Postpartum glucose intolerance following gestational diabetes mellitus: A retrospective cohort analysis of prevalence and clinical predictors in Malaysia.

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ABSTRACT

Introduction: Postpartum glucose intolerance significantly increases the risk of developing type 2 diabetes mellitus (T2DM) in women with prior gestational diabetes mellitus (GDM). This study assessed the prevalence and identified clinical predictors of postpartum glucose intolerance among Malaysian women.

Materials and Methods: This retrospective cohort study included 600 women with previous GDM attending postpartum oral glucose tolerance testing (OGTT) at 16 primary health clinics in Terengganu, Malaysia. Data collected encompassed sociodemographic details, antenatal clinical characteristics, and postpartum OGTT outcomes. Multivariable logistic regression analyses identified significant predictors.

Results: The overall prevalence of postpartum glucose intolerance was 19%, with impaired glucose tolerance (IGT) predominant (76%). Significant predictors included family history of diabetes (aOR=2.110; 95% CI: 1.324–3.365), previous GDM history (aOR=1.874; 95% CI: 1.137–3.090), primiparity (aOR=1.804; 95% CI: 1.122–2.898), elevated fasting plasma glucose at GDM diagnosis (aOR=1.636; 95% CI: 1.196–2.238), and elevated 2-hour plasma glucose at GDM diagnosis (aOR=1.452; 95% CI: 1.267–1.663).

Conclusion: The study highlights a substantial prevalence of postpartum glucose intolerance among Malaysian women with prior GDM. Identifying high-risk individuals based on family history, parity, and antenatal glucose levels may enable targeted preventive strategies to reduce the risk of progressing to T2DM.

KEYWORDS:
Diabetes, Gestational; Glucose Intolerance; Postpartum Period; Risk Factors; Prevalence

INTRODUCTION

Postpartum glucose intolerance is an emerging global health concern, particularly among women with prior gestational diabetes mellitus (GDM), which affects 6% to 13% of pregnancies worldwide.[1,2] In Terengganu, Malaysia, GDM prevalence has reached 27.3%, significantly exceeding the national average.[3] Women with GDM have a six to tenfold higher risk of developing type 2 diabetes mellitus (T2DM),[4, 5] and this risk persists for up to 35 years postpartum.[6] In South and Southeast Asia, postpartum prevalences reach 29.9% for T2DM and 25.9% for prediabetes, reflecting a 13-fold higher diabetes risk.[7]

Factors influencing postpartum glucose intolerance include obesity, maternal age, ethnicity, and family history of diabetes.[8,9] Malays, the predominant ethnic group in Terengganu, show increased susceptibility.[10] Regional disparities in healthcare access and sociocultural practices may further affect postpartum outcomes, particularly in rural areas.[11,12] Postpartum glucose intolerance also has intergenerational implications, with offspring facing increased risk of cardiovascular and metabolic diseases.[13,14] While research on GDM is expanding, data from Southeast Asia remain limited.[7] Without timely postpartum screening, many women remain undiagnosed, missing opportunities for prevention.

This study aims to assess the prevalence and identify clinical predictors of postpartum glucose intolerance among women with previous GDM in Terengganu. The findings are expected to guide targeted screening and preventive strategies, inform policy and contribute to improve maternal metabolic health in Southeast Asia.

MATERIALS AND METHODS

Study Design

This retrospective cohort study involved 16 primary health clinics across eight districts in Terengganu, Malaysia, providing Maternal and Child Health (MCH) services.

Study Population

Eligible participants were Malaysian women aged 18 years or older, with documented GDM history, who underwent postpartum oral glucose tolerance testing (OGTT) six weeks postpartum between January 2021 and December 2022. Women with pre-existing diabetes, on diabetes medication, medical conditions affecting glucose metabolism (e.g., thyrotoxicosis or acromegaly) or who relocated postpartum were excluded.

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Sample Size
Sample size calculation utilized the two-proportions formula based on previously reported family history proportion among GDM populations.15 Here, the proportion of family history of DM among GDM women with normal postpartum glucose (Po) was 58%, the estimated proportion of family history of DM among GDM women with abnormal postpartum glucose (P1) was 66.7% with level of significance (α) was 0.05 and the power of the study (β) was 80%. A calculated sample size of 475, with additional 20% to account for potential data loss, resulted in 570 participants. 600 participants were recruited to enhance precision.

Sampling Method
A stratified multistage approach was used to select study clinics, after which eligible participants were retrospectively identified from antenatal diabetes registries. Although clinic selection was random, individual sampling depended on available medical records.

Data Collection Procedures
Secondary data were extracted from the clinic copies of the Maternal Health Records, which document antenatal care, delivery and postpartum information. GDM diagnosis followed the Malaysian Clinical Practice Guidelines, using a 75g OGTT with either FPG ≥ 5.1 mmol/L or 2hPG ≥ 7.8 mmol/L as diagnostic thresholds.16 Standardized national care protocols ensure all women with GDM undergo postpartum glucose screening at six weeks.

Data were collected using a standardized proforma and entered into an Excel database. Completeness was verified, and participants with missing postpartum glucose measurements or essential variables were excluded from the analysis.

Data Categories Collected
Data were extracted from the Maternal Health Records according to the following categories:

1. Sociodemographic Data: Age, ethnicity, educational level (categorized as primary, secondary, or tertiary), and occupation.
2. Antenatal Clinical Data: Family history of diabetes (first-degree relatives), parity (primiparous or multiparous), previous GDM diagnosis, gestational age at the first prenatal booking, BMI at booking (categorized as underweight, normal, overweight, or obese), total gestational weight gain, and the gestational age at which GDM was diagnosed (first, second, or third trimester). Details on the treatment for GDM (diet control, metformin alone, insulin alone, or combined therapy) were also recorded. Additional clinical data included antenatal OGTT results (fasting plasma glucose [FPG] and 2-hour plasma glucose [2hPG]) and foetal ultrasound findings (presence of polyhydramnios or congenital abnormalities).
3. Postpartum Clinical Data: Postpartum glucose tolerance status was classified as normal or abnormal using World Health Organization (WHO) criteria.17 Women with FPG ≥ 6.1 mmol/L and 2hPG ≥ 7.8 mmol/L after ingestion of 75 g of oral glucose load were considered to have abnormal glucose tolerance.[17] Abnormal glucose tolerance was categorized as postpartum diabetes mellitus and prediabetes, which includes impaired fasting glucose (IFG), impaired glucose tolerance (IGT) or both. The WHO criteria were used in accordance with Malaysia's national guidelines.[16]

Study Variables
The variables under study were divided into dependent and independent variables:

- Dependent Variable:
  Postpartum OGTT results (FPG and 2hPG), categorized as:
  a. Normal glucose tolerance
  b. Abnormal glucose tolerance (prediabetes or diabetes)

- Independent Variables:
  a. Sociodemographic Data: Age, ethnicity, educational level and occupation.
  b. Antenatal Clinical Information: Parity, BMI at booking, previous diagnosis of GDM, family history of diabetes (first-degree relative), gestational age at GDM diagnosis, treatment for GDM, total gestational weight gain, antenatal OGTT results (FPG and 2hPG), and foetal ultrasound findings.

Data Analysis
Statistical analysis was conducted using the Statistical Package for the Social Sciences (SPSS version 26.0). Descriptive statistics summarized participant characteristics and glucose intolerance prevalence. Data were expressed as frequency and percentages for categorical variables. Associations were determined using logistic regression. Simple logistic regression was first performed, in which variables with p-value less than 0.25 or clinically significant variables were included further for multivariable logistic regression. Variables with a p-value less than 0.25 in the univariate analysis were selected for inclusion in the multivariable logistic regression model to ensure that potentially important predictors were not excluded prematurely. From the multivariable logistic regression, final adjusted model was produced, in which variables with p-value less than 0.05 considered as statistically significant. Interaction, multi-collinearity test and model fit based on Hosmer Lemeshow test were checked on the final adjusted model. The finding association for each factor was reported using crude and adjusted OR (aOR).

Ethical Approval
Ethical approval for this study was granted by Medical Research and Ethics Committee (MREC), Ministry of Health Malaysia (MOH) (NMRR ID-23-00409-TPH) and Universiti Sultan Zainal Abidin (UniSZA) Research Ethics Committee (approval No. UniSZA/UHREC/2023/521).

RESULTS

Prevalence of Postpartum Glucose Intolerance
Out of the 600 women diagnosed with GDM and tested postpartum, 114 (19.0%) were found to have abnormal OGTT results at six weeks postpartum. Of those with abnormal postpartum glucose tolerance, 15% had IFG, 76% had IGT, 4% had both IFG and IGT and 5% were diagnosed with T2DM. This prevalence highlights the considerable risk of abnormal glucose regulation among women with previous GDM.

Table I: Sociodemographic and clinical characteristics of GDM women who underwent postpartum glucose testing at six weeks postpartum (N=600)

Characteristics	Normal OGTT postpartum (N=486)			Abnormal OGTT postpartum (N=114)		
	Median (IQR)	N	%	Median (IQR)	N	%
Ethnicity						
Malay		479	98.6		113	99.1
Chinese		3	0.6		0	0
Others		4	0.8		1	0.9
Education level						
Primary school		6	1.2		3	2.6
Secondary school		240	49.4		49	43.0
Tertiary education		240	49.4		62	54.4
Employment status						
Employed		233	47.9		63	55.3
Unemployed		253	52.1		51	44.7
Parity						
Primiparous		166	34.2		50	43.9
Multiparous		320	65.8		64	56.1
History of GDM in previous pregnancies						
Yes		103	21.2		43	37.7
No		383	78.8		71	62.3
First degree relatives with DM						
Yes		237	48.8		78	68.4
No		249	51.2		36	31.6
Gestational age GDM was diagnosed						
1st trimester		182	37.4		57	50.0
2nd trimester		213	43.8		45	39.5
3rd trimester		91	18.7		12	10.5
Results of foetal ultrasound						
Normal		471	96.9		110	96.5
Abnormal		15	3.1		4	3.5
Treatment of GDM during pregnancy						
Diet		348	71.6		74	64.9
Insulin only		91	18.7		26	22.8
Metformin and insulin		9	1.9		4	3.5
Metformin only		38	7.8		10	8.8
BMI at booking						
Underweight		22	4.5		3	2.6
Normal		84	17.3		19	16.7
Overweight		148	30.5		25	21.9
Obese		232	47.7		67	58.8
OGTT upon diagnosed GDM						
Fasting plasma glucose	Median = 5.0 Minimum = 3.4 Maximum = 10.1 IQR =0.8			Median = 5.1 Minimum = 3.6 Maximum = 8.4 IQR =0.9		
2 hours plasma glucose	Median = 8.2 Minimum = 3.5 Maximum = 14.6 IQR =1.6			Median = 9.1 Minimum = 3.7 Maximum = 13.9 IQR =2.2		
Weight increase during pregnancy (kg)	Median = 7.0 Minimum = -13.0 Maximum = 20 IQR =5.5			Median = 7.0 Minimum = -6.0 Maximum = 19 IQR =6.0		

IQR: interquartile range

Table II: Simple logistic regression for factors associated with postpartum glucose intolerance

Characteristics	crude OR	95% CI	p-value
Education level			
Primary/Secondary school	1.00	(ref)	
Tertiary education	1.222	(0.812, 1.840)	0.337
Employment status			
Unemployed	1.00	(ref)	
Employed	1.341	(0.890, 2.021)	0.160
Parity			
Multiparous	1.00	(ref)	
Primiparous	1.506	(0.995, 2.280)	0.053
History of GDM in previous pregnancies			
No	1.00	(ref)	
Yes	2.252	(1.455, 3.485)	< 0.001
First degree relatives with DM			
No	1.00	(ref)	
Yes	2.276	(1.476, 3.510)	< 0.001
Gestational age GDM was diagnosed			0.024
1st trimester	1.00	(ref)	
2nd trimester	0.675	(0.435, 1.045)	0.078
3rd trimester	0.421	(0.215, 0.824)	0.012
Results of foetal ultrasound			
Normal	1.00	(ref)	
Abnormal	0.876	(0.285, 2.690)	0.817
Treatment of GDM during pregnancy			0.370
Diet	1.00	(ref)	
Insulin only	0.714	(0.374, 1.364)	0.308
Metformin with/without insulin	0.959	(0. .458, 2.008)	0.912
BMI at booking			0.150
Underweight	1.00	ref	
Normal	1.659	(0.450, 6.117)	0.447
Overweight	1.239	(0.345, 4.449)	0.743
Obese	2.118	(0.615, 7.293)	0.234
OGTT upon diagnosed GDM			
Fasting plasma glucose	1.716	(1.295, 2.274)	< 0.001
2 hours plasma glucose	1.459	(1.278, 1.665)	< 0.001
Weight increase during pregnancy	0.985	(0.942, 1.030)	0.511

OR = odd ratio, 95% CI = 95% Confident Interval

Table III: Multivariate logistic regression for factors significantly associated with postpartum glucose intolerance

Characteristics	aOR*	95% CI	p-value
Employment status			
Unemployed			
Employed	1.470	(0. 936, 2.309)	0.094
Parity			
Multiparous			
Primiparous	1.804	(1.122, 2.898)	0.015
History of GDM in previous pregnancies			
No			
Yes	1.874	(1.137, 3.090)	0.014
First degree relatives with DM			
No			
Yes	2.110	(1.324, 3.365)	0.002
Gestational age GDM was diagnosed			0.328
1st trimester			
2nd trimester	0.998	(0.610, 1.633)	0.995
3rd trimester	0.590	(0.282, 1.235)	0.162
OGTT upon diagnosed GDM			
Fasting plasma glucose	1.636	(1.196, 2.238)	0.002
2 hours plasma glucose	1.452	(1.267, 1.663)	< 0.001

aOR = Adjusted odd ratio, 95% CI = 95% Confident Interval
*Multiple Logistic Regression model using Enter method was applied
Multicollinearity and interaction term were checked and not found
Hosmer-Lemeshow test (p>0.05), classification table (overall correctly classified percentage=82.8%) and area under the ROC curve (73.1%) were applied to check the model fitness

Sociodemographic and Clinical Characteristics
Most participants were Malay, comprising 98.6% of women with normal OGTT results and 99.1% with abnormal results. Educational attainment was evenly distributed between secondary and tertiary levels, with slightly more tertiary-educated women in abnormal OGTT group (54.4%) than in the normal group (49.4%). Employment was also more common among women with abnormal OGTT results (55.3%) compared to those with normal results (47.9%).

Primiparous women were more frequent in the abnormal group (43.9%) compared to the normal group (34.2%). A previous history of GDM was reported in 37.7% of women with abnormal group versus 21.2% in the normal group. Similarly, a family history of diabetes among first-degree relatives was higher in the abnormal group (68.4%) compared with the normal group (48.8%).

Half of the women with abnormal OGTT results were diagnosed with GDM during the first trimester (50.0%), compared to 37.4% in the normal group. Conversely, fewer women in the abnormal group were diagnosed in the third trimester (10.5%) compared to the normal group (18.7%). Obesity at booking was also more prevalent in the abnormal group (58.8%) compared to the normal group (47.7%).
Table I summarizes these findings.

Predictors of Postpartum Glucose Intolerance
From the simple logistic regression, only employment status, parity, history of GDM in previous pregnancies, first degree relatives with DM, gestational age when GDM was diagnosed, FPG and 2hPG during antenatal OGTT were statistically significant at 0.25 and added to the final model. Notably, a history of GDM in previous pregnancy (OR = 2.252, 95% CI: 1.455–3.485, p < 0.001) and a family history of diabetes (OR = 2.276, 95% CI: 1.476–3.510, p < 0.001) showed the strongest association in the univariate analysis (Table II).

In the multivariable logistic regression (Table III), the model was adjusted for employment status, parity, history of GDM, family history of diabetes, gestational age at GDM diagnosis, and both antenatal glucose measures (FPG and 2hPG). Five predictors were statistically significant at 0.05, namely first-degree relatives with DM, history of GDM in previous pregnancies, parity, FPG and 2hPG level on the antenatal OGTT.

Those with first degree relatives with DM had 2.110 times the odds of having postpartum glucose intolerance, as compared to those without history of first-degree relatives with DM (aOR=2.110; 95% CI (1.324, 3.365), p = 0.002). Those with history of GDM in previous pregnancies had 1.874 times the odds of having postpartum glucose intolerance, as compared to those without history of GDM (aOR=1.874; 95% CI (1.137, 3.090), p = 0.014). Primiparous women had 1.804 times the odds of having postpartum glucose intolerance as compared to multiparous (aOR=1.804; 95% CI (1.122, 2.898), p = 0.015).

For each unit increase of FPG level on the antenatal OGTT, the odds of having postpartum glucose intolerance increased by 1.636 (aOR=1.636; 95% CI (1.196, 2.238), p = 0.002).

For each unit increase of 2hPG level on the antenatal OGTT, the odds of having postpartum glucose intolerance increased by 1.452 (aOR=1.452; 95% CI (1.267, 1.663), p = < 0.001).

No multicollinearity (highest VIF 1.054) and interactions were detected. Hosmer Lemeshow test revealed p-value of more than 0.05 (p = 0.179), with overall classified percentage of 82.8%. Area under the ROC curve was 73.1% (p < 0.05), indicating good fit of the model.

DISCUSSION

Prevalence of Postpartum Glucose Intolerance
In our study, 19.0% of women demonstrated postpartum glucose intolerance at six weeks, with IGT as the predominant abnormality. This aligns with global estimates ranging from 20% to 60% and regional findings of 27% at 6–12 weeks postpartum.[7,8,15] The slightly lower prevalence observed may reflect differences in healthcare access and postpartum behaviours in this population. Malaysian studies report similar short-term prevalences of 12–20%,[15,18-20] while long-term follow-up shows rates exceeding 50% within a decade.[13,21] These findings underscore the need for continued monitoring beyond routine postpartum testing. The predominance of IGT highlights a key opportunity for preventive lifestyle or pharmacological interventions, and the 5% immediate progression to diabetes further emphasises the urgency of early postpartum screening.

Key Predictors of Postpartum Glucose Intolerance
Our multivariable analysis identified family history of diabetes mellitus, previous history of GDM, primiparity, and elevated fasting and 2hPG at GDM diagnosis as significant predictors of postpartum glucose intolerance.

Family History of Diabetes
A family history of diabetes in first-degree relatives doubled the risk of postpartum glucose intolerance, consistent with meta-analyses showing familial predisposition as strong independent factor.[22,23] Genetic susceptibility, shared lifestyle patterns and environmental influences likely contribute. While genetic predisposition is non-modifiable, early identification and personalized lifestyle interventions could substantially mitigate long-term risks.

History of GDM in Previous Pregnancies
A previous GDM diagnosis significantly increases the likelihood of postpartum glucose intolerance, a finding consistent with global literature. Our study found out that women with a prior GDM had approximately 1.87 times higher odds of postpartum glucose intolerance, supporting international findings of increased recurrence risk.[5,24,25] Persistent insulin resistance and inadequate pancreatic beta-cell compensation may underlie this association.26 Recognizing prior GDM as a red flag can prompt preventive interventions which could delay or prevent the onset of T2DM.

Parity
Interestingly, our study found that the association between primiparity and higher risk differs from most studies that link multiparity with increased risk.[27-29] This may relate to behavioural or physiological differences during a first

pregnancy, including stress and limited experience with glucose management. Regardless, this reinforces the need for universal postpartum screening, irrespective of parity.

FPG at GDM Diagnosis
Elevated antenatal FPG independently predicted postpartum glucose intolerance, supporting previous studies showing its strong prognostic value.30 High FPG levels during pregnancy indicate substantial insulin resistance, which may persist into the postpartum period, increasing the risk of sustained glucose dysregulation.21 Clinically, women with elevated FPG should be prioritized for early postpartum glucose testing and intensive lifestyle counselling.

2hPG at GDM Diagnosis
Similarly, higher 2hPG value predicted increased postpartum glucose intolerance, consistent with studies demonstrating that post-load glucose reflects peripheral insulin resistance and delayed glucose clearance.30, 31 Therefore, an elevated 2hPG level during the antenatal OGTT should not be overlooked, even if fasting glucose was near-normal. Including both fasting and 2h values in antenatal assessment improves risk stratification and guides postpartum surveillance.

BMI and Weight Gain During Pregnancy
Although BMI and weight gain during pregnancy are clinically important indicators, neither was significantly associated with postpartum glucose intolerance in this cohort. The high baseline prevalence of overweight and obesity may have reduced variability between groups, while antenatal dietary counselling and treatment may have attenuated metabolic differences.

Clinical Implications and Practical Applications
All significant predictors were detectable during pregnancy, highlighting antenatal care as a key opportunity for early risk stratification. Linking antenatal risk factors to structured postpartum follow-up, lifestyle counselling and digital or community-based reminder systems may improve postpartum screening uptake. A simple risk-prediction tool could assist primary-care clinicians, especially in resource-limited settings.

Study Limitations and Recommendations
This retrospective design and reliance on secondary data limit certain variables' control and completeness. The predominantly Malay cohort may restrict generalizability. Further longitudinal studies, multi-ethnic cohorts, and longer-term follow-up research are recommended to confirm these findings and explore effective interventions.

CONCLUSION

This study reveals a significant prevalence of postpartum glucose intolerance in women with previous GDM, highlighting critical predictors useful for targeted intervention and preventive strategies. Strengthened antenatal risk assessment, structured postpartum screening, and lifestyle counselling may reduce long-term diabetes risk.

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