

Association of Glycaemic Control with Maternal and Neonatal Outcomes in Gestational Diabetes Mellitus: A Prospective Cohort Study

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ABSTRACT

Background: Gestational diabetes mellitus (GDM) is associated with adverse maternal and neonatal outcomes, and the degree of glycaemic control may influence the risk of these complications. **Objective:** To evaluate the association between glycaemic control and maternal and neonatal outcomes among women with GDM. **Methods & Materials:** This prospective cohort study was conducted in the Department of Obstetrics & Gynaecology, Mymensingh Medical College, Mymensingh, Bangladesh, from January to June 2026. A total of 100 women diagnosed with GDM were enrolled and categorized into well-controlled (n=60) and poorly controlled (n=40) groups according to their glycaemic status. Maternal and neonatal outcomes were recorded and compared between the groups. Associations were assessed using appropriate statistical tests, correlation analysis and multivariable logistic regression. **Results:** The mean age was 30.4 ± 4.8 years. Pre-pregnancy BMI was significantly higher in the poorly controlled group (27.0 ± 3.7 vs. 25.1 ± 3.2 kg/m², $p=0.010$). Fasting, 1-hour and 2-hour postprandial glucose and HbA1c were significantly higher among poorly controlled women (all $p<0.001$). Pre-eclampsia was more frequent in poorly controlled GDM (17.5% vs. 5.0%, $p=0.041$). Their neonates had higher birth weight (3485 ± 465 vs. 3068 ± 382 g, $p<0.001$), with increased macrosomia, LGA, neonatal hypoglycaemia and NICU admission. Glycaemic parameters positively correlated with birth weight. Poor glycaemic control independently predicted adverse neonatal outcomes (adjusted OR 3.42, 95% CI: 1.38–8.47; $p=0.008$). **Conclusion:** Poor glycaemic control was associated with increased maternal and neonatal complications. Optimal glycaemic management may improve pregnancy outcomes in women with GDM.

Keywords: Gestational diabetes mellitus; Glycaemic control; Pre-eclampsia; Macrosomia; Neonatal hypoglycaemia

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INTRODUCTION

Gestational diabetes mellitus (GDM) is one of the most common metabolic disorders complicating pregnancy and represents an important public health concern because of its implications for both maternal and neonatal health.^[1] It is characterized by hyperglycaemia first recognized during pregnancy and usually develops when the physiological insulin resistance of pregnancy exceeds the capacity of pancreatic β -cells to maintain adequate glucose homeostasis.^[2] The increasing prevalence of obesity, sedentary lifestyles, advanced maternal age and metabolic disorders has contributed to the growing burden of GDM worldwide. Recent evidence indicates that GDM is also common among women who are not overweight, particularly in Asian populations, highlighting the importance of appropriate antenatal screening irrespective of maternal body habitus.^[3] The clinical importance of GDM extends beyond the presence of maternal

hyperglycaemia. Maternal glucose concentrations are closely related to fetal growth and pregnancy complications, with the risk of adverse outcomes increasing progressively with increasing glycaemia. Findings from the Hyperglycemia and Adverse Pregnancy Outcome (HAPO) study and subsequent evidence have demonstrated that this relationship exists even within glucose concentrations previously considered to be normal during pregnancy.^[4] Current recommendations therefore emphasize early identification of abnormal glucose metabolism and screening for GDM at 24–28 weeks of gestation in women without previously diagnosed diabetes.^[2,5] The 2026 American Diabetes Association (ADA) Standards of Care recommend fasting plasma glucose below 95 mg/dL, 1-hour postprandial glucose below 140 mg/dL, or 2-hour postprandial glucose below 120 mg/dL as treatment targets during pregnancy.^[6] Poor glycaemic control in GDM may contribute to several adverse maternal

outcomes, including gestational hypertension, pre-eclampsia, excessive fetal growth, induction of labour and caesarean delivery.^[1] Hyperglycaemia promotes increased transplacental glucose transfer, resulting in fetal hyperinsulinaemia and increased fetal growth, particularly adipose tissue deposition.^[3] Consequently, women with poorly controlled GDM may have increased risks of large-for-gestational-age (LGA) infants, macrosomia and delivery-related complications. A recent systematic review and meta-analysis involving more than 642,000 participants found that GDM was associated with increased odds of caesarean delivery, pregnancy-induced hypertension, macrosomia and LGA birth.^[4] Neonatal complications are similarly important. Infants born to mothers with GDM are at increased risk of neonatal hypoglycaemia, jaundice, respiratory morbidity, preterm birth and admission to a neonatal intensive care unit (NICU).³

Recent meta-analytic evidence reported particularly strong associations between GDM and neonatal hypoglycaemia, preterm birth and NICU admission.^[4] Furthermore, a recent umbrella review incorporating 27 meta-analyses and more than 363 million participants demonstrated that GDM was associated with increased risks of hypertensive disorders, caesarean delivery, preterm birth, NICU admission, macrosomia and neonatal hypoglycaemia.^[1]

Importantly, the degree of glycaemic control may be more clinically informative than the diagnosis of GDM alone. Contemporary research using continuous glucose monitoring has demonstrated that higher mean glucose levels, glucose exposure and time above the recommended range are associated with increased risks of adverse pregnancy outcomes and LGA birth. In a prospective cohort of 1,302 women with GDM, higher continuous glucose monitoring-derived measures of hyperglycaemia were associated with greater risks of adverse pregnancy outcomes and NICU admission.^[7] Similarly, recent evidence suggests that the timing of postprandial glucose assessment may influence the identification and management of women at risk of adverse fetomaternal outcomes.^[8]

Although lifestyle modification, glucose monitoring and pharmacological therapy are routinely used to achieve recommended glycaemic targets, the relationship between the *degree of glycaemic control achieved during pregnancy* and subsequent maternal and neonatal outcomes requires further evaluation in different clinical settings.^[6] Current guidelines emphasize that appropriate glycaemic management can reduce fetal macrosomia, birth trauma, operative delivery and neonatal hypoglycaemia.^[6,9] However, evidence from contemporary cohorts is needed to determine whether women who maintain optimal glycaemic control experience substantially better outcomes than those with suboptimal control.^[10,11]

Therefore, a prospective cohort study evaluating the association between glycaemic control and maternal and neonatal outcomes among women with GDM is clinically relevant. Such an approach can help quantify the relationship between glycaemic status during pregnancy and outcomes such as hypertensive disorders, mode of delivery, macrosomia/LGA, preterm birth, neonatal hypoglycaemia, jaundice, respiratory complications and NICU admission. The findings may contribute to risk stratification and reinforce the importance of individualized glucose monitoring and timely intervention in women with GDM.

Objectives

The main objective was to determine the association between the level of glycaemic control during pregnancy and maternal and neonatal outcomes among women with gestational diabetes mellitus (GDM).

METHODS & MATERIALS

The prospective cohort study will be conducted in the Department of Obstetrics & Gynaecology, Mymensingh Medical College, Mymensingh, Bangladesh. The study will be carried out over six months from January 2026 to June 2026.

Inclusion Criteria:

- Pregnant women aged ≥ 18 years
- Women diagnosed with gestational diabetes mellitus (GDM) according to standard diagnostic criteria
- Women with a singleton pregnancy
- Women between 24 and 32 weeks of gestation at enrolment
- Women willing to undergo regular antenatal follow-up and blood glucose monitoring
- Women who provide informed written consent to participate in the study

Exclusion Criteria:

- Women with pre-existing type 1 or type 2 diabetes mellitus
- Women with multiple pregnancy
- Women with known major fetal congenital anomalies
- Women with severe pre-existing cardiac, renal, hepatic or other systemic diseases likely to affect pregnancy outcomes
- Women receiving medications that significantly affect glucose metabolism
- Women who are unable or unwilling to complete follow-up until delivery
- Women with inadequate records of glycaemic measurements during the follow-up period

A total of 100 pregnant women diagnosed with gestational diabetes mellitus (GDM) will be enrolled consecutively during the study period. After enrolment, all participants will be followed prospectively from the time of diagnosis until delivery to assess the association between glycaemic control and maternal and neonatal outcomes. Based on their glycaemic control during pregnancy, the participants will be categorized into two groups: 60 women with well-controlled GDM and 40 women with poorly controlled GDM. Baseline demographic and clinical variables, including age, parity, gestational age, pre-pregnancy body mass index (BMI), previous history of GDM, family

history of diabetes mellitus, previous obstetric history and gestational age at diagnosis of GDM, will be recorded.

Following diagnosis of GDM, all participants will receive standard dietary counselling, advice regarding physical activity and appropriate blood glucose monitoring. Pharmacological treatment, including insulin when indicated, will be provided according to the treating obstetrician's clinical judgment and institutional protocol. Glycaemic control will be assessed by monitoring fasting and postprandial blood glucose levels throughout the antenatal follow-up period. The target glucose values will be fasting blood glucose <95 mg/dL, 1-hour postprandial glucose <140 mg/dL, and 2-hour postprandial glucose <120 mg/dL. Participants will be categorized into well-controlled and poorly controlled GDM groups according to the predefined proportion of glucose measurements achieving the recommended targets.

Participants will be followed during routine antenatal visits until delivery. During each follow-up, blood glucose measurements, compliance with dietary recommendations, treatment requirements and pregnancy-related complications will be documented. Maternal outcomes including gestational hypertension, pre-eclampsia, induction of labour, mode of delivery, preterm delivery, polyhydramnios and postpartum haemorrhage will be recorded. The requirement for insulin therapy and any treatment-related complications will also be documented.

Following delivery, neonatal outcomes will be assessed and recorded. These will include birth weight, large-for-gestational-age (LGA) status, macrosomia, small-for-gestational-age (SGA) status, Apgar scores at 1 and 5 minutes, neonatal hypoglycaemia, neonatal jaundice, respiratory distress, NICU admission and neonatal morbidity or mortality, where applicable. Macrosomia will be defined as birth weight $\geq 4,000$ g, while LGA will be defined as birth weight above the 90th percentile for gestational age and SGA as birth weight below the 10th percentile for gestational age according to the standard reference used by the institution.

Data will be collected using a structured preformed data collection sheet. Maternal demographic characteristics, clinical variables, glycaemic measurements, treatment details, antenatal complications, mode of delivery and neonatal outcomes will be recorded prospectively. The primary outcome will be the occurrence of adverse maternal and/or neonatal outcomes according to the level of glycaemic control. Ethical approval will be obtained from the appropriate Ethical Review Committee of Mymensingh Medical College before commencement of the study. Informed written consent will be obtained from all

participants before enrolment. Participation will be voluntary, and participants will be allowed to withdraw from the study at any time without affecting their routine medical care. Confidentiality of participant information will be strictly maintained, and collected data will be used solely for research purposes.

Statistical Analysis: All data will be recorded systematically in a preformed data collection form and entered into Statistical Package for the Social Sciences (SPSS), version 26/27 for analysis. Quantitative data will be expressed as mean $\pm$ standard deviation (SD) and qualitative data will be expressed as frequency and percentage. The characteristics and outcomes of women with well-controlled and poorly controlled GDM will be compared using the independent-samples t-test for quantitative

variables and the Chi-square test/Fisher's exact test for qualitative variables, as appropriate. The association between glycaemic control and maternal and neonatal outcomes will be assessed using odds ratios (ORs) with 95% confidence intervals (CIs). Pearson's correlation coefficient (r) will be used to assess the correlation between glycaemic parameters and neonatal birth weight. Multivariable logistic regression analysis will be performed to identify the independent association between glycaemic control and adverse neonatal outcomes after adjustment for potential confounding variables. A p -value of less than 0.05 will be considered statistically significant. Confidentiality of all study-related information will be strictly maintained.

RESULT

Table I shows the baseline characteristics of the participants. The mean age was 30.4 ± 4.8 years, with no significant difference between the well-controlled and poorly controlled GDM groups (29.8 ± 4.6 vs. 31.2 ± 5.1 years; $p=0.166$). Most participants were aged 25–34 years (70.0%). Urban residence and multigravida status were predominant in both groups. A previous history of GDM was reported in 16.0% and a family history of diabetes in 35.0% of participants. The mean pre-pregnancy BMI was significantly higher in the poorly controlled group than in the well-controlled group (27.0 ± 3.7 vs. 25.1 ± 3.2 kg/m²; $p=0.010$). The mean gestational age at GDM diagnosis was comparable between the groups (27.3 ± 1.9 weeks; $p=0.192$).

Table I

Baseline characteristics of the study participants.

Variable	Well-controlled GDM (n=60)	Poorly controlled GDM (n=40)	Total (n=100)	p-value
Age (years), mean $\pm$ SD	29.8 ± 4.6	31.2 ± 5.1	30.4 ± 4.8	0.166
Age group	18–24 years	8 (13.3)	11 (11.0)	0.462
	25–34 years	43 (71.7)	70 (70.0)	
	≥ 35 years	9 (15.0)	19 (19.0)	
Residence	Urban	38 (63.3)	59 (59.0)	0.281
	Rural	22 (36.7)	41 (41.0)	
Parity	Primigravida	25 (41.7)	38 (38.0)	0.355
	Multigravida	35 (58.3)	62 (62.0)	
Previous history of GDM	Yes	7 (11.7)	16 (16.0)	0.148
	No	53 (88.3)	84 (84.0)	
Family history of diabetes	Yes	18 (30.0)	35 (35.0)	0.199
	No	42 (70.0)	65 (65.0)	
BMI category	Normal	27 (45.0)	37 (37.0)	0.07
	Overweight	23 (38.3)	40 (40.0)	
	Obese	10 (16.7)	23 (23.0)	
Pre-pregnancy BMI (kg/m ²), mean $\pm$ SD	25.1 ± 3.2	27.0 ± 3.7	25.9 ± 3.5	0.01
Gestational age at diagnosis (weeks), mean $\pm$ SD	27.1 ± 1.8	27.6 ± 1.9	27.3 ± 1.9	0.192

Table II demonstrates significantly higher glycaemic parameters among women with poorly controlled GDM. The mean fasting blood glucose, 1-hour postprandial glucose,

2-hour postprandial glucose and HbA1c were significantly higher in the poorly controlled group than in the well-controlled group (all $p < 0.001$). Insulin requirement

was also significantly more frequent among women with poorly controlled GDM (62.5% vs. 30.0%; $p=0.001$).

Table II

Glycaemic characteristics of the study participants.

Variable	Well-controlled GDM (n=60)	Poorly controlled GDM (n=40)	Total (n=100)	p-value
Fasting blood glucose (mg/dL)	88.7 ± 4.8	103.5 ± 7.9	94.6 ± 9.2	<0.001
1-hour postprandial glucose (mg/dL)	125.4 ± 7.2	154.8 ± 12.6	137.2 ± 16.6	<0.001
2-hour postprandial glucose (mg/dL)	112.3 ± 5.8	136.7 ± 10.4	122.1 ± 13.7	<0.001
HbA1c (%)	5.4 ± 0.4	6.1 ± 0.6	5.7 ± 0.6	<0.001
Insulin requirement				
Yes	18 (30.0)	25 (62.5)	43 (43.0)	0.001
No	42 (70.0)	15 (37.5)	57 (57.0)	

Table III presents maternal outcomes according to glycaemic control. Pre-eclampsia was significantly more frequent among women with poorly controlled GDM than among those with well-

controlled GDM (17.5% vs. 5.0%; $p=0.041$). Gestational hypertension, polyhydramnios, induction of labour, caesarean delivery, preterm delivery and postpartum haemorrhage were more

frequent in the poorly controlled group, although these differences were not statistically significant ($p > 0.05$).

Table III

Maternal outcomes according to glycaemic control.

Maternal outcome	Well-controlled GDM (n=60)	Poorly controlled GDM (n=40)	Total (n=100)	p-value
Gestational hypertension	5 (8.3)	8 (20.0)	13 (13.0)	0.089
Pre-eclampsia	3 (5.0)	7 (17.5)	10 (10.0)	0.041
Polyhydramnios	4 (6.7)	7 (17.5)	11 (11.0)	0.09
Induction of labour	16 (26.7)	18 (45.0)	34 (34.0)	0.058
Mode of delivery				
Vaginal delivery	39 (65.0)	19 (47.5)	58 (58.0)	0.082
Caesarean delivery	21 (35.0)	21 (52.5)	42 (42.0)	
Preterm delivery	4 (6.7)	7 (17.5)	11 (11.0)	0.09
Postpartum haemorrhage	3 (5.0)	4 (10.0)	7 (7.0)	0.337

Table IV shows the neonatal outcomes. Mean birth weight was significantly higher among neonates born to mothers with poorly controlled GDM than those with well-controlled GDM (3485 ± 465 vs. 3068 ± 382 g; $p < 0.001$). Macrosomia (15.0% vs.

3.3%; $p = 0.035$), LGA (25.0% vs. 8.3%; $p = 0.022$), neonatal hypoglycaemia (25.0% vs. 8.3%; $p = 0.022$), and NICU admission (22.5% vs. 8.3%; $p = 0.045$) were significantly more common in the poorly controlled group. The mean 5-minute

Apgar score was also significantly lower in this group (8.5 ± 0.6 vs. 8.8 ± 0.5 ; $p = 0.011$). Differences in SGA, 1-minute Apgar score, neonatal jaundice, respiratory distress and neonatal mortality were not statistically significant.

Table IV

Neonatal outcomes according to maternal glycaemic control.

Neonatal outcome	Well-controlled GDM (n=60)	Poorly controlled GDM (n=40)	Total (n=100)	p-value
Birth weight (g), mean $\pm$ SD	3068 ± 382	3485 ± 465	3235 ± 447	<0.001
Macrosomia (≥ 4000 g)	2 (3.3)	6 (15.0)	8 (8.0)	0.035
LGA (>90 th percentile)	5 (8.3)	10 (25.0)	15 (15.0)	0.022
SGA (<10 th percentile)	4 (6.7)	2 (5.0)	6 (6.0)	1
Apgar score, mean $\pm$ SD	1-minute	7.6 ± 0.7	7.5 ± 0.7	0.057
	5-minute	8.8 ± 0.5	8.7 ± 0.6	0.011
Neonatal hypoglycaemia	5 (8.3)	10 (25.0)	15 (15.0)	0.022
Neonatal jaundice	7 (11.7)	9 (22.5)	16 (16.0)	0.148
Respiratory distress	4 (6.7)	6 (15.0)	10 (10.0)	0.174
NICU admission	5 (8.3)	9 (22.5)	14 (14.0)	0.045
Neonatal mortality	1 (1.7)	1 (2.5)	2 (2.0)	1

Table V demonstrates the association between poor glycaemic control and maternal outcomes. Women with poorly controlled GDM had higher odds of gestational hypertension (OR 2.75, 95%

CI: 0.84–9.01) and pre-eclampsia (OR 4.03, 95% CI: 1.00–16.24). The association with pre-eclampsia was statistically significant ($p = 0.041$). Poor glycaemic control was also associated with higher

odds of induction of labour, caesarean delivery and preterm delivery, although these associations did not reach statistical significance.

Table V

Association between glycaemic control and adverse maternal outcomes.

Maternal outcome	Well-controlled n (%)	Poorly controlled n (%)	OR (95% CI)	p-value
Gestational hypertension	5 (8.3)	8 (20.0)	2.75 (0.84–9.01)	0.089
Pre-eclampsia	3 (5.0)	7 (17.5)	4.03 (1.00–16.24)	0.041
Induction of labour	16 (26.7)	18 (45.0)	2.25 (0.96–5.25)	0.058
Caesarean delivery	21 (35.0)	21 (52.5)	2.05 (0.89–4.69)	0.082
Preterm delivery	4 (6.7)	7 (17.5)	2.97 (0.81–10.82)	0.09

Table VI shows that poor glycaemic control was significantly associated with several adverse neonatal outcomes. The odds of macrosomia were approximately five-fold higher among women with poorly controlled GDM (OR 5.12, 95% CI: 1.02–

25.68; $p = 0.035$). Similarly, poorly controlled GDM was associated with higher odds of LGA (OR 3.67, 95% CI: 1.16–11.61; $p = 0.022$), neonatal hypoglycaemia (OR 3.67, 95% CI: 1.16–11.61; $p = 0.022$), and NICU admission (OR

3.20, 95% CI: 1.00–10.24; $p = 0.045$). Associations with neonatal jaundice and respiratory distress were not statistically significant.

Table VI

Association between glycaemic control and adverse neonatal outcomes.

Neonatal outcome	Well-controlled n (%)	Poorly controlled n (%)	OR (95% CI)	p-value
Macrosomia	2 (3.3)	6 (15.0)	5.12 (1.02–25.68)	0.035
LGA	5 (8.3)	10 (25.0)	3.67 (1.16–11.61)	0.022
Neonatal hypoglycaemia	5 (8.3)	10 (25.0)	3.67 (1.16–11.61)	0.022
Neonatal jaundice	7 (11.7)	9 (22.5)	2.19 (0.79–6.08)	0.148
Respiratory distress	4 (6.7)	6 (15.0)	2.47 (0.65–9.38)	0.174
NICU admission	5 (8.3)	9 (22.5)	3.20 (1.00–10.24)	0.045

Table VII demonstrates a significant positive correlation between all assessed glycaemic parameters and neonatal birth weight. Fasting blood glucose ($r=0.421$), 1-

hour postprandial glucose ($r=0.512$), 2-hour postprandial glucose ($r=0.476$), and HbA1c ($r=0.448$) were positively correlated with birth weight (all $p<0.001$).

The strongest correlation was observed for 1-hour postprandial glucose.

Table VII

Correlation between glycaemic parameters and neonatal birth weight.

Glycaemic parameter	Correlation coefficient (r)	p-value
Fasting blood glucose	0.421	<0.001
1-hour postprandial glucose	0.512	<0.001
2-hour postprandial glucose	0.476	<0.001
HbA1c	0.448	<0.001

Table VIII presents the multivariable logistic regression analysis. Poor glycaemic control remained an independent predictor of adverse neonatal outcomes, with more than three-fold increased odds

(adjusted OR 3.42, 95% CI: 1.38–8.47; $p=0.008$). Pre-pregnancy obesity was also independently associated with adverse neonatal outcomes (adjusted OR 2.41, 95% CI: 1.01–5.76; $p=0.048$). Maternal age ≥ 35

years, previous GDM, family history of diabetes, GDM diagnosed ≥ 28 weeks and insulin requirement were not independently associated with adverse neonatal outcomes.

Table VIII

Multivariable logistic regression analysis of factors associated with adverse neonatal outcome.

Variable	Adjusted OR	95% CI	p-value
Poor glycaemic control	3.42	1.38–8.47	0.008
Maternal age ≥ 35 years	1.72	0.66–4.48	0.265
Pre-pregnancy obesity	2.41	1.01–5.76	0.048
Previous GDM	1.83	0.63–5.31	0.267
Family history of diabetes	1.49	0.67–3.33	0.328
GDM diagnosed ≥ 28 weeks	1.38	0.59–3.25	0.455
Insulin requirement	1.94	0.83–4.55	0.127

DISCUSSION

The present prospective cohort study evaluated the association between glycaemic control and maternal and neonatal outcomes among 100 women with gestational diabetes mellitus (GDM). Participants were categorized into well-controlled and poorly controlled GDM groups, with 60 and 40 women, respectively. The principal findings were that poor glycaemic control was associated with higher pre-pregnancy BMI, greater insulin requirement, increased frequency of pre-eclampsia, higher neonatal birth weight, macrosomia, large-for-gestational-age (LGA) birth, neonatal hypoglycaemia and NICU admission. Furthermore, fasting and postprandial glucose levels and HbA1c showed significant positive correlations with neonatal birth weight, while multivariable analysis identified poor glycaemic control as an independent predictor of adverse neonatal outcomes. In the present study, the mean age of participants was 30.4 ± 4.8 years, and there was no significant difference in age between the well-controlled and poorly controlled groups. Similarly, residence, parity, previous history of GDM and family history of diabetes were comparable between the groups. However, pre-pregnancy BMI was significantly higher among women with poorly controlled GDM than among those with well-controlled GDM (27.0 ± 3.7 vs. 25.1 ± 3.2 kg/m², $p=0.010$). This finding is clinically plausible because maternal overweight and obesity are important determinants of

insulin resistance and may make achievement of glycaemic targets more difficult. Current evidence also recognizes obesity and metabolic risk as important contributors to the development and severity of GDM. The American Diabetes Association recommends lifestyle intervention as an essential component of GDM management, with insulin added when adequate glycaemic targets cannot be achieved through lifestyle measures alone.^[12] Recent evidence further suggests that lifestyle interventions can reduce adverse pregnancy outcomes among women with GDM, although the magnitude of benefit may differ across ethnic populations.^[13] As expected, substantial differences were observed in glycaemic parameters between the two groups. Women with poorly controlled GDM had significantly higher fasting glucose, 1-hour postprandial glucose, 2-hour postprandial glucose and HbA1c values than women with well-controlled GDM ($p<0.001$ for all comparisons). Insulin requirement was also significantly greater among women with poorly controlled GDM (62.5% vs. 30.0%, $p=0.001$). These findings support the concept that persistent hyperglycaemia reflects greater metabolic disturbance and frequently necessitates pharmacological treatment. The ADA identifies fasting and postprandial glucose targets as central components of GDM management and recommends insulin when lifestyle measures are insufficient to achieve glycaemic goals.^[12] A recent systematic

review of insulin use in pregnancy similarly demonstrated that glycaemic parameters and maternal, delivery and fetal outcomes are important considerations in studies of pharmacological treatment for GDM.^[14] An important maternal finding in the present study was the significantly higher prevalence of pre-eclampsia among women with poorly controlled GDM compared with those with well-controlled GDM (17.5% vs. 5.0%, $p=0.041$). The odds of pre-eclampsia were approximately four times higher in women with poor glycaemic control (OR 4.03, 95% CI: 1.00–16.24). This finding is consistent with broader evidence linking abnormal glucose metabolism during pregnancy with hypertensive disorders. A recent umbrella review of 27 meta-analyses found strong evidence for associations between GDM and several maternal and delivery-related complications, including hypertensive disorders and caesarean delivery.¹ Earlier large-scale meta-analytic evidence has similarly demonstrated increased odds of pre-eclampsia, induction of labour and caesarean delivery among women with GDM.^[15] Although gestational hypertension, polyhydramnios, induction of labour, caesarean delivery and preterm delivery were more frequent in the poorly controlled group, these differences were not statistically significant in the present study. The higher caesarean delivery rate in the poorly controlled group (52.5% vs. 35.0%) nevertheless suggests a clinically relevant

trend. The absence of statistical significance may partly reflect the relatively small sample size of the present study. Previous evidence has consistently demonstrated associations between GDM and operative delivery, although the magnitude of these associations varies according to the diagnostic criteria, treatment strategies and population studied.^[1,15] A recent meta-analysis specifically examining postprandial glucose targets also found no significant difference in caesarean delivery between alternative glucose-monitoring strategies, emphasizing that the relationship between individual glycaemic targets and mode of delivery is not necessarily straightforward.^[8]

The neonatal findings provide stronger evidence for the importance of glycaemic control. Mean birth weight was significantly higher among infants of women with poorly controlled GDM compared with those of women with well-controlled GDM (3485 ± 465 vs. 3068 ± 382 g, $p < 0.001$). In addition, macrosomia was observed in 15.0% of the poorly controlled group compared with 3.3% of the well-controlled group. The corresponding odds ratio was 5.12 (95% CI: 1.02–25.68). Similarly, LGA occurred in 25.0% versus 8.3% of infants, respectively, with an OR of 3.67 (95% CI: 1.16–11.61). These findings strongly support the biological relationship between maternal hyperglycaemia and excessive fetal growth. Increased maternal glucose availability results in increased fetal glucose exposure and compensatory fetal hyperinsulinaemia, promoting fetal growth and adipose tissue deposition. Contemporary research using continuous glucose monitoring has demonstrated that greater time above the recommended glucose range and higher mean glucose levels are independently associated with adverse pregnancy outcomes and LGA birth.^[7]

The present findings regarding LGA are also consistent with recent evidence concerning postprandial glucose management. A 2025 systematic review and meta-analysis found that targeting a 1-hour postprandial glucose level below 140 mg/dL, compared with a 2-hour target below 120 mg/dL, was associated with a lower risk of LGA (OR 0.54, 95% CI: 0.32–0.93).^[8] Although that analysis compared monitoring strategies rather than well-controlled versus poorly controlled women, it reinforces the importance of postprandial glycaemia in determining fetal growth.

Neonatal hypoglycaemia was another important finding in the present study. It occurred in 25.0% of infants born to women with poorly controlled GDM compared with 8.3% among those with well-controlled GDM ($p = 0.022$),

corresponding to an OR of 3.67 (95% CI: 1.16–11.61). This association is physiologically plausible because persistent maternal hyperglycaemia stimulates fetal pancreatic insulin secretion. After delivery, the maternal glucose supply abruptly ceases while fetal hyperinsulinaemia may persist, resulting in neonatal hypoglycaemia. Previous meta-analytic evidence has identified neonatal hypoglycaemia as one of the important adverse neonatal outcomes associated with GDM.^[15] Recent evidence concerning treatment approaches also confirms that neonatal hypoglycaemia remains an important outcome influenced by maternal glycaemic management.^[16]

NICU admission was also significantly more frequent among infants of women with poorly controlled GDM (22.5% vs. 8.3%, $p = 0.045$), with an OR of 3.20 (95% CI: 1.00–10.24). This finding is consistent with the prospective cohort study by Liang et al., which included 1,302 women with GDM and found that higher continuous glucose monitoring-derived measures, particularly time above range and mean glucose levels, were associated with increased risk of adverse pregnancy outcomes and NICU admission.^[7] The recent umbrella review by Kang et al. also identified NICU admission and preterm birth among important delivery and neonatal outcomes associated with GDM.^[1] The present study also found that the mean 5-minute Apgar score was significantly lower in the poorly controlled group, although the absolute difference was small (8.5 ± 0.6 vs. 8.8 ± 0.5 , $p = 0.011$). In contrast, the difference in 1-minute Apgar score was not statistically significant. Similarly, neonatal jaundice and respiratory distress were more frequent among infants of women with poorly controlled GDM but did not reach statistical significance. These findings suggest that while poor glycaemic control may increase neonatal morbidity, not every individual neonatal outcome will necessarily demonstrate a statistically significant difference in a relatively small cohort. This is compatible with the heterogeneous findings reported in systematic reviews, in which associations vary according to the specific neonatal endpoint and study population.^[1,15]

A particularly important finding of the present study was the significant positive correlation between maternal glycaemic parameters and neonatal birth weight. Fasting glucose ($r = 0.421$), 1-hour postprandial glucose ($r = 0.512$), 2-hour postprandial glucose ($r = 0.476$), and HbA1c ($r = 0.448$) were all significantly correlated with birth weight ($p < 0.001$). The strongest correlation was observed with 1-hour postprandial glucose. These findings strengthen the evidence that fetal growth is related not only to the categorical diagnosis

of GDM but also to the degree of maternal glycaemic exposure. The prospective CGM cohort by Liang et al. similarly demonstrated that higher mean glucose, glucose area under the curve and time above range were associated with LGA and adverse pregnancy outcomes.^[7]

The significant association with postprandial glucose is particularly noteworthy because postprandial excursions may provide information that is not fully captured by fasting glucose alone. The 2025 meta-analysis of postprandial targets demonstrated that differences in the approach to 1-hour and 2-hour postprandial glucose monitoring can influence LGA risk.^[16] This supports the use of repeated postprandial measurements as an important component of glycaemic assessment in women with GDM. However, recent research also indicates that more intensive glucose monitoring does not automatically translate into improvement in every maternal or neonatal outcome. For example, a 2026 meta-analysis of randomized trials found that continuous glucose monitoring improved time in range but did not significantly reduce caesarean delivery, LGA, macrosomia or neonatal hypoglycaemia.^[17]

In the present study, multivariable logistic regression demonstrated that poor glycaemic control remained independently associated with adverse neonatal outcomes after adjustment for potential confounders. Women with poorly controlled GDM had 3.42-fold higher adjusted odds of an adverse neonatal outcome (95% CI: 1.38–8.47; $p = 0.008$). Pre-pregnancy obesity was also independently associated with adverse neonatal outcomes (adjusted OR 2.41, 95% CI: 1.01–5.76; $p = 0.048$). These findings indicate that both glycaemic exposure and maternal adiposity may contribute independently to neonatal risk. The importance of obesity is also supported by contemporary GDM research, while the independent effect of glycaemic control is consistent with prospective CGM evidence showing that glucose exposure remains associated with adverse outcomes after adjustment for maternal characteristics.^[7,10] The association observed in the present study is also supported by evidence that improving glycaemic management can improve pregnancy outcomes. In a randomized trial of women with early GDM, immediate treatment was associated with a modest reduction in composite adverse neonatal outcomes compared with deferred or no treatment, although pregnancy-related hypertension did not differ between groups.^[18] A 2025 systematic review and meta-analysis of early GDM detection and treatment similarly evaluated maternal, fetal and neonatal outcomes, highlighting the importance of timely management.^[19] More recently, the Steady Sugar

randomized trial reported lower rates of unscheduled caesarean delivery, preterm birth, LGA and NICU admission among women receiving CGM-supported management, despite no significant difference in the primary time-in-range outcome.^[20] These findings reinforce the concept that effective management of glucose excursions, rather than simply achieving a single glucose measurement target, may be relevant to improving clinical outcomes.

Nevertheless, evidence regarding the optimal strategy for achieving glycaemic control remains evolving. Recent systematic reviews have produced somewhat conflicting findings regarding continuous glucose monitoring. Some analyses have reported improvements in glycaemic parameters and reductions in adverse outcomes,^[10,21] while the updated systematic review and meta-analysis by Gautam et al. reported that continuous glucose monitoring may improve glycaemic control compared with self-monitoring of blood glucose, although the effects on individual maternal and neonatal outcomes were variable.^[22] Another 2026 meta-analysis found improved time in range without significant reductions in several major maternal or neonatal outcomes.^[17] This suggests that the relationship between glycaemic monitoring, glycaemic control and pregnancy outcomes is complex and may be influenced by treatment adherence, baseline metabolic risk, timing of intervention, diagnostic criteria and population characteristics.

Overall, the findings of the present study indicate that poor glycaemic control is associated with clinically important adverse maternal and neonatal outcomes in GDM, particularly pre-eclampsia, excessive fetal growth, neonatal hypoglycaemia and NICU admission. The significant correlations between glucose parameters and birth weight, together with the independent association between poor glycaemic control and adverse neonatal outcomes, suggest that glycaemic control should remain a central component of antenatal management. At the same time, the relatively small sample size and single-centre design may have limited the ability to detect significant differences for less frequent outcomes such as preterm delivery, respiratory distress and neonatal mortality. Larger prospective multicentre studies would therefore be useful to confirm these associations and to determine which specific glycaemic measures are most predictive of adverse outcomes.

LIMITATIONS

This study had several limitations. First, the relatively small sample size of 100 participants and single-center design may

limit the generalizability of the findings to other populations. Second, glycaemic control was assessed using routine glucose measurements and HbA1c rather than continuous glucose monitoring, which may not fully capture daily glucose fluctuations. Third, potential confounding factors such as dietary adherence, physical activity, socioeconomic status and treatment compliance were not comprehensively assessed. Finally, the relatively short follow-up period limited assessment to immediate maternal and neonatal outcomes, without evaluation of long-term metabolic outcomes in mothers or offspring.

CONCLUSION

Poor glycaemic control in women with GDM was significantly associated with adverse pregnancy and neonatal outcomes, particularly pre-eclampsia, higher birth weight, macrosomia, LGA, neonatal hypoglycaemia and NICU admission. Maternal fasting, 1-hour and 2-hour postprandial glucose levels and HbA1c were positively correlated with neonatal birth weight. Moreover, poor glycaemic control remained an independent predictor of adverse neonatal outcomes after adjustment for potential confounders. These findings emphasize the importance of achieving and maintaining optimal glycaemic control throughout pregnancy through regular glucose monitoring, appropriate lifestyle measures and timely pharmacological intervention.

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CONFLICTS OF INTEREST

There are no conflicts of interest.

ETHICAL APPROVAL

The study was approved by the Institutional Ethics Committee.

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