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Original Research Article

Adverse maternal and neonatal outcomes among women with gestational diabetes mellitus: a retrospective cohort study in Western Kenya

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ABSTRACT

Background: Gestational diabetes mellitus (GDM) is a growing public health concern associated with adverse maternal and neonatal outcomes, yet evidence from Sub-Saharan Africa, including Kenya, remains limited. This study examined the association between GDM and adverse maternal and neonatal outcomes among women delivering at a tertiary hospital in western Kenya and identified key risk factors for these outcomes.

Methods: A retrospective case-control study was conducted using hospital and maternal fetal medicine (MFM) registry records from January 2020 to December 2022. A total of 210 women were analyzed, 105 with GDM and 105 without, matched by age, parity, and gestational age at delivery. Data on demographic, obstetric, and clinical characteristics were extracted and analyzed using descriptive statistics, chi-square tests, and multivariate logistic regression to determine independent predictors of adverse outcomes.

Results: Women with GDM had significantly higher rates of cesarean delivery (58% versus 40%), postpartum hemorrhage (21% versus 7.6%), and macrosomia (21% versus 1%) compared to those without GDM ($p<0.05$). Newborn unit admissions (44% versus 27%) and respiratory distress syndrome (15% versus 6.7%) were also more common among infants born to GDM mothers, consistent with previous findings. Obesity (aOR=11.3; 95% CI: 4.3-32.5), prior history of GDM (aOR=4.7; 95% CI: 1.3-22.7), and advanced maternal age emerged as independent predictors of adverse outcomes.

Conclusions: These findings demonstrates that GDM substantially increases the risk of maternal and neonatal complications in this setting. Strengthened screening between 24 and 28 weeks of gestation, targeted management, and structured postpartum follow-up are recommended to improve outcomes and reduce the long-term burden of diabetes among mothers and infants.

Keywords: Cesarean section, Gestational diabetes mellitus, Kenya, Macrosomia, Maternal outcomes, Neonatal outcomes

INTRODUCTION

Gestational diabetes mellitus (GDM), defined as glucose intolerance first detected during pregnancy, is a growing public health concern globally and across Sub-Saharan Africa (SSA).[1] The condition is associated with significant adverse maternal outcomes, such as pre-eclampsia, caesarean delivery, and postpartum haemorrhage, and neonatal complications including macrosomia, hypoglycaemia, respiratory distress, and neonatal intensive care unit admission.[2-4] Established risk factors include obesity, previous GDM, increasing maternal age, and family history of diabetes.[4,5] Rising trends in obesity and metabolic disorders, particularly in

LMICs, have contributed to increasing GDM prevalence and underscore the need for context-specific evidence to guide prevention and management.

Globally, GDM affects an estimated 15-16% of pregnancies, with most cases occurring in low- and middle-income countries.[1] In SSA, a 2024 meta-analysis reported a pooled prevalence of 12.63% (95% CI: 9.66-15.92), with higher rates observed in studies applying the IADPSG diagnostic criteria.[4,6] Within Kenya, prevalence estimates vary widely due to inconsistent screening practices. Studies in western and central Kenya report prevalence ranging from 2.6% to 3% using OGTT-based diagnosis, though these figures are believed to underestimate the true burden due to limited testing, late presentation to antenatal care, and variations in diagnostic thresholds.[5,6]

The interplay between obesity, hyperglycaemia, and adverse pregnancy outcomes is of particular relevance in Kenya, where metabolic disorders are rising alongside persistent undernutrition. Maternal hyperglycaemia during pregnancy contributes to excessive fetal growth and increases the risk of long-term metabolic disorders in offspring, including obesity and type 2 diabetes.[7-9] Evidence from longitudinal studies demonstrates a U-shaped relationship between birth weight and future cardiometabolic risk, underscoring the intergenerational consequences of poor glycemic control in pregnancy.[8,9]

Despite the significant burden of GDM-related complications in SSA, most of the evidence informing global guidelines originates from high-income countries (HIC) settings. The hyperglycemia and adverse pregnancy outcome (HAPO) study did not include African populations, limiting the applicability of its findings to low-resource settings.[9,10] In Kenya, challenges such as inadequate screening coverage, resource constraints, and non-standardized diagnostic protocols further hinder early detection and effective management.[11-15]

Moi Teaching and Referral Hospital is the second largest referral hospital in Kenya and conducts over 11,000 deliveries annually. Diabetes is among the most common medical complications of pregnancy at this facility, yet systematic evaluation of GDM-related outcomes remains limited.[19] Understanding the maternal and neonatal risks associated with GDM, and identifying key predictors of adverse outcomes, is critical for strengthening screening strategies, enhancing clinical decision-making, and informing evidence-based policy within the Kenyan health system. Generating locally relevant evidence will support the optimization of antenatal care protocols, facilitate the adaptation of global guidelines to local settings, and inform national strategies aligned with sustainable development goal 3 on reducing maternal and neonatal morbidity and mortality.

This study therefore aimed to evaluate the association between GDM and adverse maternal and neonatal outcomes and to identify key risk factors contributing to these outcomes.

METHODS

Study design and setting

This study employed a retrospective cohort design conducted at Moi Teaching and Referral Hospital (MTRH), a national tertiary hospital in western Kenya. The hospital provides comprehensive antenatal, intrapartum, and neonatal services and serves as a referral center for the Western region and neighboring counties. The study utilized routinely collected clinical data from the maternal and newborn health records and the maternal fetal medicine (MFM) registry covering the period January 2020 to December 2022.

Study population and eligibility criteria

The study population comprised pregnant women who delivered at the facility during the study period. Two groups were compared: women diagnosed with gestational diabetes mellitus (GDM) and those without GDM. Eligible participants were identified from antenatal records, delivery registers, and laboratory OGTT logs.

Inclusion criteria

Women of reproductive age (15-49 years) who delivered at MTRH. For GDM cases: documented diagnosis of GDM using OGTT (≥5.1 mmol/l fasting, ≥10.0 mmol/l at 1 hour, or ≥8.5 mmol/l at 2 hours). Gestational age ≥28 weeks at the time of diagnosis.

Exclusion criteria

Women with pre-existing type 1 or type 2 diabetes mellitus. Women with severe anemia (Hb <8 gm/dl). Women with polycystic ovarian syndrome (PCOS). Records with missing critical data.

Diagnosis of gestational diabetes mellitus

GDM diagnosis followed the World Health Organization (WHO) 2013 criteria, based on the 75-gm oral glucose tolerance test (OGTT) conducted between 24 and 28 weeks' gestation. After an overnight fast, participants underwent venous blood sampling at fasting, 1 hour, and 2 hours post-glucose ingestion. GDM was confirmed if any of the following thresholds were met:

Fasting glucose ≥5.1 mmol/l, 1-hour glucose ≥10.0 mmol/l, 2-hour glucose ≥8.5 mmol/.

These internationally recognized criteria allowed comparability with published literature and ensured standardization of diagnosis.

Sample size and sampling procedure

A total of 210 women were included in the study, consisting of 105 women with GDM and 105 without GDM. Controls were selected using matched sampling, where each GDM case was matched to a non-GDM participant based on maternal age (±2 years), parity, and gestational age at delivery. This approach minimized confounding due to demographic and obstetric factors.

Data collection procedures

Data were abstracted using a structured data extraction tool developed from previous studies and refined after pilot testing. Information extracted included:

Maternal characteristics: age, BMI, parity, antenatal clinic attendance, medical and obstetric history.

Clinical parameters: OGTT results, blood pressure, treatment for GDM.

Maternal outcomes: mode of delivery, hypertensive disorders, postpartum hemorrhage, prolonged labor.

Neonatal outcomes: birth weight, Apgar scores, hypoglycemia, respiratory distress, and need for neonatal unit admission.

Data management and analysis

Completed data abstraction forms were reviewed daily for completeness before entry into REDCap, a secure web-based system with built-in range and logic checks. Ten percent of records underwent double entry, and discrepancies were resolved using source documents. The final dataset was exported to R software (version 4.3.2) for cleaning, coding, and analysis.

Data management procedures included recoding categorical variables, addressing missing data using multiple imputation where appropriate, and creating derived outcome variables. Descriptive statistics summarized participant characteristics: means and standard deviations for normally distributed variables, medians and IQRs for skewed data, and frequencies with percentages for categorical variables.

Comparisons between women with GDM and non-GDM controls employed independent t-tests or Mann-Whitney U tests for continuous variables, and Chi-square or Fisher's exact tests for categorical variables. To identify independent predictors of adverse maternal and neonatal outcomes, multivariable logistic regression models were fitted. Variables with $p \leq 0.20$ in bivariate analysis and clinically relevant covariates were included. Backward elimination retained variables significant at $p<0.05$, and adjusted odds ratios with 95% CIs were reported.

Model fit was evaluated using the Hosmer–Lemeshow test, ROC curves, and assessment of multicollinearity via VIFs (<10 acceptable). Statistical significance was set at $p<0.05$.

Ethical consideration

Since this was a retrospective, record-based study, no participants were contacted and informed consent was not required. There were no direct risks or benefits to individual patients. Nonetheless, the study's findings are anticipated to inform clinical practice and contribute to improved maternal and neonatal outcomes among women with gestational diabetes mellitus in Kenya.

RESULTS

A total of 210 participants were analyzed, equally divided between women with GDM (n=105) and those without GDM (n=105). The overall mean age was 31.2 years (SD=5.6). Women with GDM were significantly older compared to non-GDM women (32.2±5.5 versus 30.2±5.5 years, p=0.03).

Table 1: Clinical and systemic characteristics of the study participants by GDM status.

Variables	N	Overall n=210[1]	Non-GDM n=105[1]	GDM positive n=105[1]	P value[2]
Age (years), mean (SD)	210	31.2 (5.6)	30.2 (5.5)	32.2 (5.5)	
Significant systemic examinations					
Weight	210	74 (12)	69 (8)	78 (13)	<0.001
Height	210	163.9 (3.3)	164.8 (3.0)	163.0 (3.3)	<0.001
BMI	210	27.4 (4.4)	25.5 (2.7)	29.4 (4.9)	<0.001
BMI CAT	210				<0.001
Underweight		0 (0%)	0 (0%)	0 (0%)	
Normal weight		75 (36%)	53 (50%)	22 (21%)	
Overweight		83 (40%)	44 (42%)	39 (37%)	
Obese		52 (25%)	8 (7.6%)	44 (42%)	
Hypertension	210				<0.001
No hypertension		84 (40%)	25 (24%)	59 (56%)	
Hypertension		126 (60%)	80 (76%)	46 (44%)	

[1]N (%), [2]Fisher's exact test.

Table 2: Obstetric and medical history of study participants by GDM status.

Variables	N	Overall N=210[1]	Non-GDM N=105[1]	GDM positive N=105[1]	P value[2]
Obstetric history					
GA DIAG CAT	210				>0.9
<24 weeks		0 (0)	0 (0)	0 (0)	
24-28 weeks		207 (99)	104 (99)	103 (98)	
>28 weeks		3 (1.4)	1 (1.0)	2 (1.9)	
History of GDM BIN	209	25 (12)	3 (2.9)	22 (21)	<0.001
(Missing)		1	0	1	
Previous HTN BIN	209	89 (43)	50 (48)	39 (38)	0.14
(Missing)		1	0	1	
History of diabetes	210	143 (68)	87 (83)	56 (53)	<0.001

[1]N (%), [2]Fisher's exact test; Pearson's Chi-squared test.

Table 3: Childbirth details of study participants by GDM status.

Variables	N	Overall n=210[1]	Non-GDM n=105[1]	GDM positive n=105[1]	P value[2]
Childbirth details					
Mode of birth	210				0.009
Cesarean delivery (CS)		103 (49)	42 (40)	61 (58)	
Vaginal delivery (SVD)		107 (51)	63 (60)	44 (42)	
Age at birth	210	36.4 (2.7)	36.4 (3.2)	36.4 (2.2)	0.3

[1]Mean (SD); N (%). [2]Wilcoxon rank sum test; Fisher's exact test; Pearson's Chi-squared test.

Table 4: Maternal outcome and perinatal complications by GDM status.

Variables	N	Overall n=210[1]	Non-GDM n=105[1]	GDM positive n=105[1]	P value[2]
Maternal outcomes					
Maternal outcome	209				0.9
Live birth		193 (92)	97 (93)	96 (91)	
Neonatal death		2 (1.0)	1 (1.0)	1 (1.0)	
Stillbirth (>20 weeks)		14 (6.7)	6 (5.8)	8 (7.6)	
(Missing)		1	1	0	
Perinatal complications					
Cardiovascular	210	3 (1.4)	3 (2.9)	0 (0)	0.2
Preeclampsia	210	122 (58)	77 (73)	45 (43)	<0.001
Eclampsia	210				
HELP syndrome	210	2 (1.0)	1 (1.0)	1 (1.0)	>0.9
Postpartum hemorrhage	210	30 (14.3)	8 (7.6)	22 (21)	<0.001
PPROM	210	10 (4.8)	5 (4.8)	5 (4.8)	>0.9
None	210	23 (11)	4 (3.8)	19 (18)	<0.001
Other	210	107 (51)	51 (49)	56 (53)	0.5

[1]N (%). [2]Fisher's exact test; Pearson's Chi-squared test.

In systemic examinations, GDM participants had significantly higher mean weight (78±13 kg versus 69±8 kg), higher mean BMI (29.4 versus 25.5 kg/m^2, $p<0.001$), and were more often obese (42% versus 7.6%). Hypertension was more frequent among non-GDM women (76% versus 44%, $p<0.001$).

In obstetric history, almost all participants (99%) were diagnosed with GDM between 24 and 28 weeks of gestation. A prior history of GDM was significantly higher among current GDM women (21% versus 2.9%, $p<0.001$), while a history of diabetes outside pregnancy was more common in non-GDM women (83% versus 53%, $p<0.001$).

Cesarean delivery was more frequent among GDM participants (58% versus 40%, $p=0.009$), while spontaneous vaginal delivery predominated among non-GDM women. The mean gestational age at birth did not differ significantly between the groups (both 36.4 years, $p=0.3$), These findings are summarized in Table 3.

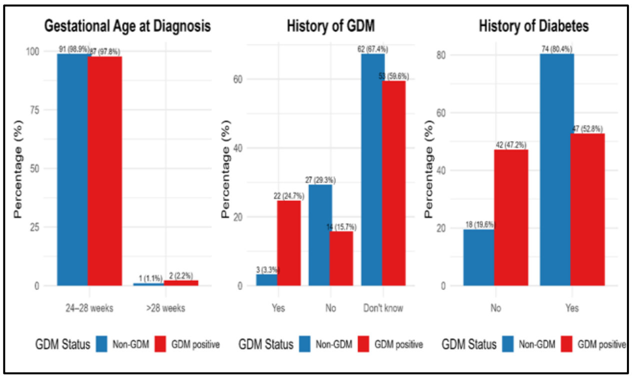

Figure 1: Obstetric and medical history distribution by GDM status.

In terms of maternal outcomes, the majority of participants in both groups had live births (91% versus 93%), with no significant difference (p=0.9). Stillbirths were slightly higher in the GDM group (7.6% versus 5.8%).

Regarding perinatal complications, preeclampsia was significantly more common among non-GDM women (73% versus 43%, p<0.001). Postpartum hemorrhage was more frequent among GDM participants (21% versus 7.6%, p<0.001). Other complications such as eclampsia, HELLP syndrome, cardiovascular events, and PPROM showed no significant group differences (Table 4).

Association between GDM and neonatal outcomes (objective II)

Newborns of GDM mothers had significantly higher mean birth weight (3,149±949 g versus 2,471±788 gm, p<0.001). Macrosomia (≥4,000 gm) was more common among GDM infants (21% versus 1%), while low birth weight (<2,500 gm) was more frequent in the non-GDM group (47% versus 19%) (Table 5).

Large-for-gestational-age (LGA) infants were more frequent among GDM mothers (39% versus 1%), while small-for-gestational-age (SGA) was more common in the non-GDM group (35% versus 11%, p<0.001).

Newborn unit admission was significantly higher among infants born to GDM mothers (44% versus 27%, p=0.009). Respiratory distress syndrome (15% versus 6.7%, p=0.047) and shoulder dystocia (7.6% versus 0%, p=0.007) were also more common among GDM infants. Other complications, including birth asphyxia, prematurity and APGAR score, showed no significant differences.

Table 5: Fetal outcome and complications by GDM status.

Variables	N	Overall n=210[1]	Non-GDM n=105[1]	GDM positive n=105[1]	P value[2]
Fetal outcomes					
Apgar score	210				0.14
Good score		155 (74)	81 (77)	74 (70)	
Average		32 (15)	17 (16)	15 (14)	
Poor score		23 (11)	7 (6.7)	16 (15)	
Birth weight	210	2,810 (934)	2,471 (788)	3,149 (949)	<0.001
Birth weight CAT	210				<0.001
Low birth weight (<2500 gm)		69 (33)	49 (47)	20 (19)	
Normal (2500-3999 gm)		118 (56)	55 (52)	63 (60)	
Macrosomia (≥4000 gm)		23 (11)	1 (1.0)	22 (21)	
Weight conclusion	208				<0.001
Appropriate gestational age		119 (57)	67 (64)	52 (50)	
Small for gestation age (SGA)		47 (23)	36 (35)	11 (11)	
Large for gestational age (LGA)		42 (20)	1 (1.0)	41 (39)	
(Missing)		2	1	1	
Nbu admission	210	74 (35)	28 (27)	46 (44)	0.009
Fetal complications					
Normal birth	210	121 (58)	71 (68)	50 (48)	0.003
Prematurity	210	34 (16)	20 (19)	14 (13)	0.3
RDS	210	23 (11)	7 (6.7)	16 (15)	0.047
MAS	210	2 (1.0)	1 (1.0)	1 (1.0)	>0.9
Asphyxia	210	11 (5.2)	3 (2.9)	8 (7.6)	0.12
Dystocia	210	8 (3.8)	0 (0)	8 (7.6)	0.007
Other	210	33 (16)	7 (6.7)	26 (25)	<0.001

[1]N (%); Mean (SD). [2]Pearson's Chi-squared test; Wilcoxon rank sum test; Fisher's exact test.

Table 6: Logistic regression analysis of risk factors associated with GDM.

	Unadjusted OR (95% CI)				Adjusted OR (95% CI)		
Characteristic	**N**	**OR[1]**	**95% CI[1]**	**P value**	**OR[1]**	**95% CI[1]**	**P value**
Age	210	1.07	1.02, 1.13	0.009	1.03	0.97, 1.10	0.4
BMI CAT	210						
Normal weight		—	—		—	—	
Overweight		2.14	1.11, 4.17	0.024	2.30	1.12, 4.84	0.025
Obese		13.3	5.62, 34.7	<0.001	11.3	4.30, 32.5	<0.001
History of diabetes	210						
No		—	—		—	—	
Yes		0.24	0.12, 0.44	<0.001	0.22	0.10, 0.44	<0.001
History of GDM BIN	209	9.12	3.03, 39.5	<0.001	4.67	1.29, 22.7	0.030
Previous HTN BIN	209	0.66	0.38, 1.14	0.14	0.54	0.27, 1.05	0.074

[1]OR = Odds Ratio, CI = Confidence interval.

Risk factors associated with adverse maternal and neonatal outcomes (objective III)

Bivariate analyses identified several variables significantly associated with GDM, including higher BMI, prior history of GDM, and prior history of diabetes (Tables 1-3).

In multivariable logistic regression, overweight women had more than twice the odds of GDM compared to normal-weight women (aOR=2.30; 95% CI: 1.12-4.84, p=0.025), and obesity was associated with an eleven-fold increase in odds (aOR=11.3; 95% CI: 4.30-32.5, p<0.001). A prior history of GDM was independently associated with higher risk (aOR=4.67; 95% CI: 1.29-22.7, p=0.03). Conversely, a history of diabetes outside pregnancy was associated with lower odds of GDM (aOR=0.22; 95% CI: 0.10-0.44, p<0.001). Age and hypertension were not significantly associated in the adjusted model (Table 6).

DISCUSSION

This study demonstrated that gestational diabetes mellitus (GDM) is a significant contributor to adverse maternal and neonatal outcomes in western Kenya. Across the three objectives, the findings consistently showed that maternal hyperglycemia substantially increases obstetric risk and predisposes infants to multiple metabolic complications. Women with GDM were more likely to undergo caesarean delivery and experience postpartum hemorrhage, findings consistent with previous studies linking maternal hyperglycemia to fetal macrosomia and dysfunctional labour.[9,10,12]

Neonates born to mothers with GDM had higher birth weights, increased rates of macrosomia, respiratory distress syndrome, shoulder dystocia, and increased neonatal unit admission. These outcomes align with evidence demonstrating that maternal hyperglycemia accelerates fetal growth and compromises neonatal metabolic adaptation.[12-14]

Obesity and a prior history of GDM emerged as the strongest predictors of adverse outcomes, reinforcing the role of modifiable metabolic factors in pregnancy outcomes.[13,14,22-24] These findings reflect Kenya's ongoing epidemiological transition, where increasing overweight and non-communicable diseases are reshaping maternal health risks.[11,16] They further highlight the importance of targeted preconception and interpregnancy interventions to break the cycle of GDM recurrence.

Overall, these findings highlight the dual clinical and health-system challenge posed by GDM in low-resource settings. Strengthening antenatal screening, structured nutritional counselling, improving glycemic control, and ensuring structured postpartum follow-up are critical to reducing preventable maternal and neonatal complications.[16,17] A multidisciplinary model involving obstetricians, endocrinologists, nutritionists, and nursing teams would enhance the quality of care.

At the policy level, integrating GDM prevention and management within existing maternal and child health programmes, coupled with public health strategies promoting healthy weight among women of reproductive age, would help mitigate the rising metabolic burden.

CONCLUSION

In summary, this study confirms that GDM significantly heightens the risk of adverse maternal and neonatal outcomes, many of which are preventable through timely diagnosis, effective glycemic control, and coordinated care pathways. Addressing obesity, recurrence of GDM, and system-level gaps is critical for improving pregnancy outcomes and advancing Kenya's maternal health agenda.

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