ORIGINAL ARTICLE

Proportion of women with history of gestational diabetes mellitus who performed an oral glucose test at six weeks postpartum in Johor Bahru with abnormal glucose tolerance

Fatin AAB,Alina TI

Fatin AAB,Alina TI. Proportion of women with history of gestational diabetes mellitus who performed an oral glucose test at six weeks postpartum in Johor Bahru with abnormal glucose tolerance. *Malays Fam Physician.* 2019;14(3);2–9.

Keywords:
Glucose intolerance, postpartum glucose testing, gestational diabetes mellitus

Authors:

Fatin Aina Abu Bakar
(Corresponding author)
MD, MPH
Department of Community Medicine
School of Medical Sciences
Universiti Sains Malaysia, 16150
Kubang Kerian, Kelantan
Email: fatinaina41@student.usm.my

Tengku Alina Tengku Ismail
MD, MCM
Department of Community Medicine
School of Medical Sciences
Universiti Sains Malaysia

Abstract

Introduction: Glucose testing at six weeks postpartum has been recommended by the World Health Organization as the earliest period in which to detect abnormal glucose tolerance among women with a history of gestational diabetes mellitus (GDM). This study aimed to determine the outcomes of six weeks postpartum glucose testing and its associated factors among women with a history GDM who attended government primary health clinics in Johor Bahru.
Methods: The study was a cross sectional study which was conducted among women with a history of GDM who registered from January to June 2016 at primary health clinics in Johor Bahru and underwent an oral glucose tolerance test at six weeks postpartum. Secondary data were obtained from Maternal Health Records (clinic copy). Data were analyzed using SPSS Version 23.0. Descriptive statistics and simple logistic regression analysis were used.
Results: One hundred and twenty-two women with a history of GDM completed the postpartum glucose testing. Approximately 12% of these women were reported to have abnormal glucose tolerance. Insulin usage (OR:5.44; 95% CI:1.53, 19.43; p=0.009), abnormal glycated hemoglobin (OR:8.70; 95% CI:2.68,26.27; p<0.01), hospital follow-up (OR:3.38; 95% CI: 1.11, 10.34; p=0.033) and neonatal intensive care unit admission (OR:3.96; 95% CI: 1.16, 13.54; p=0.028) were found to have significant associations with abnormal glucose tolerance at six weeks postpartum.
Conclusion: The proportion of women with a history of GDM and abnormal glucose tolerance at six weeks postpartum in Johor Bahru was 12% and was associated with insulin usage, abnormal glycated hemoglobin, hospital follow-up and neonatal intensive care unit admission. Screening during the postpartum period offers a window of opportunity for early identification of diabetes and prediabetes, as women with history of GDM are at increased risk of future glucose intolerance.

Introduction

The global prevalence of gestational diabetes mellitus (GDM) ranges from 1-28%.[1-3] It is increasing globally, as there is a trend towards late marriage, which leads to older maternal age, an epidemic of obesity and diabetes and an increase in sedentary lifestyles.[4] In addition to having a higher risk of developing GDM in subsequent pregnancies, women with a history of GDM are seven times more at risk for developing type 2 diabetes compared to women with normal pregnancies. Thus, postpartum follow-up of women with GDM is crucial in order to improve their overall health and wellbeing.

During the postpartum period, abnormal glucose tolerance may indicate the presence of diabetes, prediabetes, impaired glucose tolerance, impaired fasting glucose or elevated glucose tolerance.[5] The proportion of women with abnormal glucose tolerance at postpartum ranges between 20% to 60%, varies between countries and is influenced by the timing of the postpartum screening.[6,7] A study by Jindal et al. conducted at a tertiary care center among Asian-Indian women who had GDM in their recent pregnancy, found that out of 62 women, one-third (33.8%) had an abnormal oral glucose tolerance test result at six weeks postpartum.[5]

The incidence of postpartum glucose intolerance among Filipino women with GDM was high at 42%, with 7.3% classified as having overt diabetes, and 34.7% classified as having prediabetes.[8] This incidence was slightly higher than those of our Asian counterparts. Jang reported the rates of postpartum diabetes and impaired glucose tolerance in Korea to be 15.1% and 23.2%,

respectively, at 6-8 weeks postpartum.[9] Meanwhile, at the Diabetes Centre of Prince of Wales Hospital, 35.8% of Chinese women with a history of GDM had abnormal glucose tolerance 6 weeks postdelivery.[10] Recognizing the variations in the reported prevalence, it is important to identify the magnitude of the problem in our local setting, especially because of the limited existing information.

According to Malaysian clinical practice guidelines for diabetes in pregnancy, it is recommended that women with a history of GDM undergo postpartum glucose testing six weeks after delivery.[11] This service is widely available in our local government health clinics and appointments for the test are made during the first month postpartum visit. Clinicians should be more vigilant and strategies to implement compliance with postpartum glucose testing must be formulated in order to increase the rates of follow-up testing among these women.[8] The postpartum glucose test is important because it can facilitate early detection of pre-diabetes and treatment of diabetes.

This study was conducted in Johor Bahru, which is the capital city of Johor. Johor has the second-largest population in Malaysia. It is located in the southern part of Peninsular Malaysia, with a causeway across the Straits of Johor connecting it to Singapore. The state's ethnic composition consists of Malay (53.9%), Chinese (29.9%), Indians (6.4%), other ethnic groups (0.5%) and non-citizens (9.3%).[12] The aim of this study was to determine the proportion of postpartum women with abnormal glucose tolerance and its associated factors among those women with a history of GDM who underwent oral glucose tolerance testing at six weeks postpartum in Johor Bahru in 2016.

Methods

Study design and setting

This was a cross-sectional study involving 13 primary health clinics in Johor Bahru that offer maternal and child health services.

The information was gathered from Maternal Health Records (clinic copies). The Maternal Health Record is initiated once the women attend their first antenatal check-up and continues until six weeks after delivery. All information related to the pregnancy, delivery and postpartum period are entered into the record. There are two copies of the record for each pregnancy. One is a home-based card which belongs to the woman, and the other copy is kept by the respective health clinic.

Study participants

This study was conducted among women with a history of GDM who underwent a six weeks postpartum oral glucose tolerance test. Women who were registered in health clinics between January to June 2016 were included. Those who had their postpartum follow-ups in other districts were excluded from the study. Since this study involved a secondary data review, records missing at least one of the study variables were also excluded.

The sample size required was calculated based on the following formula suggested by Naing et al.: $n = (Z^2 \times p[1-p])/d^2$.[13] The estimated proportion of women who had GDM with abnormal glucose tolerance at six weeks postpartum was sourced from a study by Ogonowski.[14] Here, 'n' is the required sample size, 'Z' is the Z-statistic for a 95% confidence level (standard value = 1.96), 'p' is the estimated proportion of women with abnormal glucose tolerance (13.5%%), and 'd' is the margin of error at 5% (standard value = 0.05). Based on this calculation, the sample size was 200.

Data collection and analysis

This study involved secondary data collection. Data was retrieved from the respective primary health care clinics. A list of women with a history of GDM was obtained, and their socio-demography, clinical, obstetrics and glucose screening results during pregnancy and after delivery were extracted from their Maternal Health Records that were kept at the clinics (clinic copy). The information was reviewed and recorded in the data collection form by a single researcher. To ensure accuracy, the researcher re-checked the data collected from records with the data kept in the clinics. Clinic returns were recorded by appointed staff at the clinics on a monthly basis and contained detailed information on women with GDM that had their follow-up in these primary care facilities.

From the record, three main components of information were obtained: i) socio-demographic data, ii) clinical data and iii)

healthcare data. The socio-demographic information that was collected in this study included the age of the women as well as their ethnicities, marital status, educational levels, and occupations. The educational level was classified into "primary or secondary education" or "tertiary education."

The clinical data included a family history of diabetes, parity and any previous diagnosis of GDM. Other data obtained were any underlying medical illnesses, gestational age at booking (booking was defined as the first antenatal visit to any clinic undertaken by the women and classified according to the gestational stage at the time of booking- it was divided into early booking, which was done before 12 weeks of gestation, and late booking, which occurred later than 12 weeks of gestation). In the Maternal Health Record, information, such as on gestational weight gain, insulin usage and glycated hemoglobin (HbA1c level, which was measured right after the diagnosis of GDM was made during the antenatal period), was entered in the follow-up columns by the attending physicians at the health clinics. Other clinical data that were retrieved included mode of delivery, infant birth weight and admission to the neonatal intensive care unit (NICU).

Information on postpartum visits, home visits, and hospital follow-ups were also among the healthcare data obtained from the record. Information regarding postpartum glucose testing and the results from the tests were attached to the postnatal column of the Maternal Health Record. The women were recorded as undergoing postpartum glucose testing if they came in for the test at six weeks postpartum as scheduled.

Postpartum glucose testing was conducted using the 75g, 2-h oral glucose tolerance test (OGTT) at the nearest health clinic at six weeks postpartum by appointment. The postpartum test results were categorized according to normal and abnormal glucose tolerance levels. In this study, an abnormal glucose reading was defined as abnormal glucose tolerance, which includes diabetes, prediabetes, impaired glucose tolerance, impaired fasting glucose and elevated glucose tolerance diagnosed at 6 weeks postpartum, in accordance with ICD 10.[15] Those with fasting plasma glucose ≥ 6.1mmol/L and 2-hour post-prandial glucose ≥7.8mmol/L from the OGTT were considered to have abnormal glucose tolerance.[16]

All the information was analyzed using SPSS software Version 23. Data were expressed as frequency and percentages for categorical variables. Simple logistic regression analysis was used to evaluate the factors associated with abnormal glucose tolerance at six weeks postpartum. The significance level was set at $p < 0.05$.

Results

A total of 341 women diagnosed with GDM were included in the study initially. However, only 122 of them returned for postpartum glucose testing at six weeks and were included in the analysis. The characteristics of those who underwent and did not undergo the postpartum glucose testing were: mean age 31.73 (underwent) vs 31.69 (did not undergo); completed secondary education at 94.3% (underwent) vs 97.3% (did not undergo); unemployed at 49.2% (underwent) vs 55.3% (did not undergo) and multiparous at 67.2% (underwent) vs 64.8% (did not undergo). Among women who performed the postpartum test, 59% had a family history of diabetes, and 29% had GDM in at least one previous pregnancy. Meanwhile, among women who did not perform the postpartum glucose test, 49% had a family history of diabetes, and 18% of them had GDM in at least one previous pregnancy. Of those who underwent the postpartum glucose testing, 107 (87.7%) cases were normoglycemic and only 15 (12.3%) cases had abnormal glucose tolerance. Of the 15 cases with abnormal glucose tolerance, one (6.3%) case was diagnosed as diabetes mellitus, and 14 (93.7%) cases were diagnosed as impaired glucose tolerance. Table 1 shows the socio-demographic and clinical characteristics of the GDM women who underwent postpartum glucose testing at six weeks postpartum in Johor Bahru.

Table 1: Socio-demographic and clinical characteristics of GDM women who underwent postpartum glucose testing at six weeks postpartum in Johor Bahru (n=122).

Variable	Normal glucose level (n=107)			Abnormal glucose level (n=15)		
	Mean (SD)	N	%	Mean (SD)	N	%
Age (years)	31.73			31.69		
	(5.19)			4.79)		
Ethnicity						
Malay		71	(66.4)		8	(53.3)
Chinese		21	(19.6)		4	(26.7)
Indian		10	(9.3)		2	(13.3)
Other		5	(4.7)		1	(6.7)
Education						
Tertiary education		102	(95.3)		13	(86.7)
Primary/secondary		5	(4.7)		2	(13.3)
Employment status						
Employed		51	(47.7)		9	(60.0)
Unemployed		56	(52.3)		6	(40.0)
Parity						
Primiparous		73	(68.2)		9	(60.0)
Multiparous		34	(31.8)		6	(40.0)
Family history of diabetes						
No		45	(42.0)		5	(33.3)
Yes		62	(58.0)		10	(66.7)
Previous diagnosis of GDM						
No		78	(72.9)		9	(60.0)
Yes		29	(27.1)		6	(40.0)
Gestational age at booking						
12 weeks and above		52	(48.6)		10	(66.7)
Less than 12 weeks		55	(51.4)		5	(33.3)
Other medical illness						
No		92	(86.0)		11	(73.3)
Yes		15	(14.0)		4	(26.7)
Insulin usage						
No		98	(91.6)		10	(66.7)
Yes		9	(8.4)		5	(33.3)
Hospital follow-up						
No		85	(79.4)		8	(53.3)
Yes		22	(20.6)		7	(46.7)
Gestational weight gain						
Normal		59	(55.2)		10	(66.7)
Excessive		18	(16.8)		2	(13.3)
Poor		30	(28.0)		3	(20.0)
Glycated hemoglobin (HbA1C)						
Normal (<6.0 mmol/L)		91	(85.0)		7	(46.7)
Abnormal (≥6.0 mmol/L)		16	(15.0)		8	(53.3)
Mode of delivery						
Vaginal delivery		81	(75.7)		8	(53.3)
Caesarian section		26	(24.3)		7	(46.7)
Infant birth weight (grams)						
2500-3500		84	(78.5)		7	(46.7)
< 2500		8	(7.5)		1	(6.6)
> 3500		15	(14.0)		7	(46.7)

In this study, the mean HbA1c was 5.4%, with 19.7% (n=24) having a HbA1c of 6.0% and above. Factors associated with abnormal glucose tolerance among GDM women who underwent glucose testing at six weeks postpartum were determined by performing simple logistic regression. There were no significant associations between socio-demographic factors and abnormal glucose intolerance at six weeks postpartum. The variables that were significant in this univariable analysis were insulin usage, NICU admission, hospital follow- up and glycated hemoglobin (HbA1C) (**Table 2**).

The multiple logistic regression analysis is not reported here, as the number of abnormal glucose tolerance (n=15) results at six weeks postpartum was small relative to the number of independent variables in the analysis.

Table 2: Factors associated with abnormal glucose tolerance at six weeks postpartum among women with a history of GDM using simple logistic regression (n=122).

Variable	B	Crude OR (95% CI)	Wald statistics (df)	p-value
Parity				
Multiparous		1		
Primiparous	0.359	0.69 (0.69,1.78)	0.40(1)	0.658
Education level				
Secondary and lower		1		
Tertiary and above	1.144	0.32 (0.06,1.81)	1.66(1)	0.197
Employment status				
Unemployed		1		
Employed	0.499	0.61 (0.20,1.83)	0.79(1)	0.374
Family history of diabetes				
No		1		
Yes	0.373	1.45 (0.46,4.54)	0.41(1)	0.522
Previous diagnosis of GDM				
No		1		
Yes	0.584	1.79 (0.59,5.48)	1.05(1)	0.306
Gestational age at booking				
12 weeks and above		1		
Less than 12 weeks	0.637	0.53 (0.17,1.65)	1.20(1)	0.273
Other medical illness				
No		1		
Yes	0.727	2.23 (0.63,7.93)	1.27(1)	0.215
Insulin usage				
No		1		
Yes	1.695	5.44(1.53,19.43)	6.82(1)	0.009
Gestational weight gain				
Normal		1		
Excessive	0.422	0.66 (0.13,3.27)	0.27(1)	0.607
Poor	0.528	0.59 (0.15,2.31)	0.58(1)	0.448
Glycated hemoglobin (HbA1C)				
Normal		1		
Abnormal	2.163	8.70 (2.68,28.27)	12.95(1)	<0.01
Mode of delivery				
Vaginal delivery		1		
Caesarian section	1.003	2.72 (0.90,8.24)	3.16(1)	0.076
Infant birth weight				
2500-3500		1		
< 2500	0.405	1.50 (0.16,13.77)	0.13(1)	0.720
> 3500	1.723	5.60 (1.72, 18.28)	8.15(1)	0.004
Hospital follow-up				
No		1		
Yes	1.218	3.38 (1.11, 10.34)	4.56 (1)	0.033
NICU admission				
No		1		
Yes	1.376	3.96 (1.16,13.54)	4.81(1)	0.28

Discussion

This study examined abnormal glucose tolerance among women with a history of GDM at six weeks postpartum in government health clinics in Johor Bahru from January to June 2016.

About 12% of the women had abnormal glucose tolerance, which was lower than the rates found in other studies that, which ranged from 30% to 40%.[5,8,11] A local study done in public health clinics in Selangor reported a prevalence of postpartum abnormal glucose tolerance of 12.1%,[2] which is similar to the value found in this study. The differences in screening rates might be due to variations in the criteria and methods used to diagnose abnormal glucose tolerance. Studies that use the World Health Organization criteria would be expected to find a smaller proportion of women progressing to abnormal glucose tolerance, even with an increase in the number of women identified with GDM, compared to those using the National Diabetes Data Group (NDDG) or Carpenter-Coustan criteria.[17] Ethnically homogenous cohorts who are known to be at high risk of GDM, as well as variations in cultural and lifestyle practices during the postpartum period, might contribute to a higher prevalence of abnormal glucose tolerance in some countries.[5] In addition, a longer interval between delivery and screening might increase the number of women that return for postpartum glucose testing, as reported by Chew et al.[18] Their study was conducted among women aged 20-50 who had history of GDM at a university hospital in Malaysia, and the reported prevalence of abnormal glucose tolerance was 61.7% when the period from the index pregnancy with GDM to testing ranged from three months to 15 years postpartum.[18] The association between GDM and type 2 diabetes can be explained by the fact that most of the risk factors for the two disorders are the same and include high body mass index, a family history of diabetes and ethnic origin.[19]

A systematic review of studies investigating the incidence of postpartum type 2 diabetes among women with a history of GDM reported that 5 to 10% of them became diabetic during the first year postpartum.[20] It was found that the development of type 2 diabetes was correlated with progressive pancreatic β-cell failure in order to compensate for the ongoing insulin resistance in women with a history of GDM. Pre-conception care, maternal diet and exercise, and other lifestyle factors are among the interventions which can be used to mitigate modifiable risk factors that may have an impact on the preservation of β-cell function.[21] In addition, pharmacological therapies, such as metformin, troglitazone and pioglitazone, have also been shown to reduce the development of diabetes by 50% or more.[22] Hence, for optimal success, interventions to prevent or delay this process should be initiated as early as possible to avoid prolonged exposure, and the risk of diabetes may be determined by postpartum glucose testing as early as six weeks after delivery.[23]

In this study, women with elevated glycated hemoglobin (HbA1C) during pregnancy were found to have higher odds of having abnormal glucose tolerance at six weeks postpartum compared to those within normal levels. Hemoglobin A1c (HbA1c) has less intra-individual variability, is easily measured with a single blood test and does not require fasting. Our findings in this study largely agree with previously published studies which indicate that HbA1c at GDM diagnosis is associated with an increased risk of postpartum abnormal glucose tolerance.[24-26] In addition, a systematic review found that HbA1c at GDM diagnosis was positively associated with postpartum abnormal glucose. Women with postpartum diabetes or impaired glucose tolerance had higher mean HbA1c levels at GDM diagnosis than those with normal post-partum glucose ($p \leq 0.002$), and a 1% increase in HbA1c at GDM diagnosis was associated with 2.36 times higher odds of postpartum abnormal glucose 6 weeks after delivery.[27] HbA1c above 5.55% is a strong predictor of postpartum diabetes in a study that evaluated the clinical usefulness of HbA1c in predicting risk of future diabetes among GDM patients.[24]

In the present study, insulin usage for the management of hyperglycemia in pregnancy was associated with abnormal glucose tolerance. Findings reported by Nouhjah et al. showed that pharmacotherapy (use of insulin or metformin) for GDM management was a strong predictor of abnormal glucose tolerance at 6-12 weeks postpartum.[28] Treatment with insulin is an indicator of the severity of the hyperglycemia and may reflect impairment in the β-cell function in women with a history of GDM.

A scheduled postpartum test is important for detecting abnormal glucose tolerance and

initiating prompt intervention in order to reduce the risk of diabetes or diabetes-related complications.[23] By performing the glucose test at six weeks postpartum, the onset of type 2 diabetes may be prevented and delayed soon after the postpartum period through lifestyle modifications such as dietary changes, physical activity, weight management and/or pharmacological intervention.[7] In order to facilitate postpartum testing, the risk of type 2 diabetes must be discussed during routine GDM care to increase the risk perception among women with GDM, and postpartum care reminders should be considered.[29] Strategic and effective measures, such as flexible time for the test, active involvement from health staff, and strengthening continuous care, need to be implemented to reduce the rate of subsequent diabetes and improve the outcomes of future pregnancies. The use of a short messaging system (SMS) and phone reminders have also been shown to improve the return rate for postpartum testing.[30] Primary care providers have a key role in organizing postpartum screening strategies and increasing the awareness of these women concerning their high risk of progression to type 2 diabetes through health promotion and education.

To our knowledge, this is the first study to report on the proportion of women with a history of GDM who attended primary health clinics with postpartum abnormal glucose tolerance, particularly in Johor Bahru. Nevertheless, several limitations should be taken into consideration when interpreting this study. These findings are not generalizable to the general population due to its small sample size. In addition, we were unable to assess what factors could be contributing to failure to undergo postpartum glucose testing, which may include service quality, time and financial constraints. Further studies are recommended for investigating why women with GDM do not return for postpartum glucose testing.

In conclusion, the proportion of women who have had GDM exhibiting abnormal glucose tolerance at six weeks postpartum in Johor Bahru was 12%. The diagnosis of GDM should initiate a long-term intervention and diagnostic process in order to minimize the risk of developing diabetes or to diagnose it as early in its course as possible. Screening during the postpartum period offers a window of opportunity for early identification of diabetes and prediabetes and prompt initiation of treatment. Hence, current management strategies for women with a history of GDM should be strengthened to ensure compliance with postpartum glucose testing.

Conflicts of Interest

The research received no funding. The authors declare there are no conflicts of interest.

Acknowledgements

The authors would like to thank the Director General of Health Malaysia, Johor Health Director, and Johor Bahru District Health Officers for their kind permission and support in conducting and presenting this study. We would also like to thank the nursing staff for their invaluable assistance in data collection.

This study was approved by the Medical Research and Ethics Committee, Ministry of Health Malaysia and registered under the National Medical Research Register (NMRR-16-2352-33522).

How does this paper make a difference to general practice?

- Despite the availability of guidelines, attendance for six weeks postpartum glucose readings were less than optimal.
- This paper may encourage primary care practitioners to perform postpartum screenings for the detection of prediabetes or diabetes.
- To our knowledge, there is no published study that has investigated abnormal glucose tolerance at six weeks postpartum among women with history of gestational diabetes mellitus who attended primary care clinics in Malaysia, particularly in Johor Bahru.

References

1. Nguyen CL, Pham NM, Binns CW, et al. Prevalence of gestational diabetes mellitus in Eastern and Southeastern Asia: a systematic review and meta-analysis. *J Diabetes Res*. 2018; 2018:10. Article ID 6536974.

2. Logakodie S, Azahadi O, Fuziah P, et al. The prevalence, associated factors and foeto-maternal outcome of women attending antenatal care. *Malays Fam Physician*. 2017;12(2):9-17.

3. Jiwani A, Marseille E, Lohse N, et al. Gestational diabetes mellitus: results from a survey of country prevalence and practices. *J Matern Fetal Neonatal Med*. 2012; 25(6):600-10.

4. Ferrara A. Increasing prevalence of gestational diabetes mellitus: a public health perspective. *Diabetes Care*. 2007 Jul;30(Suppl 2):S141-6.

5. Jindal R, Siddiqui MA, Gupta N, Wangnoo SK. Prevalence of glucose intolerance at 6 weeks postpartum in Indian women with gestational diabetes mellitus. *Diabetes Metab Syndrome*. 2015;9(3):143-6.

6. Kwong S, Mitchell RS, Senior PA, et al. Postpartum diabetes screening: adherence rate and the performance of fasting plasma glucose versus oral glucose tolerance test. Diabetes Care. 2009 Dec;32(12):2242-4.

7. Lawrence JM, Black MH, Hsu J-W, et al. Prevalence and timing of postpartum glucose testing and sustained glucose dysregulation after gestational diabetes mellitus. *Diabetes Care*. 2010;33(3):569-76.

8. Malong CL, Sia-Atanacio A, Andag-Silva A, et al. Incidence of postpartum diabetes and glucose intolerance among Filipino patients with gestational diabetes mellitus seen at a tertiary hospital. *Journal of the ASEAN Federation of Endocrine Societies*. 2014;28(1):56.

9. Jang HC. Gestational diabetes in Korea: incidence and risk factors of diabetes in women with previous gestational diabetes. *Diabetes Metab J*. 2011 Feb;35(1):1-7.

10. Ko GT, Chan JC, Tsang LW, et al. Glucose intolerance and other cardiovascular risk factors in Chinese women with a history of gestational diabetes mellitus. *Aust N Z J Obstet Gynaecol*. 1999 Nov;39(4):478-83.

11. Ministry of Health Malaysia. Clinical practice guidelines: management of diabetes in pregnancy. 1st edition. Kuala Lumpur: Ministry of Health, Malaysia; 2017.

12. Department of Statistics Malaysia. Population quick info. Population by states and ethnic group in 2015. Kuala Lumpur: Department of Statistics, Malaysia: 2016.

13. Naing L, Winn T, Rusli BN. Practical issues in calculating the sample size for prevalence studies. Archives of Orofacial Sciences. 2006;1:9-14.

14. Ogonowski J, Miazgowski T. The prevalence of 6 weeks postpartum abnormal glucose tolerance in Caucasian women with gestational diabetes. *Diabetes Res Clin Pract*. 2009 Jun;84(3):239-44.

15. World Health Organization. The ICD-10 classification of mental and behavioural disorders: clinical descriptions and diagnostic guidelines. Geneva, Switzerland: World Health Organization; 1992.

16. Ministry of Health Malaysia. Clinical practice guidelines: management of type 2 diabetes mellitus. 5th edition. Kuala Lumpur: Ministry of Health, Malaysia, 2015.

17. Noctor E, Dunne FP. Type 2 diabetes after gestational diabetes: the influence of changing diagnostic criteria. *World J Diabetes*. 2015 Mar 15;6(2):234-44.

18. Chew WF, Rokiah P, Chan SP, et al. Prevalence of glucose intolerance, and associated antenatal and historical risk factors among Malaysian women with a history of gestational diabetes mellitus. *Singapore Med J*. 2012 Dec;53(12):814-20.

19. Erem C, Kuzu UB, Deger O, et al. Prevalence of gestational diabetes mellitus and associated risk factors in Turkish women: the Trabzon GDM Study. *Arch Med Sci*. 2015;11(4):724-35.

20. Kim C, Newton KM, Knopp RH. Gestational diabetes and the incidence of type 2 diabetes: a systematic review. *Diabetes Care*. 2002;25(10):1862-8.

21. Rice GE, Illanes SE, Mitchell MD. Gestational diabetes mellitus: a positive predictor of type 2 diabetes? *Int J Endocrinol*. 2012 (2012):721653.

22. Ratner RE, Christophi CA, Metzger BE, et al. Prevention of diabetes in women with a history of gestational diabetes: effects of metformin and lifestyle interventions. *J Clin Endocrinol Metab*. 2008 Dec;93(12):4774-9.

23. Feig DS, Zinman B, Wang X, et al. Risk of development of diabetes mellitus after diagnosis of gestational diabetes. *CMAJ*. 2008 Jul 29;179(3):229-34.

24. Claesson R, Ignell C, Shaat N, et al. HbA1c as a predictor of diabetes after gestational diabetes mellitus. *Prim Care Diabetes*. 2017 Feb;11(1):46-51.

25. Inoue H, Ishikawa K, Takeda K, et al. Postpartum risk of diabetes and predictive factors for glucose intolerance in East Asian women with gestational diabetes. *Diabetes Res Clin Pract*. 2018 Jun;140:1-8.

26. Rayanagoudar G, Hashi AA, Zamora J, et al. Quantification of the type 2 diabetes risk in women with gestational diabetes: a systematic review and meta-analysis of 95,750 women. *Diabetologia*. 2016;59(7):1403-11.

27. Katon J, Williams MA, Reiber G, et al. Antepartum A1C, maternal diabetes outcomes, and selected offspring outcomes: an epidemiological review. *Paediatr Perinatal Epidemiol*. 2011 May;25(3):265-76.

28. Nouhjah S, Shahbazian H, Shahbazian N, et al. Incidence and contributing factors of persistent hyperglycemia at 6–12 weeks postpartum in Iranian women with gestational diabetes: results from LAGA Cohort Study. *J Diabetes Res* 2017; 2017: 9786436.

29. Keely E. An opportunity not to be missed–how do we improve postpartum screening rates for women with gestational diabetes? *Diab Metab Res Rev*. 2012 May;28(4):312-6.

30. Mohd Suan MA. Return for postpartum oral glucose tolerance test following gestational diabetes mellitus. Asia Pac J Public Health. 2015 Sep;27(6):601-9.