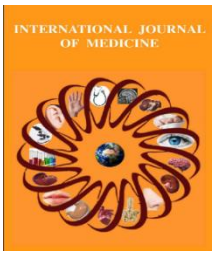

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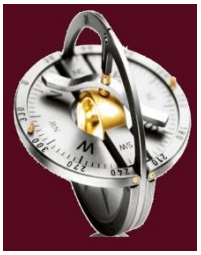

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Original Research

Maternal and Perinatal Outcomes Among Women With Gestational Diabetes Mellitus: A Prospective Observational Study.

Dr. CH. Jyothi[1]*, Dr. CH. Mamatha[2]
[1]Associate Professor, Department of Obstetrics and Gynecology, Singareni Institute of Medical Sciences, Ramagundam, Telangana, India
[2]Associate Professor, Department of Obstetrics and Gynecology, Singareni Institute of Medical Sciences, Ramagundam, Telangana, India

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Abstract
Background: Gestational diabetes mellitus (GDM) is associated with hypertensive disorders, operative delivery, excessive fetal growth, and neonatal metabolic complications. Local prospective data describing these outcomes and their relationship with antenatal glycaemic control remain limited. *Objectives:* To assess maternal and perinatal outcomes among women with GDM and compare selected outcomes between women with adequate and suboptimal glycaemic control. *Methods:* This prospective observational study included 100 pregnant women with GDM managed at Government Medical College, Ramagundam, Telangana, India, from October 2024 to September 2025. Maternal characteristics, glycaemic parameters, treatment, delivery details, and neonatal outcomes were recorded prospectively. Outcomes were compared according to glycaemic-control status using Fisher's exact test. *Results:* The mean maternal age was 28.8 ± 4.7 years, and 74.0% of participants were overweight or obese. Glycaemic targets were achieved by 76.0% of women; 44.0% were managed with lifestyle measures alone, 26.0% received metformin, and 30.0% required insulin. Hypertensive disorders occurred in 15.0%, preeclampsia in 9.0%, polyhydramnios in 12.0%, and preterm labour in 11.0%. Caesarean delivery was performed in 46.0%. There were 98 live births and two stillbirths. Preterm birth occurred in 13.0%, macrosomia in 10.0%, and large-for-gestational-age birth in 18.0%. Among live-born neonates, 22.4% required neonatal intensive care and 14.3% developed hypoglycaemia. Suboptimal glycaemic control was associated with higher frequencies of preeclampsia, caesarean delivery, preterm birth, macrosomia, neonatal intensive care admission, neonatal hypoglycaemia, and the composite adverse perinatal outcome. *Conclusion:* GDM was accompanied by appreciable maternal and neonatal morbidity. Suboptimal glycaemic control identified a subgroup with substantially poorer outcomes, supporting timely diagnosis, structured glucose monitoring, and treatment escalation during pregnancy.

Keywords: *gestational diabetes mellitus; glycaemic control; maternal outcomes; perinatal outcomes; neonatal hypoglycaemia; caesarean delivery.*

Introduction

Gestational diabetes mellitus (GDM) is hyperglycaemia first recognized during pregnancy that does not meet the criteria for overt pre-existing diabetes. It arises when progressive pregnancy-related insulin resistance exceeds maternal pancreatic beta-cell reserve. The condition has become an important obstetric and public-health concern because increasing maternal age, excess adiposity, sedentary behaviour, and a strong background risk of type 2 diabetes are now common in women of reproductive age. The Hyperglycemia and Adverse Pregnancy Outcome study established a continuous association between maternal glucose concentrations and clinically relevant outcomes, even below glucose levels previously considered diagnostic of diabetes.[1] Subsequent evidence has confirmed that GDM is associated with several adverse pregnancy outcomes across different populations and diagnostic strategies.[2]

Maternal complications linked to GDM include gestational hypertension, preeclampsia, polyhydramnios, induction of labour, operative delivery, and postpartum metabolic dysfunction. For the fetus and newborn, maternal hyperglycaemia promotes transplacental glucose transfer, fetal hyperinsulinaemia, accelerated adipose deposition, and excessive growth. These mechanisms contribute to macrosomia, large-for-gestational-age birth, shoulder dystocia, birth injury, neonatal hypoglycaemia, respiratory morbidity, jaundice, and admission to neonatal intensive care. Maternal obesity frequently coexists with GDM and independently amplifies obstetric and neonatal risk, creating a combined metabolic burden that is greater than either condition alone.[3]

Address for Correspondence Dr. CH. Jyothi, Associate Professor, Department of Obstetrics and Gynecology, Singareni Institute of Medical Sciences, Ramagundam, Telangana, India.

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The clinical importance of GDM extends beyond delivery. Women with a history of GDM have a markedly increased risk of future type 2 diabetes, while exposed offspring show higher indices of adiposity and metabolic susceptibility during childhood and adolescence.[4,5] Pregnancy therefore represents an opportunity to identify women and families at heightened cardiometabolic risk and to initiate preventive counselling, postpartum glucose testing, and long-term surveillance.

Diagnostic approaches vary internationally. The International Association of Diabetes and Pregnancy Study Groups proposed one-step 75-g oral glucose tolerance test thresholds derived from observed pregnancy risks in the HAPO cohort.[6] These criteria increased recognition of milder hyperglycaemia and strengthened the need for risk-stratified clinical management. Treatment is clinically meaningful: randomized trials have demonstrated that dietary counselling, glucose monitoring, and pharmacological therapy reduce fetal overgrowth, shoulder dystocia, hypertensive complications, and selected delivery-related outcomes.[7,8] Current guidance recommends individualized nutrition therapy and physical activity, with insulin as the established pharmacological standard and metformin used in selected clinical settings after informed discussion.[9,10]

Prospective data from public-sector tertiary hospitals in India remain valuable because maternal risk profiles, referral patterns, access to glucose monitoring, treatment practices, and neonatal-care thresholds differ across health systems. The present study was therefore undertaken to describe the demographic and obstetric profile, glycaemic management, maternal complications, mode of delivery, and perinatal outcomes among women with GDM at a tertiary teaching institution in Telangana. The study also aimed to compare selected maternal and neonatal outcomes between women who achieved predefined glycaemic targets and those with suboptimal glycaemic control.

Materials and Methods

Study design and setting: This prospective hospital-based observational study was conducted in the Department of Obstetrics and Gynaecology, Government Medical College, Ramagundam, Telangana, India, from October 2024 to September 2025. Pregnant women diagnosed with GDM and receiving antenatal and delivery care at the institution were recruited consecutively and followed until maternal discharge and completion of the early neonatal period.

Ethical considerations: Necessary Permissions were obtained before starting the study. Written informed consent was obtained before enrolment. Participant information was coded and handled confidentially.

Participants: Women aged 18 years or older with a singleton pregnancy and GDM diagnosed during the current pregnancy were eligible. Exclusion criteria were known type 1 or type 2 diabetes before conception, multiple gestation, major fetal structural anomaly, or incomplete delivery follow-up. Of 106 women assessed, 100 formed the final cohort.

Diagnosis and management: GDM was diagnosed by a 75-g oral glucose tolerance test using International Association of Diabetes and Pregnancy Study Groups thresholds: fasting glucose ≥92 mg/dL, 1-hour glucose ≥180 mg/dL, or 2-hour glucose ≥153 mg/dL; one abnormal value established the diagnosis.[6] All women received individualized nutrition therapy, advice regarding safe physical activity, and glucose monitoring. Metformin, insulin, or both were prescribed when lifestyle measures were insufficient. Treatment targets were fasting glucose <95 mg/dL and 2-hour postprandial glucose <120 mg/dL.[9] Adequate control was defined as at least 80% of recorded values within both targets; the remainder were classified as having suboptimal control. Metformin use followed institutional practice and individualized counselling.[10]

Data collection and outcome definitions: A structured proforma recorded age, parity, body mass index, relevant medical and obstetric history, timing of diagnosis, glucose measurements, HbA1c, and treatment. Maternal outcomes were hypertensive disorders, preeclampsia, polyhydramnios, premature rupture of membranes, preterm labour, induction, delivery mode, shoulder dystocia, postpartum haemorrhage, intensive-care admission, and death. Perinatal outcomes included gestational age, live birth, stillbirth, birth weight, size for gestational age, Apgar score, neonatal intensive care admission, hypoglycaemia, respiratory distress, hyperbilirubinaemia, sepsis, birth trauma, and early neonatal death. Preterm birth was delivery before 37 completed weeks; low birth weight was <2.5 kg; macrosomia was ≥4.0 kg; and large or small for gestational age represented birth weight above the 90th or below the 10th percentile. The composite adverse perinatal outcome comprised preterm birth, macrosomia, 5-minute Apgar score <7, neonatal intensive care admission, stillbirth, or early neonatal death.

Sample size and statistical analysis: Assuming an outcome proportion of 50%, 95% confidence, and 10% absolute precision, the minimum sample was 96; 100 women were included. Data were analysed using IBM SPSS Statistics version 26.0. Continuous variables were summarized as mean ± standard deviation and categorical variables as number and percentage. Glycaemic-control groups were compared using Fisher's exact test. A two-sided p-value <0.05 indicated statistical significance.

Results

Participant recruitment

During the study period, 106 pregnant women diagnosed with gestational diabetes mellitus were assessed for eligibility. Six women were excluded: three did not meet the eligibility criteria, two declined participation, and one had incomplete delivery records. The remaining 100 women were enrolled and included in the final analysis. Maternal and perinatal outcome data were available for all 100 pregnancies.

Maternal demographic and obstetric characteristics

The mean maternal age was 28.8 ± 4.7 years, with a range of 19-40 years. Forty-two women (42.0%) were aged 25-29 years, while 36 (36.0%) were aged 30 years or older. Forty-one participants (41.0%) were primigravidae and 59 (59.0%) were multigravidae. The mean body mass index at enrolment was 27.4 ± 3.9 kg/m²; 44 women (44.0%) were overweight and 30 (30.0%) were obese. A family history of diabetes was reported by 36 participants (36.0%), previous GDM by 15 (15.0%), and previous delivery of a macrosomic infant by 12 (12.0%). GDM was diagnosed in the first trimester in 11 women (11.0%), the second trimester in 69 (69.0%), and the third trimester in 20 (20.0%). The mean gestational age at diagnosis was 26.8 ± 4.2 weeks (Table 1).

Table 1. Baseline demographic and obstetric characteristics of the participants

Characteristic	Value (N=100)
Maternal age, years	28.8 ± 4.7
Age <25 years	22 (22.0%)
Age 25-29 years	42 (42.0%)
Age 30-34 years	26 (26.0%)
Age ≥35 years	10 (10.0%)
Primigravida	41 (41.0%)
Multigravida	59 (59.0%)
Body mass index, kg/m²	27.4 ± 3.9
Normal body mass index	26 (26.0%)
Overweight	44 (44.0%)
Obese	30 (30.0%)
Family history of diabetes mellitus	36 (36.0%)

Previous gestational diabetes mellitus	15 (15.0%)
Previous macrosomic infant	12 (12.0%)
Polycystic ovary syndrome	13 (13.0%)
Chronic hypertension	7 (7.0%)
Gestational age at diagnosis, weeks	26.8 ± 4.2

Data are presented as mean ± standard deviation or number (percentage).

Glycaemic parameters and management

The mean fasting plasma glucose level at diagnosis was 99.6 ± 13.8 mg/dL, the mean 2-hour postprandial glucose level was 147.8 ± 23.4 mg/dL, and the mean HbA1c was 6.3 ± 0.7%. Glycaemic control was achieved with medical nutrition therapy and physical activity alone in 44 women (44.0%). Twenty-six women (26.0%) received metformin, while 30 (30.0%) required insulin, either alone or in combination with metformin. Overall, 76 women (76.0%) achieved the predefined glycaemic targets and 24 (24.0%) had suboptimal control during pregnancy.

Maternal outcomes

Pregnancy-induced hypertensive disorders occurred in 15 women (15.0%), including preeclampsia in nine (9.0%). Polyhydramnios was observed in 12 participants (12.0%), premature rupture of membranes in 10 (10.0%), and preterm labour in 11 (11.0%). Labour was induced in 38 women (38.0%). Vaginal delivery occurred in 54 participants (54.0%), including six assisted vaginal deliveries, while caesarean delivery was performed in 46 (46.0%). The leading indications for caesarean delivery were fetal distress, failed induction, suspected macrosomia or cephalopelvic disproportion, and previous caesarean delivery. Postpartum haemorrhage occurred in five women (5.0%), shoulder dystocia in three (3.0%), and maternal intensive-care admission in two (2.0%). No maternal death occurred (Table 2).

Table 2. Maternal outcomes among women with gestational diabetes mellitus

Maternal outcome	Number (%)
Pregnancy-induced hypertensive disorder	15 (15.0%)
Preeclampsia	9 (9.0%)
Polyhydramnios	12 (12.0%)
Premature rupture of membranes	10 (10.0%)
Preterm labour	11 (11.0%)
Induction of labour	38 (38.0%)
Vaginal delivery	54 (54.0%)
Assisted vaginal delivery	6 (6.0%)
Caesarean delivery	46 (46.0%)
Shoulder dystocia	3 (3.0%)
Postpartum haemorrhage	5 (5.0%)
Maternal intensive care admission	2 (2.0%)
Maternal mortality	0 (0.0%)

Preeclampsia is included within pregnancy-induced hypertensive disorders. Assisted vaginal deliveries are included within vaginal deliveries.

Perinatal outcomes

The mean gestational age at delivery was 38.0 ± 1.5 weeks. Preterm delivery before 37 completed weeks occurred in 13 pregnancies (13.0%). There were 98 live births (98.0%) and two stillbirths (2.0%). The mean birth weight was 3.18 ± 0.54 kg. Twelve newborns (12.0%) had a birth weight below 2.5 kg, 10 (10.0%) had macrosomia, 18 (18.0%) were large for gestational age, and eight (8.0%) were small for gestational age. Among the 98 live-born neonates, eight (8.2%) had a 5-minute Apgar score below 7 and 22 (22.4%) required neonatal intensive-care admission. Neonatal hypoglycaemia occurred in 14 (14.3%), respiratory distress in 10 (10.2%), and hyperbilirubinaemia requiring phototherapy in 11 (11.2%). Four neonates (4.1%) developed sepsis, three (3.1%) sustained birth trauma, and two (2.0%) died during the early neonatal period. Overall perinatal mortality was 4.0%, including two stillbirths and two early neonatal deaths (Table 3).

Table 3. Perinatal outcomes among the study population

Perinatal outcome	Number (%)
Gestational age at delivery, weeks	38.0 ± 1.5
Preterm birth, <37 weeks	13 (13.0%)
Live birth	98 (98.0%)
Stillbirth	2 (2.0%)
Birth weight, kg	3.18 ± 0.54
Low birth weight, <2.5 kg	12 (12.0%)
Macrosomia, ≥4.0 kg	10 (10.0%)
Large for gestational age	18 (18.0%)
Small for gestational age	8 (8.0%)
Five-minute Apgar score <7*	8 (8.2%)
Neonatal intensive care admission*	22 (22.4%)
Neonatal hypoglycaemia*	14 (14.3%)
Respiratory distress*	10 (10.2%)
Hyperbilirubinaemia requiring phototherapy*	11 (11.2%)
Neonatal sepsis*	4 (4.1%)
Birth trauma*	3 (3.1%)
Early neonatal death*	2 (2.0%)
Overall perinatal mortality†	4 (4.0%)

Data are presented as mean ± standard deviation or number (percentage).
*Percentages were calculated using 98 live-born neonates as the denominator.
†Overall perinatal mortality included stillbirths and early neonatal deaths and used 100 pregnancies as the denominator.

Outcomes according to glycaemic control

Women with suboptimal glycaemic control experienced less favourable maternal and neonatal outcomes than those who achieved the recommended targets. Preeclampsia occurred in 25.0% of women with suboptimal control compared with 3.9% of women with adequate control (p=0.006). Caesarean delivery was also more frequent in the suboptimal-control group (66.7% versus 39.5%; p=0.033). Preterm birth, macrosomia, neonatal intensive-care admission, and neonatal hypoglycaemia were significantly more frequent with suboptimal control. A composite adverse perinatal outcome occurred in 58.3% of women with suboptimal control compared with 26.3% of women with adequate control (p=0.006) (Table 4).

Table 4. Maternal and perinatal outcomes according to glycaemic control

Outcome	Adequate control (n=76)	Suboptimal control (n=24)	p-value
Preeclampsia	3 (3.9%)	6 (25.0%)	0.006
Caesarean delivery	30 (39.5%)	16 (66.7%)	0.033
Preterm birth	6 (7.9%)	7 (29.2%)	0.013
Macrosomia	4 (5.3%)	6 (25.0%)	0.012
Neonatal intensive care admission	12 (15.8%)	10 (41.7%)	0.012
Neonatal hypoglycaemia	7 (9.2%)	7 (29.2%)	0.037
Composite adverse perinatal outcome	20 (26.3%)	14 (58.3%)	0.006

Data are presented as number (percentage). Fisher's exact test was used for all comparisons.
The composite adverse perinatal outcome comprised preterm birth, macrosomia, 5-minute Apgar score <7, neonatal intensive care admission, stillbirth, or early neonatal death.

Discussion

This prospective study describes the clinical course of 100 women with GDM managed in a public tertiary-care setting. The cohort had a substantial metabolic-risk burden: 74% were overweight or obese, 36% reported a family history of diabetes, and 28% had either previous GDM or a previous macrosomic infant. These findings support the close relationship between maternal adiposity, inherited susceptibility, and pregnancy-related dysglycaemia. The HAPO analyses demonstrated that GDM and obesity independently increase adverse pregnancy outcomes, with greater risk when both are present.[3]

Hypertensive disorders occurred in 15% of participants, including preeclampsia in 9%, while 46% underwent caesarean delivery. Large observational datasets and contemporary meta-analyses have similarly linked GDM with preeclampsia, preterm delivery, and operative birth.[2,12] The caesarean frequency in the present cohort exceeded that reported in some Indian series, although comparisons require caution because referral status, previous caesarean delivery, induction practices, fetal-growth surveillance, and thresholds for intervention differ between hospitals.[13] The three cases of shoulder dystocia and five cases of postpartum haemorrhage further illustrate the delivery-related morbidity associated with fetal overgrowth and obstetric intervention.

Perinatal morbidity remained clinically important despite active management. Preterm birth occurred in 13%, macrosomia in 10%, and large-for-gestational-age birth in 18%. Among live-born neonates, 22.4% required intensive care and 14.3% developed hypoglycaemia. These outcomes are biologically consistent with fetal hyperinsulinaemia and altered growth caused by maternal glucose exposure. Systematic evidence shows a graded relation between antenatal glucose concentrations and macrosomia, large-for-gestational-age birth, neonatal hypoglycaemia, and other adverse outcomes, without a distinct risk threshold.[11] The two stillbirths and two early neonatal deaths require cautious interpretation because the sample was small and individual causal pathways were not evaluated.

The clearest study finding was the poorer outcome profile among women with suboptimal glycaemic control. Preeclampsia, caesarean delivery, preterm birth, macrosomia, neonatal intensive-care admission, neonatal hypoglycaemia, and the composite adverse perinatal outcome were all significantly more frequent in this group. These associations agree with randomized trials showing that treatment of GDM reduces fetal overgrowth, shoulder dystocia, preeclampsia, and selected operative-delivery outcomes.[7,8] Nevertheless, treatment intensity also reflects baseline disease severity, so the observed group differences cannot be interpreted as direct treatment effects.

Lifestyle measures alone achieved control in 44% of women, whereas 26% received metformin and 30% required insulin. The Metformin in Gestational Diabetes (MiG) trial found comparable short-term composite neonatal outcomes with metformin and insulin, although supplemental insulin was frequently required.[10] Women diagnosed earlier in pregnancy can retain higher adverse-outcome risks despite treatment, reflecting greater underlying metabolic dysfunction.[14] Overall, the present findings reinforce structured screening, nutrition support, reliable glucose monitoring, timely treatment escalation, fetal-growth assessment, and coordinated neonatal preparedness for pregnancies complicated by GDM.

LIMITATIONS

This study was conducted at a single tertiary-care centre and included only 100 women, which restricts external validity. Consecutive sampling and the absence of a normoglycaemic comparison group limit estimation of the excess risk attributable to GDM. Glycaemic exposure was classified from routine monitoring records rather than continuous measurements. Residual confounding from maternal obesity, treatment selection, and obstetric decision-making remains. Long-term maternal and childhood outcomes were not assessed.

Conclusion

Among women with gestational diabetes mellitus, hypertensive disorders, caesarean delivery, preterm birth, abnormal fetal growth, neonatal hypoglycaemia, and neonatal intensive care admission contributed substantially to maternal and perinatal morbidity. Women with suboptimal glycaemic control experienced significantly higher frequencies of preeclampsia, operative delivery, prematurity, macrosomia, neonatal hypoglycaemia, and composite adverse perinatal outcomes. These findings emphasize the importance of early recognition, individualized nutritional care, regular glucose monitoring, and timely escalation to pharmacological treatment. Coordinated antenatal surveillance, delivery planning, and neonatal preparedness are essential components of GDM care. Larger multicentre studies with adjusted analyses and long-term follow-up are required to define independent predictors and subsequent cardiometabolic consequences in mothers and children.

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