Factors Associated with Postpartum Glucose Testing Following Gestational Diabetes Mellitus

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ABSTRACT

Objectives: Glucose testing at six weeks after delivery has been recommended by the World Health Organization as the earliest period to detect abnormal glucose tolerance among women with gestational diabetes mellitus (GDM). However, the rate of postpartum glucose testing in many parts of the world is low, between 30–60%. Therefore, we sought to determine the proportion of women with GDM who underwent glucose testing at six weeks postpartum and the factors associated with the compliance to the test. *Methods*: We conducted a cross-sectional study between January and April 2017 in 13 governmental primary health care clinics in the southern part of Peninsular Malaysia. All eligible postpartum women registered from January to June 2016 who had GDM during their most recent pregnancy were included. Descriptive and multiple logistic regression analyses were performed. *Results:* Out of 341 women, 35.8% attended primary health care clinics for glucose testing six weeks postpartum. The factors significantly associated with the compliance to postpartum glucose testing were GDM diagnosis in previous pregnancy (adjusted odds ratio (AOR) = 1.76; 95% confidence interval (CI): 1.04–2.99; p = 0.036) and normal level of glycated hemoglobin during the most recent pregnancy (AOR = 2.49; 95% CI: 1.06–5.86; p = 0.036). *Conclusions:* The proportion of women with GDM who underwent postpartum glucose testing remained low. Hence, strategies should be reinforced to encourage all women with GDM to undergo postpartum glucose testing.

G lobally, the number of people with diabetes has increased significantly in recent decades. A similar trend is documented in Malaysia. In 2011 the prevalence of diabetes was 15.2%, and it is projected to reach 21.6% in 2020, affecting approximately 4.5 million Malaysians aged 18 years and above.[1] This trend is attributed to the increasing prevalence of overweight and obesity resulting from physical inactivity and high consumption of sugar and fatty food in both developed and developing countries.[2,3]

As the current epidemic of obesity and diabetes has increased, the prevalence of type 2 diabetes mellitus (T2DM) in women of childbearing age and the number of pregnant women with undiagnosed T2DM has also increased.[4] Likewise, the number of gestational diabetes mellitus (GDM) cases has grown in recent decades.[4] GDM is first diagnosed during the second or third trimester of pregnancy, and whether this is either a pre-existing type 1 diabetes or T2DM is unclear.[5] There is a strong association between GDM and T2DM. Women with GDM

have at least seven times higher risk of developing T2DM than those with normal pregnancies.[6] In addition, untreated carbohydrate intolerance during pregnancy causes maternal morbidity and perinatal morbidity and mortality.[7] In women with GDM, insulin resistance already exists before pregnancy, but it worsens during pregnancy. Insulin secretion is inadequate to compensate for the insulin resistance, leading to hyperglycemia, which is detected by routine glucose screening during pregnancy. Thus, chronic insulin resistance is a central component of the pathophysiology of women with GDM.[8]

Carbohydrate intolerance during pregnancy usually resolves after delivery. However, postpartum testing reveals that up to one-third of affected women have DM or impaired glucose tolerance.[5,9] Glucose testing performed at six weeks postpartum may delay or prevent the onset of T2DM, which manifests soon after the postpartum period, through lifestyle modification, such as dietary changes, physical activity, weight management, and/or pharmacological intervention.[9] However, most

women with GDM are not screened for T2DM after delivery; thus, diabetes prevention and treatment opportunities are missed. A scheduled postpartum test is important to detect prediabetes and diabetes and allow prompt intervention to reduce the risk of diabetes or diabetes-related complications.[10]

Malaysia follows the recommended protocol of glucose testing at six weeks postpartum. During the first postpartum visit in primary health care clinics, all women with GDM are given an appointment for the test at six weeks postpartum. These primary health care facilities, which women attend for their antenatal check-ups, are easily accessible as they are situated near the women's place of residence, approximately 5 km away in the urban areas and 3 km away in rural areas. The services offered in these health clinics include maternal and child health services, which provide antenatal and postnatal care to all mothers. Despite the availability and accessibility of these primary care services, there is no existing system that reminds women to undergo postpartum glucose testing.[11,12]

Given that early detection of glucose abnormalities postpartum can delay or prevent T2DM in women with glucose intolerance, postpartum glucose testing is important because it allows early detection of prediabetes and treatment of diabetes. Our study determined the current postpartum glucose testing rate among women with GDM. To our knowledge, this study is the first to determine the compliance rate of women with GDM for glucose testing at six weeks postpartum and the associated factors influencing the compliance with the test in the southern part of Peninsular Malaysia.

METHODS

This cross-sectional study was conducted in Johor Bahru District, the state capital city of Johor. The state's geographical position being the southernmost city in Peninsular. Johor has the second largest population in Malaysia at 3 230 440 in 2010, increasing to 3 601 690 in 2016.[13] The state's ethnic composition include Malays (51.2%), Chinese (33.5%), Indian (10.7%), other ethnic groups (0.1%), and non-citizens (4.5%). Johor Bahru District has 16 government primary health care clinics, but only 13 offer maternal and child health services.

This study was conducted based on the medical records of postpartum women who had registered in primary health care clinics in Johor Bahru from January to June 2016 and had GDM in their most recent pregnancy. Those who had their postpartum follow-up in other districts or were unable to attend testing because of physical disability (e.g., being bed-ridden) were excluded. Since this study involved reviewing secondary data, records missing at least one of the required information were excluded. This study was approved by the Human Research Ethics Committee of the Universiti Sains Malaysia [USM/JEPeM/16120599] and the Medical Research and Ethics Committee of the Ministry of Health, Malaysia [NMRR-16-2352-33522(IIR)].

The sample size was estimated using the single proportion formula to determine the proportion of individuals who undergo postpartum glucose testing and using power and sample size calculation software to compare two independent proportions. From all the sample sizes determined, the biggest sample size was 345. A total of 516 postpartum women with GDM were registered from January to June 2016. Of these, 341 cases met the inclusion criteria, and the records of all these women were reviewed.

This study involved secondary data collection from primary health care clinics. A list of women with GDM was obtained. Sociodemographic, clinical, obstetric characteristics, and glucose screening results during pregnancy and after delivery were extracted from their maternal health records. The retrieved information were reviewed and recorded in the data collection form by a researcher.

The maternal health record was assigned during the women's first antenatal check-up and maintained until six weeks after delivery. Information related to the pregnancy, delivery, and postpartum period was recorded. The record was prepared in two copies for each pregnancy; one copy was a home-based card, which belongs to the pregnant women, and the respective health clinic kept the other copy.

The record consists of three sets of information: the women's sociodemographic, clinical, and healthcare data. The sociodemographic information collected in this study included the women's age, ethnicity, marital status, educational level, and occupation. Educational level was classified into secondary and lower education or tertiary and higher education.

Clinical data included family history of diabetes, parity, and previous diagnosis of GDM.

The women diagnosed with GDM in pregnancies before their most recent pregnancy were classified as having a prior diagnosis of GDM. Other data obtained include any underlying medical illness and gestational age at booking. Booking is defined as the first antenatal visit of the respondents to any clinic. It is classified according to gestational age at the time of booking, namely, early booking, which is done before 12 weeks of gestation, and late booking, which is done after 12 weeks gestation. In the maternal health record, information such as gestational weight gain, treatment with metformin or insulin, and glycated hemoglobin (HbA_{1c}) level were recorded by the attending physicians at the health clinics. Other clinical data retrieved include mode of delivery, infant birth weight, and admission to a neonatal intensive care unit. These data were all recorded in the postnatal column found in the last pages of the maternal health record.

In addition, postpartum, home, and hospital follow-up visits were among the health care data obtained from the maternal health record. During each visit, the dates for subsequent follow-up visits in the clinic or hospital setting were recorded. Data were recorded in the maternal health record during each home visit by an attending nurse. Information regarding postpartum glucose testing compliance and the test results were recorded in the postnatal column of the maternal health record. The women were indicated to have undergone postpartum glucose testing if they were tested six weeks postpartum as scheduled on their appointment date. Moreover, the women were indicated to have abnormal glucose tolerance if they had diabetes, prediabetes, impaired glucose tolerance, impaired fasting glucose, or elevated glucose tolerance.[14]

All information were analyzed using SPSS Statistics (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.). Data were expressed as frequency and percentages for categorical variables. Simple and multiple logistic regression analyses were used to evaluate the factors associated with compliance with postpartum glucose testing. All variables were tested for their association with postpartum glucose testing. The dependent variable was postpartum glucose testing, which was either performed or not performed. In variable selection, the stepwise, forward and backward methods were used. In selecting a model, the three rules considered were

Table 1: Sociodemographic and clinical characteristics of women with gestational diabetes mellitus (GDM) (n = 341).

Variables	Mean±SD	n	%
Age, years	31.7 ± 4.9		
Ethnicity			
Malay		213	62.5
Chinese		70	20.5
Indian		41	12.0
Others		17	5.0
Marital status			
Married		337	98.8
Single		4	1.2
Education			
Tertiary and above		13	3.8
Secondary and lower		328	96.2
Parity			
Multiparous		224	65.7
Primiparous		117	34.3
Family history of diabetes			
No		167	49.0
Yes		174	51.0
Previous diagnosis of GDM			
No		267	78.3
Yes		74	21.7
Gestational age at booking, weeks			
≥ 12		170	49.9
< 12		171	50.1
Underlying medical illness			
No		299	87.7
Yes		42	12.3
Insulin usage			
No		305	89.4
Yes		36	10.6
Gestational weight gain			
Normal		185	54.3
Excessive		48	14.1
Poor		108	31.7
Glycated hemoglobin (HbA_{1c})			
Abnormal (> 6.5 mmol/L)		24	7.0
Normal (< 6.5 mmol/L)		317	93.0
Mode of delivery			
Cesarian section		89	26.1
Vaginal delivery		252	73.9
Infant birth weight, g			
2500–3500		265	77.7
< 2500		24	7.0
> 3500		52	15.2

SD: standard deviation.

statistical significance, parsimony, and biological plausibility. Any possible two-way interaction was checked in the model. The fitness of the model was tested using the Hosmer–Lemeshow goodness of fit test. The classification table and area under receiver operating characteristic curve were used to determine the fitness of the model. The final model was presented in terms of adjusted odds ratio (AOR), 95% confidence interval (CI), Wald statistics, and *p*-value. The significance level was set at *p* < 0.050.

RESULTS

A total of 341 postpartum women with GDM were included in this study. Their age ranged between 18 and 48 years with a mean (±SD) of 31.7±4.9 years. Majority of subjects were Malays (n = 213; 62.5%), married (n = 337; 98.8%), and had secondary and lower education (n = 328; 96.2%). Table 1 shows the sociodemographic and clinical characteristics of the subjects.

The proportion of women who showed up in primary healthcare clinics for glucose testing at six weeks postpartum was 35.8%. The remaining 219 (64.2) did not show up during their appointments, which their attending healthcare providers set during their routine follow-up within the immediate postpartum period. Among those who underwent postpartum glucose testing, 107 (87.7%) were

normoglycemic, and 15 (12.3%) had abnormal glucose tolerance at six weeks postpartum. Out of the 15 cases with abnormal glucose tolerance, one patient (6.7%) was diagnosed with DM, and 14 (93.3%) were diagnosed with impaired glucose tolerance. Figure 1 shows the prevalence of abnormal glucose tolerance among postpartum women with GDM who have undergone glucose testing.

Simple logistic regression analysis was conducted to determine the factors associated with postpartum glucose testing among women with GDM. No significant association between sociodemographic factors and glucose testing at six weeks postpartum was found among women with GDM in Johor Bahru. The age, ethnicity, educational level, and employment status of the women did not significantly influence their behavior toward postpartum glucose testing. By contrast, the significant variables in this univariable analysis were family history of diabetes (*p* = 0.028), previous diagnosis of GDM (*p* = 0.020), and HbA_{1c} level (*p* = 0.021) [Table 2].

Multiple logistic regression analysis was used to identify the associated factors after controlling for all other variables. Educational level, family history of diabetes, previous diagnosis of GDM, presence of underlying medical illness, hospital follow-up, and HbA_{1c} level were the variables with a *p*-value of < 0.050; thus, they were selected for multiple logistic regression analysis. From this analysis, the significant factors associated with postpartum glucose testing at six weeks among women with GDM when other variables were controlled were previous diagnosis of GDM (AOR = 1.76; 95% CI: 1.04–2.99; *p* = 0.036) and normal HbA_{1c} level (AOR = 2.49; 95% CI: 1.06–5.86; *p* = 0.036) [Table 3].
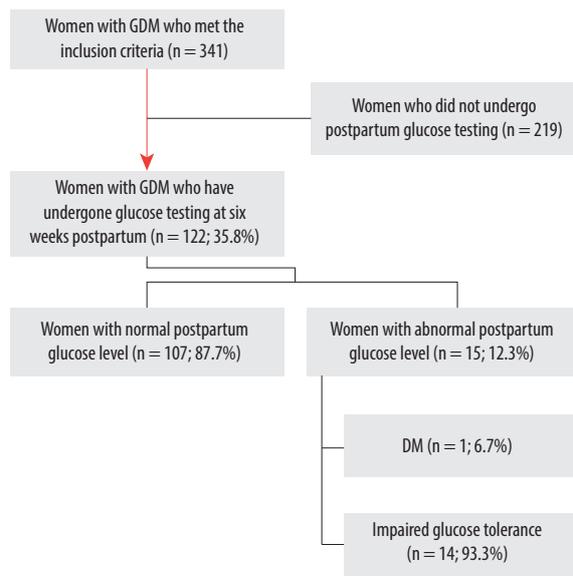
Figure 1: Flow chart showing the prevalence of abnormal glucose tolerance among postpartum women with gestational diabetes mellitus (GDM) who have undergone glucose testing.

DISCUSSION

This study examined the compliance with postpartum glucose testing for diabetes detection among women diagnosed with GDM during their most recent pregnancy. These women were registered in government primary health care clinics in Johor Bahru from January to June 2016. The postpartum glucose screening rate among this cohort of vulnerable women was low at 35.8%, consistent with previous results wherein postpartum screening rates ranged from 19–67%.[14–17]

There are several potential explanations for the low postpartum testing rates reported in this study.

Table 2: Factors associated with six weeks postpartum glucose testing using simple logistic regression analysis (n = 341).

Variables	Perform glucose testing, n = 122		Not perform glucose testing, n = 219		Crude OR (95% CI)	Wald statistics (df)	p-value
	Mean ± SD	n (%)	Mean ± SD	n (%)			
Age, years	31.7 ± 5.1		31.6 ± 4.7		1.00 (0.96–1.05)	0.00 (1)	0.949
Parity							
Multiparous		82 (67.2)		142 (64.8)	1		
Primiparous		40 (32.8)		77 (35.2)	1.11 (0.69–1.78)	0.01 (1)	0.658
Ethnicity							
Malay		79 (64.8)		134 (61.2)	1		
Chinese		25 (20.5)		45 (20.5)	0.94 (0.54–1.65)	0.04 (1)	0.836
Indian		12 (9.8)		29 (13.2)	0.70 (0.34–1.45)	0.91 (1)	0.341
Others		6 (4.9)		11 (5.0)	0.93 (0.33–2.59)	0.02 (1)	0.883
Education level							
No higher education		115 (94.3)		213 (97.3)	1		
Higher education		7 (5.7)		6 (2.7)	2.16 (0.71–6.58)	1.84 (1)	0.175
Employment status							
Unemployed		60 (49.2)		121 (55.3)	1		
Employed		62 (50.8)		98 (44.7)	1.28 (0.82–1.99)	1.16 (1)	0.282
Family history of diabetes							
No		50 (41.0)		117 (53.4)	1		
Yes		72 (59.0)		102 (46.6)	1.65 (1.06–2.59)	4.82 (1)	0.028
Previous diagnosis of gestational diabetes mellitus							
No		87 (71.3)		180 (82.2)	1		
Yes		35 (28.7)		39 (17.8)	1.86 (1.10–3.13)	5.37 (1)	0.020
Gestational age at booking, weeks							
≥ 12		57 (46.7)		113 (51.6)	1		
< 12		65 (53.3)		106 (48.4)	0.82 (0.53–1.28)	0.75 (1)	0.388
Underlying medical illness							
No		102 (83.6)		197 (90.0)	1		
Yes		20 (16.4)		22 (10.0)	0.57 (0.29–1.09)	2.87 (1)	0.090
Insulin usage							
No		108 (88.5)		197 (90.0)	1		
Yes		14 (11.5)		22 (10.0)	1.16 (0.57–2.36)	0.17 (1)	0.681
Gestational weight gain							
Normal		69 (56.6)		116 (53.0)	1		
Excessive		20 (16.4)		28 (12.8)	1.20 (0.63–2.29)	0.31 (1)	0.579
Poor		33 (27.0)		75 (34.2)	0.74 (0.45,1.23)	1.36 (1)	0.243
Glycated hemoglobin (HbA$_{Ic}$)							
Abnormal		14 (11.5)		10 (4.6)	1		
Normal		108 (88.5)		209 (95.4)	2.71 (1.17–6.30)	5.36 (1)	0.021
Mode of delivery							
Caesarian section		33 (27.0)		56 (25.6)	1		
Vaginal delivery		89 (73.0)		163 (74.4)	1.08 (0.65–1.78)	0.09 (1)	0.766
Infant birth weight, g							
2500–3500		91 (74.6)		174 (79.5)	1		
< 2500		9 (7.0)		15 (6.8)	1.15 (0.48–2.72)	0.10 (1)	0.755
> 3500		22 (18.4)		30 (13.7)	1.42 (0.77–2.57)	1.20 (1)	0.274
Hospital follow-up							
No		93 (76.2)		183 (83.6)	1		

Table 2: Factors associated with six weeks postpartum glucose testing using simple logistic regression analysis (n = 341).

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Variables	Perform glucose testing, n = 122		Not perform glucose testing, n = 219		Crude OR (95% CI)	Wald statistics (df)	*p*-value
	Mean ± SD	n (%)	Mean ± SD	n (%)			
Yes		29 (23.8)		36 (16.4)	0.63 (0.36–1.09)	2.70 (1)	0.100
NICU admission							
No		105 (86.1)		193 (88.1)	1		
Yes		17 (13.9)		26 (11.9)	0.83 (0.43–1.60)	0.30 (1)	0.583

SD: standard deviation; OR: odds ratio; CI: confidence interval; NICU: neonatal intensive care unit.

Table 3: Factors associated with six-week postpartum glucose testing using multiple logistic regression (n = 341).

Variables	B	Adjusted OR (95% CI)	Wald statistics (df)	*p*-value
Previous diagnosis of gestational diabetes mellitus				
No		1		
Yes	0.567	1.76 (1.04–2.99)	4.40 (1)	0.036
Glycated hemoglobin				
Abnormal		1		
Normal	0.915	2.49 (1.06–5.86)	4.71 (1)	0.036

B: regression coefficient; OR: odds ratio; CI: confidence interval.

The results indicate that postpartum follow-up of women with GDM was insufficiently incorporated into the primary care system. Women with GDM have limited knowledge about their true risk of T2DM after delivery. They do not practice other positive preventive lifestyle changes, such as increasing the frequency of exercise even if they perceive that they are at high risk for T2DM. For postpartum testing to be facilitated, the risk of T2DM must be discussed during routine antenatal care, and offering of continuing education program during the postpartum period is essential to increase risk perception among women with GDM.[18] However, this measure might be influenced by lack of approved protocols, insufficient or unclear communication from the attending physician in secondary care, and lack of sufficient reminder and tracking systems in primary care practices.[19] Postpartum glucose testing rates after GDM may be increased by incorporating alerts into electronic medical records to ensure that postpartum glucose testing orders are automatically generated or are physician-ordered. An automated live or recorded telephone or email message could also be used to remind women to go for the test after it was ordered.[9]

In previous studies, the use of a reminder system involving a short messaging system to ensure that mothers show up for postpartum tests has resulted in high postpartum glucose testing rates.[20,21] However, in Malaysia, a systematic reminder system that reminds women to show up for postpartum glucose testing does not exist. Although women with GDM who show up for their first postpartum visit to health clinics were given an appointment date for the test at six weeks postpartum, no further follow-up or reminder was given.

In this study, women with normal HbA_{1c} levels during pregnancy have approximately 2.5 times higher odds of showing up for postpartum glucose testing at six weeks postpartum than those with abnormal results.

Studies have examined the association between HbA_{1c} level and compliance for postpartum glucose testing, but all of these studies have found no associations between the two.[14,22,23] The reason behind the current findings, particularly for women with GDM, is unclear. However, the current finding may be a reflection of a 'healthy cohort' effect, in which individuals with normal HbA_{1c} levels are more health-conscious

and likely to seek treatment or to show up for a check-up.[15]

Moreover, this study found that previous diagnosis of GDM significantly influenced the compliance for postpartum glucose testing. The women diagnosed with GDM in their pregnancies before the most recent one have approximately two times higher odds of attending postpartum glucose testing. Women diagnosed with GDM in their previous pregnancies may have already gained some basic knowledge about the disease and its future implication; thus, they are more likely to return for the screening test.[21] By contrast, those with no prior diagnosis of GDM had a lower awareness score than those with current or former GDM, given that they had not received any information or health advice and education on the subject. Nevertheless, many of them had already presented several risk factors for GDM and T2DM, including high body mass index, family history of diabetes, non-white ethnicity, and smoking.[24]

A study in the USA has found that women who failed to return for postpartum glucose testing are more likely to have a history of GDM in their previous pregnancies compared with women who returned.[25] However, other studies conducted in the USA, Australia, Brazil, and Canada to investigate the influence of a history of GDM in previous pregnancies on postpartum testing did not find statistically significant associations between the two.[6,16,23,26,27] Meanwhile, other studies have concluded that the knowledge and awareness of women with GDM on the importance of postpartum glucose testing may be limited.[19] Thus, although they have been diagnosed with GDM in previous pregnancies and despite understanding the association between GDM and development of T2DM, those women did not perceive themselves to be at risk of future diabetes.[28]

Some limitations should be kept in mind when interpreting our findings. As our study findings were based on maternal health record, other factors were missed, such as patients' perception and health belief on the risk of developing diabetes, difficulty in assessing health services, and quality of health services. Further studies are needed to explore the other possible factors contributing to compliance with postpartum glucose testing.

Our study is the first to report the rate of compliance and the factors associated with compliance with postpartum glucose testing among women with GDM in primary health care in Johor Bahru, Malaysia. Despite the appointments given during the early postpartum period, many of these women failed to comply. The proportion of women with GDM who showed up for postpartum glucose testing remained low, and improvements are needed. The detection rate of abnormal glucose status among those who showed up for the test was more or less similar to that reported in other studies. The significant factors associated with compliance to postpartum glucose testing include a previous diagnosis of GDM and a normal HbA_{1c} level during pregnancy. Strategies must be reinforced to increase the compliance of more women with GDM for the test.

CONCLUSION

The postpartum glucose testing rate of women with GDM in our population was low. Women with normal HbA_{1c} levels during pregnancy and those with a previous diagnosis of GDM were more likely to attend postpartum glucose testing at six weeks. Strategies to enhance compliance for postpartum glucose testing should be strengthened. Educating all women with GDM is essential, with special emphasis to those having poor glycemic control during pregnancy.

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