndrome, and high-risk ethnic groups. Nevertheless, these factors could have different proportions in populations. These risk factors should be identified not only to facilitate early detection, but also to take certain preventive measures and special surveillance during pregnancy.

Despite the many studies being conducted in the past years, there are still a lot of controversies relating to the best way to screen and diagnose GDM. The issue of whether universal screening should be used or selective screening based on risk factors should be used is one of the main controversies. Moreover, the world is yet to agree on the best diagnostic test and the most optimal cut-off values of blood glucose levels. The inconsistency of diagnosis and prevalence rates of the disease was caused by variations in criteria offered by various organizations. These ambiguities underscore the need to engage in further research to shed more light on the best and workable strategies that can be used to identify and manage GDM.

Since there is a possibility of severe morbidity in both the mother and the fetus and with the increasing number of cases of diabetes among the reproductive age group, there is an urgent need to determine the risk factors of GDM and the implications of this disease in pregnancy. An overall comprehension of these associations will help in formulating evidence-based guidelines to screen, manage and follow up mothers, which will eventually enhance maternal and neonatal health.

The current research is expected to evaluate the risk factors of gestational diabetes mellitus, as well as to determine the effects of GDM on both mothers and infants. Recognizing the risk factors involved and examining their role in causing pregnancy-related complications, the proposed study aims at deepening the knowledge of the clinical importance of GDM and contribute to more beneficial approaches in the field of early diagnosis, treatment, and prevention of unfavorable maternal and infant outcomes.

Methodology

Study Design: This research was conducted as a prospective observational study to assess the risk factors associated with Gestational Diabetes Mellitus (GDM) and to evaluate their impact on maternal and fetal outcomes. The prospective design enabled systematic follow-up of diagnosed cases from the time of detection until delivery, allowing for

assessment of treatment response and pregnancy outcomes.

Study Area: The study was carried out in the Department of Obstetrics and Gynaecology, Nalanda Medical College and Hospital, Patna, Bihar, India.

Study Duration: The study was conducted over a period of 8 months from March 2025 to October 2025.

Study Population: The study population comprised pregnant women attending the antenatal outpatient department of the Department of Obstetrics and Gynaecology who were diagnosed with GDM during the study period. These women were monitored throughout their pregnancy to evaluate associated risk factors and pregnancy outcomes.

Sample Size: A total of 60 pregnant women diagnosed with GDM and meeting the inclusion criteria were enrolled consecutively during the study period. The sample included all eligible participants identified within the 8-month duration.

Source of Data: All pregnant women attending antenatal care were subjected to universal screening for GDM between 24 and 28 weeks of gestation using a 75 g oral glucose load, followed by measurement of 2-hour plasma glucose levels. A value greater than 140 mg/dL was considered diagnostic of GDM as per the guidelines of the Diabetes in Pregnancy Study Group India, which are a modified version of the criteria recommended by the World Health Organization. After diagnosis, HbA1c estimation was performed. Women with HbA1c values greater than 6.5% were considered to have overt diabetes and were excluded from the study. In women who tested negative during the second trimester, the screening test was repeated at 32–34 weeks of gestation.

Inclusion Criteria

- Pregnant women diagnosed with GDM at:
 - Second trimester (24–28 weeks)
 - Third trimester (32–34 weeks)

Exclusion Criteria

The following women were excluded:

- Women with overt diabetes mellitus (HbA1c >6.5%).
- Women with pre-existing chronic medical disorders diagnosed before pregnancy (e.g., chronic hypertension, renal disease, cardiac disease, thyroid disorders).
- Women unwilling to provide informed consent.

Data Collection: Upon enrollment, detailed history and clinical information were obtained using a

structured proforma. Information collected included maternal age, marital duration, family history of diabetes, obstetric history (including previous abortions, intrauterine fetal demise, and history of macrosomia), past medical history, and body mass index (BMI). All patients diagnosed with GDM were counseled regarding Medical Nutritional Therapy (MNT) and lifestyle modification. They were advised regular self-monitoring of blood glucose levels at home. After two weeks of MNT, venous plasma glucose was reassessed. If the 2-hour postprandial blood sugar remained above 120 mg/dL, insulin therapy was initiated in consultation with a physician or endocrinologist.

Procedure: After confirmation of GDM diagnosis, patients were categorized based on the mode of treatment into two groups: those managed with Medical Nutritional Therapy alone and those requiring both Medical Nutritional Therapy and insulin. All participants were followed regularly during antenatal visits until delivery. Maternal outcomes such as pregnancy-induced hypertension, polyhydramnios, preterm labor, and mode of delivery were recorded. Fetal and neonatal outcomes including birth weight, macrosomia, neonatal hypoglycemia, NICU admission, and perinatal mortality were documented and analyzed.

Statistical Analysis: Data collected were entered into Microsoft Excel and analyzed using appropriate statistical software. Descriptive statistics such as mean, standard deviation, frequencies, and percentages were used to summarize demographic and clinical variables. The association between qualitative variables was assessed using the Chi-square test. A p-value of less than 0.05 was considered statistically significant.”

Result

Table 1 summarizes the socio-demographic and obstetric characteristics of the study population (n = 60). The majority of women were aged 21–25 years (26, 43.33%), followed by 26–30 years (20, 33.33%), ≥31 years (9, 15%), and <20 years (5, 8.33%). Regarding parity, 22 women (36.67%) were primigravida, 18 (30%) were gravida-2, 12 (20%) gravida-3, 6 (10%) gravida-4, and 2 (3.33%) gravida-5. A family history of gestational diabetes mellitus (GDM) was present in 20 women (33.33%), while 40 (66.67%) had no such history. In terms of BMI, 28 women (46.67%) had BMI 20.1–24.9 kg/m², 19 (31.67%) were overweight (25.0–29.9 kg/m²), 10 (16.67%) were obese (≥30.0 kg/m²), and 3 (5%) had BMI <20 kg/m². Overall, most participants were young adults, predominantly primigravida or second gravida, with a considerable proportion being overweight or obese.

Variable	Category	Number	Percentage
Age (Years)	<20	5	8.33
	21–25	26	43.33
	26–30	20	33.33
	≥31	9	15
Parity	Primigravida	22	36.67
	Gravida-2	18	30
	Gravida-3	12	20
	Gravida-4	6	10
	Gravida-5	2	3.33
Family History of GDM	Present	20	33.33
	Absent	40	66.67
BMI (kg/m²)	<20.0	3	5
	20.1–24.9	28	46.67
	25.0–29.9	19	31.67
	≥30.0	10	16.67

Table 2 outlines the previous obstetric history among 38 multiparous women. The most common prior complication was abortion, reported in 14 women (36.84%). A previous history of gestational diabetes mellitus (GDM) was noted in 8 women (21.05%). Preterm delivery had occurred in 7 cases (18.42%), while congenital anomalies were reported

in 6 cases (15.79%). Macrosomia was documented in 5 women (13.16%), and intrauterine death (IUD) in 4 women (10.53%). Overall, a substantial proportion of multiparous women had experienced adverse obstetric outcomes in previous pregnancies, with abortion being the most frequent.

Complication	Number	Percentage
Abortion	14	36.84
Congenital anomaly	6	15.79
Previous H/O GDM	8	21.05
Preterm delivery	7	18.42
Macrosomia	5	13.16
Intrauterine death (IUD)	4	10.53

Table 3 summarizes maternal complications, treatment, and pregnancy outcomes among 60 women. Regarding maternal complications, polyhydramnios was the most common (8 cases, 13.33%), followed by pre-eclampsia (6, 10%), urinary tract infection (5, 8.33%), and vaginitis (4, 6.67%), while the majority (37, 61.67%) had no complications. In terms of therapy, most women were managed with medical nutrition therapy (MNT) alone (38, 63.33%), whereas 22

(36.67%) required MNT plus insulin. Concerning gestational age at delivery, 45 women (75%) delivered at term and 15 (25%) had preterm deliveries. Vaginal delivery was the most common mode (36, 60%), while 24 women (40%) underwent cesarean section (LSCS). Overall, most pregnancies had favorable outcomes with term delivery and vaginal birth predominating.

Variable	Category	Number	Percentage
Maternal Complications	Polyhydramnios	8	13.33
	Pre-eclampsia	6	10
	UTI	5	8.33
	Vaginitis	4	6.67
	No complication	37	61.67
	Therapy Advised	MNT alone	38
MNT + Insulin		22	36.67
Gestational Age at Delivery	Preterm	15	25
	Term	45	75
Mode of Delivery	Vaginal delivery	36	60
	Cesarean section (LSCS)	24	40

Table 4 presents the neonatal outcomes among 60 newborns. The majority, 38 neonates (63.33%), had no complications. Macrosomia (>3.5 kg) was the most common adverse outcome, observed in 14 cases (23.33%). NICU admission was required for 9 neonates (15%). Neonatal hypoglycemia occurred in

6 cases (10%), while hyperbilirubinemia was noted in 5 cases (8.33%). Overall, although most neonates had favorable outcomes, macrosomia and NICU admissions were the most frequent complications observed.

Outcome	Number	Percentage
Macrosomia (>3.5 kg)	14	23.33
Neonatal hypoglycemia	6	10
Hyperbilirubinemia	5	8.33
NICU admission	9	15
No complication	38	63.33

Table 5 shows the association between parity and maternal complications among 60 women. Among primiparous women (n = 22), 9 (40.91%) developed maternal complications, while 13 did not. In the multiparous group (n = 38), 14 women (36.84%) developed complications and 24 had no complications.

Overall, 23 out of 60 women experienced maternal complications, whereas 37 did not. The proportion of complications was slightly higher in primiparous women compared to multiparous women, although the difference appears minimal.

Parity	Maternal Complication Developed (%)	No Maternal Complication	Total
Primiparity (n=22)	9 (40.91)	13	22
Multiparity (n=38)	14 (36.84)	24	38
Total	23	37	60

Table 6 presents the significant correlations among clinical variables in 60 subjects. Gestational age showed a moderate negative correlation with OGTT values (R = -0.432, p = 0.001), indicating that higher OGTT levels were associated with lower gestational age. Birth weight was positively correlated with gestational age (R = 0.402, p = 0.002), suggesting that longer gestation was associated with higher birth weight. APGAR score had a moderate negative

correlation with OGTT (R = -0.389, p = 0.003), while it demonstrated a strong positive correlation with gestational age (R = 0.681, p < 0.001) and a moderate positive correlation with birth weight (R = 0.521, p < 0.001). Overall, higher gestational age and birth weight were significantly associated with better APGAR scores, whereas higher OGTT levels were associated with poorer neonatal outcomes.

Sl. No.	Variable-1	Variable-2	Correlation Coefficient (R)	P-value
1	Gestational age	OGTT	-0.432	0.001*
2	Birth weight	Gestational age	0.402	0.002*
3	APGAR	OGTT	-0.389	0.003*
4	APGAR	Gestational age	0.681	0.000*
5	APGAR	Birth weight	0.521	0.000*

Discussion

Gestational diabetes mellitus (GDM) continues to be a major factor leading to poor maternal and birth outcomes, especially in patient groups with high background rates of glucose intolerance. In the current study, most women fell in the age group of 21-30 years (43.33%), 26-30 (33.33%). Whereas classical literature stressed the advanced maternal age (>35 years) as a risk factor, recent evidence suggests that the risk starts to increase significantly after 25 years. The GDM incidence curves in Lao et al., (2006) [7] showed a gradual rise in incidence after 25 years, which confirms our finding of the trends of the large

percentage of affected women in the age bracket of 21-30 years. In the same manner, Seshiah et al., (2008) [8] indicated growing prevalence of GDM among younger Indian women, which is caused by lifestyle changes and as a result, upward adiposity. These results suggest that screening interventions in high-risk ethnic groups cannot be reduced to older gravidas.

Body mass index (BMI) turned out to be a significant risk factor in our cohort, and 31.67 percent of them were overweight and the other 16.67 percent were obese. The correlation of high BMI and GDM is highly established. American Diabetes

Association stated that GDM complicates about 7 percent of pregnancies, and obesity is a key factor that could be modified (American Diabetes Association [ADA], 2010) [9]. Similar to our results of 33.33% participants having familial predisposition to GDM, Moses et al., (1997) [10] found higher GDM rates in women with positive family history (11.6%). The disproportionately higher percentage in our study can be attributed to genetic susceptibility within the Indian populations as they are known to have very high insulin resistance with a lower BMI index.

As to obstetric history, 21.05% of women who had multiple parities had a history of GDM, significant percentages had a history of previous abortions (36.84), preterm birth (18.42), birth anomalies (15.79), macrosomia (13.16), and intrauterine mortality (10.53). The findings can be compared with other previous accounts by O'Sullivan et al., (1964) [11] who characterized the relationship between maternal hyperglycemia and poor perinatal outcomes and found that, the rate of perinatal mortality among GDM pregnancies was 6.4 percent. Despite our study showing no cases of maternal or perinatal mortality, probably caused by better glycemic monitoring and institutional births, the fact that our indicators of morbidity, including macrosomia and NICU admission remained high still points to the clinical burden.

Maternal complications were also noted in 38.33, the most common was polyhydramnios (13.33) and pre-eclampsia (10). Classical research by Garner et al., (1992) [12] revealed that the occurrence of pre-eclampsia was almost twice in GDM pregnancies. This high risk corresponds with our 10 percent charge, but some modern studies have doubted the intensity of this relationship. Sibain et al., (2000) [13] found that 9 percent of the diabetic women were delivering preterm before 35 weeks versus 4.5 percent of non-diabetics. Conversely, we had a higher preterm rate at 25% that might be attributed to the variations in the severity of glycemic or referral bias in tertiary care or other risk factors of obstetrics.

There was polyhydramnios in 13.33 of our participants. Earlier statistics indicate that a proportion of about 14% of cases of polyhydramnios is caused by diabetes, which indicates the same in our results. Pathophysiology is associated with osmotic diuresis induced by hyperglycemia in fetuses due to maternal hyperglycemia, and the strictness of glucose regulation can help in its prevention. In our analysis, 63.33% of the women were treated to medical nutrition therapy (MNT) only and 36.67% needed insulin, similarities of which had been previously reported in Indian cohort studies by Anjalakshi et al., (2009) [14] who had validated the use of 75 g OGTT with or without previous meals but found that glycemic detection was effective with this method.

Mode of delivery analysis has shown that the rate of cesarean section is higher than general obstetric populations at 40 per cent which is more or less similar to the literature on GDM due to the presence of macrosomia and obstetric complications. Delivery in the vagina took place in 60% indicating that with good glycemic control the rate of operative intervention could be cut. The prevalence of neonatal macrosomia was found to be 23.33% in newborns, which is similar to the world figure of 15-45% in GDM pregnancies. In our study, results of the moderate positive correlation between the gestational age and birth weight ($R = 0.402$, $p = 0.002$) are consistent with the already known facts that the duration of hyperglycemia exposure can help in improving fetal growth.

It is further indicated that metabolic effects of maternal hyperglycemia occur in neonatal hypoglycemia (10%), hyperbilirubinemia (8.33%), and NICU admission (15%). Notably, APGAR score had a moderate-magnitude negative relationship with the OGTT values ($R = -0.389$, $p = 0.003$) and strong positive relationship with gestational age ($R = 0.681$, $p < 0.001$). These results support the idea expressed by Jarrett, (1993) who argued the clinical case of slight gestational hyperglycemia only to admit that it is correlated with quantifiable neonatal NIHL [4]. With our findings, it is evident that the worsening of glucose intolerance is negatively associated with the immediate well-being of the neonate, regardless of whether it is fatal or not.

The correlation between gestational age and OGTT values is negative ($R = -0.432$, $p = 0.001$), which is why it is possible that a low level of glycemic control can precondition premature delivery, whether it is spontaneous or induced. This is consistent with pathophysiological insights presented in classical obstetric literature by Bassaw et al., (2018) that indicate that uncontrolled maternal hyperglycemia leads to placental dysfunction and obstetric intervention [15].

In general, although there were no cases of maternal and perinatal mortality in our cohort, the indicators of morbidity that were of concern include preterm birth, polyhydramnios, pre-eclampsia, macrosomia, and NICU admission. The better results that we have had, compared with the older reports of higher mortality, are likely due to universal screening, early diagnosis of 75 g OGTT, nutritional therapy, insulin use where needed, and better neonatal care. However, the statistically relevant associations between glycemic measurements and neonatal variables support the dose-response association between maternal hyperglycemia and poor outcomes. The results indicate the possibility of early risk evaluation, particularly among younger, overweight female patients with a positive family history, and substantiate the idea that strict glycemic management is the

cornerstone of the optimal mother and fetus prognosis in GDM.

Conclusion

The current research paper illuminates that the occurrence of gestational diabetes mellitus is based on various socio-demographic and obstetric and clinical risk factors, such as the maturation of maternal age, high parity, excessive body mass index, positive family history, and poor past obstetric prognosis. These were linked to a significant rate of maternal complications including polyhydramnios and pre-eclampsia and neonatal complications, which included macrosomia, hypoglycemia, hyperbilirubinemia, and higher NICU admissions. Although a majority of women achieved favorable outcomes with medical nutrition therapy alone, a substantial proportion required insulin support. Significant correlations between glycemic status, gestational age, birth weight, and APGAR scores further emphasize the impact of glycemic control on both maternal and fetal outcomes. Overall, early identification of risk factors, vigilant monitoring, and timely intervention are essential to minimize complications and improve pregnancy outcomes in women with gestational diabetes mellitus.

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