



Original Article

Effects of maternal age, parity and pre-pregnancy body mass index on the glucose challenge test and gestational diabetes mellitus



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Received 22 November 2016; revised 18 January 2017; accepted 22 January 2017; Available online 22 February 2017

المخلص

أهداف البحث: يهدف البحث لدراسة تأثير العمر، وعدد الولادات ومعامل كتلة الجسم على اختبار التحدي للجلوكوز ٥٠ غرام الإيجابي وسكري الحمل لدى السيدات الحوامل العمانيات السليمات.

طرق البحث: أُستخدم ٥٠ غراما من الجلوكوز لإجراء اختبار التحدي للجلوكوز على ٣٠٧ سيدة عمانية حامل سليمة خلال الأسبوع ٢٤-٢٨ من الحمل. أُعتبر اختبار التحدي للجلوكوز إيجابيا إذا كان مستوى الجلوكوز في الدم < ٧.٨ ملمول/ل، عند قياسه بعد ساعة واحدة. وتم تأكيد تشخيص السيدات بسكري الحمل باختبار تحمل الجلوكوز عن طريق الفم بعد ساعتين من استخدام ٧٥ غراما من الجلوكوز، عندما يكون أي من قيمة الاختبار عند الصوم أو بعد ساعتين من تناول ٧٥ غراما من الجلوكوز < ٥.٥ ملمول/ل و < ٨ ملمول/ل، على التوالي، تعتبر السيدات مصابات بسكري الحمل.

النتائج: تم اختبار ٣٠٧ سيدة، وتحديد ٨٣ (٢٧,٠٣%) سيدة لديها اختبار إيجابي، و ٢٣ (٧,٥%) حالة إيجابية لسكري الحمل. يزداد اختبار التحدي للجلوكوز الإيجابي وسكري الحمل بشكل كبير مع زيادة عمر الأم، من ٢٠% و ٢,٢% على التوالي، لدى السيدات اللاتي أعمارهن ≤ ٢٥ عاما إلى ٣٧,٨% و ١٤,٧% على التوالي، عند السيدات اللاتي أعمارهن < ٣٥ عاما. كما يزداد اختبار التحدي للجلوكوز الإيجابي وسكري الحمل بشكل كبير مع زيادة معامل كتلة الجسم قبل الحمل من ١٩,٨% و ٣,٨% على التوالي، لدى السيدات بمعامل كتلة الجسم ≤ ٢٥ كجم/م^٢ إلى ٣٧,٨% و ٩,٩%، على التوالي عند السيدات بمعامل كتلة الجسم < ٢٥ كجم/م^٢.

الاستنتاجات: عمر الأمهات ومعامل كتلة الجسم قبل الحمل لهما تأثير كبير على اختبار التحدي للجلوكوز ٥٠ غرام الإيجابي وسكري الحمل.

الكلمات المفتاحية: العمر؛ معامل كتلة الجسم؛ سكري الحمل؛ اختبار التحدي للجلوكوز؛ عدد الولادات

Abstract

Objectives: To study the effects of age, parity and body mass index (BMI) on the incidence of a positive 50 g glucose challenge test (OGCT) and gestational diabetes mellitus (GDM) in healthy pregnant Omani women.

Methods: A 50 g OGCT was performed on 307 healthy pregnant Omani women at 24–28 weeks of gestation. When the venous plasma glucose concentration (VPG) reached >7.8 mmol/l after 1 h, the OGCT was considered to be positive. Women with positive OGCTs had a confirmatory diagnosis of GDM, which was established by performing a 2-h 75 g oral glucose tolerance test (OGTT). When either fasting or post-2-h 75 g OGTT values were >5.5 mmol/l or >8 mmol/l, respectively, women were considered diabetic.

Results: This study screened 307 women and identified 83 (27.03%) OGCT-positive and 23 (7.5%) GDM-positive cases. The incidences of a positive OGCT and GDM increased significantly with increasing maternal age from 20.0% to 2.2%, respectively, in women aged ≤ 25 years to 37.8% and 14.7%, respectively, in women aged >35 years ($p = 0.02$ and $p = 0.009$, respectively). The incidences of a positive OGCT and GDM increased markedly with increasing pre-pregnancy BMI, from 19.8% to 3.8%, respectively, in women with BMIs ≤ 25 kg/m² to 37.8% and 9.9%, respectively, in women with BMIs >25 kg/m² ($p = 0.02$ and $p = 0.04$, respectively).

Conclusion: Maternal age and pre-pregnancy BMI have profound effects on the incidences of a positive OGCT and GDM.

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Peer review under responsibility of Taibah University.



Production and hosting by Elsevier

Keywords: Age; Body mass index; Gestational diabetes; Glucose challenge test; Parity

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Introduction

Gestational DM is defined as carbohydrate intolerance that is diagnosed for the first time during pregnancy and usually disappears after the puerperium.¹ The incidence of GDM varies from 1.2% in Sweden to 22.3% in Sardinia, depending on the criteria used for diagnosing GDM.^{2,3} Gestational DM adversely affects both the mother and the foetus. Maternal adverse effects include maternal vasculopathy, pre-eclampsia, and genital and urinary tract infections. Foetal adverse effects include macrosomia, intrauterine growth restriction, congenital malformation, and intrauterine foetal death.^{4–6} Babies born to diabetic mothers are more likely to develop respiratory distress syndrome, hypoglycaemia, jaundice and birth trauma.⁷ Women with GDM and their children are at an increased risk of developing type 2 diabetes early in their lives.⁸

The OGTT is considered, by many, as the gold standard for the diagnosis of DM.⁹

It has been reported that positive OGCTs and GDM are common in women aged ≥ 30 years, BMI ≥ 25 kg/m², and parity ≥ 4 .¹⁰

The study intends to determine whether maternal age, parity and pre-pregnancy BMI are associated with a positive OGCT and GDM in Omani women.

Materials and Methods

This report describes a prospective study conducted at the department of Obstetrics and Gynaecology, Sultan Qaboos University Hospital (SQUH), Muscat, Sultanate Oman between 15 September 2013 and 14 September 2014. This study was approved by the ethical committee at Sultan Qaboos University.

In this study, all healthy pregnant Omani women with singleton pregnancies that were not diabetic and attended the antenatal clinic at SQUH were studied. All women in this study who were not at an increased risk of developing DM had random blood sugar analyses performed upon booking a visit as early as possible during pregnancy (usually between 6 and 8 weeks gestation). If the results showed a VPG level >7.8 mmol/l, then the 2-h 75 g OGTT was performed to diagnose covert pre-gestational diabetes mellitus (PGDM).

Pregnant women who were at an increased risk of developing DM and were not known to be diabetic (such as those with a previous history of macrosomic baby, recurrent miscarriages, unexplained intrauterine foetal death, congenital foetal malformations, previous GDM and a family history of DM) received the 2-h 75 g OGTT upon booking a visit. If the fasting or the 2-h VPG level exceeded 5.5 and 8 mmol/l,

Table 1: Results of the 50 g OGCT and GDM in different age groups.

Age (n = 307) n (%)	Positive OGCT ^a (n = 83) n (%)	GDM (n = 23) ^b n (%)
15–19 years, 5 (1.6)	1 (20.0)	0 (0)
20–25 years, 5 (24.5)	15 (20.0)	2 (2.7)
26–30 years, 99 (32.4)	21 (21.2)	5 (5.1)
31–35 years, 66 (21.4)	23 (34.8)	7 (10.6)
>35 years, 61 (20.1)	23 (37.8)	9 (14.7)

^a OGCT = oral glucose challenge test.

^b OGTT = oral glucose tolerance test.

respectively, then the woman was diagnosed as having PGDM. All remaining women, whether at an increased risk of GDM or not, had the 50 g OGCT performed between 24 and 28 weeks gestation. Fasting is not required to perform this test. If the 1-h VPG level was >7.8 mmol/l, then the test was considered positive. Women with a positive OGCT screening test underwent a 75 g 2-h OGTT, which is the diagnostic test for GDM. If either fasting or 2-h VPG exceeded 5.5 and 8 mmol/l, respectively, then the woman was considered as having GDM.

Weight gain during pregnancy was between 8 and 13 kg and the HbA1C values in all women were below 6% as women with HbA1C values $>6\%$ were excluded from the study.

The data collected included maternal age, gestational age at screening, parity and BMI at booking. We assumed that BMI at booking, which usually occurs between 6 and 8 weeks of gestation, is similar to pre-pregnancy BMI as pregnant women are not expected to have gained weight at this early gestational age. Foetal and maternal risk factors that may be attributed to diabetes mellitus, such as unexplained stillbirth, macrosomic baby (birth weight > 4000 g), and a previous history of GDM, a family history of DM in first degree relatives, recurrent miscarriages, and polyhydramnios, were studied.

Women who were found to be diabetic were treated with either diet modification alone or with metformin. Only 15% of the women needed insulin treatment.

Statistical analysis was performed using the Chi-square test, the Mann–Whitney test and Fisher's exact test where appropriate. The differences between the values were considered significant when $P \leq 0.05$.

Results

In this study, 307 pregnant women were screened during pregnancy between 24 and 28 weeks with the 50 g OGCT. Of these subjects, 83 women (27.1%) had positive OGCT results. Pregnant women with positive OGCT results underwent a 75 g 2-h OGCT. 23 of these women (7.5%) were found to have abnormal OGCT results and were diagnosed as having GDM.

Table 1 shows the results of positive OGCTs and GDM in different age groups. In women aged 20–25 years, 15 (20%) had positive OGCTs and 2 (2.7%) were found to have GDM.

In women aged between 26 and 30 years, 21 (21.2%) had positive OGCTs but only 5 (5.1%) were found to have GDM. In women aged 31–35 years, 23 (34.8%) had positive OGCTs and 7 (10.6%) women were considered diabetic. In women older than 35 years, 23 (37.8%) had positive OGCTs and 9 (14.7%) ($P = 0.02$) were found to be diabetic. This shows that there is strong, direct relationship between increasing maternal age and the possibility of having a positive OGCT and developing GDM during pregnancy.

Table 2 shows the results of positive OGCTs and GDM in different BMI groups. There was a steady increase in the incidences of positive OGCTs and abnormal OGTTs with increasing BMI. The incidence of a positive OGCT was 18.8% in women with BMIs of 18–20 kg/m². This incidence increased to 33.3% in grossly obese women with BMIs >35 kg/m². The incidence of GDM increased from 3.1% in women with BMIs of 18–20 kg/m² to 11.8% in women with BMIs >35 kg/m² ($P = 0.04$).

Table 3 shows the results of the OGCT and GDM in relation to parity.

There was a steady increase in the incidences of positive OGCTs and GDM with increasing parity. The incidence of a positive OGCT was 21.2% in nulliparous women. This incidence increased steadily as parity increased, reaching 37.5% in women with parity ≥ 4 . The incidence of GDM increased steadily from 3.5% in nulliparous women to 14.6% in women with parity ≥ 4 . The differences between parity groups were not statistically significant.

Table 4 shows the risk factors associated with a positive OGCT and GDM. Among the screened women, the most common risk factor was a family history of DM (33.5%) followed by a history of recurrent miscarriages (3.8%) and a previous history of GDM (3.6%). 57.6% of the screened women had no risk factors for GDM.

A positive OGCT was observed in 54.5% of women with histories of GDM and in 34.9% of women with family histories of DM. GDM was observed in 27.3% of women with histories of GDM and in 14.6% of women with family histories of DM.

Hypertension and pre-eclampsia were observed in 12% of the women screened.

Caesarean section was performed in 23% of the women studied. Instrumental delivery was performed in 3.5% of the women and the remaining women delivered vaginally.

Table 2: Comparison of the results of the 50 g OGCT and GDM in different body mass index groups.

BMI kg/m ² (n = 307) n (%)	Positive OGCT ^a (n = 83) n (%)	GDM (n = 23) ^b n (%)
18–20, 32 (10.5)	6 (18.8)	1 (3.1)
21–25, 74 (24.2)	15 (20.3)	3 (4.1)
26–30, 102 (33.3)	31 (30.4)	8 (7.8)
31–35, 47 (15.4)	14 (27.7)	5 (10.6)
>35, 51 (16.6)	17 (33.3)	6 (11.8)

^a OGCT = oral glucose challenge test.

^b OGTT = oral glucose tolerance test.

Table 3: Results of the 50 g OGCT and GM in relation to parity.

Parity, n (%)	Positive OGCT ^a n (%)	GDM (n = 23) ^b n (%)
0, 85 (27.9)	18 (21.2)	3 (3.5)
1, 77 (25.1)	17 (22.1)	3 (3.9)
2, 56 (18.1)	16 (28.6)	5 (8.9)
3, 41 (13.3)	14 (34.1)	5 (12.1)
≥ 4 , 48 (15.6)	18 (37.5)	7 (14.6)

^a OGCT = oral glucose challenge test.

^b OGTT = oral glucose tolerance test.

Table 4: Comparison of the results of the 50 g OGCT and GDM in pregnant women with different risk factors.

Risk factor	Positive OGCT ^a (n = 83) n (%)	GDM ^b (n = 23) n (%)
Total (n = 307)		
Family history of diabetes mellitus, 103 (33.5)	36 (34.9)	15 (14.6)
Previous history of GDM, 11 (3.6)	6 (54.5)	3 (27.3)
Previous macrosomic baby, 5 (1.5)	1 (20.0)	0 (0)
Previous unexplained intrauterine foetal death, 3 (0.9)	1 (33.3)	0 (0)
History of recurrent miscarriages, 12 (3.8)	1 (8.3)	0 (0)
No risk factors, 175 (57.6)	39 (22.3)	5 (2.9)

^a OGCT = oral glucose challenge test.

^b OGTT = oral glucose tolerance test.

Discussion

The OGCT was performed in all pregnant women between 24 and 28 weeks of gestation to screen for GDM.¹¹ Gestational DM has adverse effects on both the mother and the foetus during pregnancy, so screening for GDM is very beneficial for early diagnosis and treatment.¹²

The OGCT screening test can be easily performed as an outpatient procedure. It is easy to perform, inexpensive, and highly convenient for screening purposes, since pregnant women are not required to fast and only one blood sample is taken. This test was accepted by all women.¹¹

In the present study, some risk factors associated with a positive OGCT and GDM, such as maternal age, parity, pre-pregnancy BMI, a family history of DM and a previous history of GDM, were investigated for the first time in Oman.

Maternal age is strongly associated with a positive OGCT and GDM. It has been reported that the incidence of GDM increased markedly with increasing maternal age.^{13,14} In this study, the incidence of a positive OGCT increased significantly with rising maternal age, from 20.0% in women aged ≤ 25 years to 37.8% in women aged > 35 years ($P = 0.02$). The incidence of GDM increased with rising maternal age from 2.2% in women aged < 25 years to

14.7% in women aged >35 years ($P = 0.009$). The association of rising maternal age was more significant with GDM compared to OGCT. This association has been reported by other investigators.¹³

The incidences of both a positive OGCT and GDM rose markedly in women >30 years compared to younger women. This result suggests that in order to reduce the chance of developing GDM during pregnancy, pregnancy is better planned at or before the age of 30 years.

Obesity is strongly associated with the development of a positive OGCT and GDM.^{15,16} In Oman, the prevalence of obesity ($BMI > 30 \text{ kg/m}^2$) among Omani women is 23.8%, and that of overweight ($BMI > 25 \text{ kg/m}^2$) is 27.3%, meaning that more than 50% of Omani pregnant women have $BMI > 25 \text{ kg/m}^2$.¹⁷ An increasing prevalence of obesity in Oman is very likely to lead to an increase in the prevalence of GDM. In this study, pre-pregnancy BMI had a strong positive association with a positive OGCT and GDM. In this study, the incidence of a positive OGCT increased significantly with increasing BMI, from 19.8% in women with $BMI < 25 \text{ kg/m}^2$ to 37.8% in women with $BMI > 25 \text{ kg/m}^2$ ($P = 0.02$). The incidence of GDM increased with increasing BMI, from 3.8% in women with $BMI \leq 25 \text{ kg/m}^2$ to 9.9% in women with $BMI > 25 \text{ kg/m}^2$ ($P = 0.04$).

Although there is steady increase in the incidences of positive OGCTs and GDM with increasing parity, the differences were not statistically significant. This finding may be observed because the sample size in this study was relatively small and that high parity can be achieved at a younger age in Oman, which is inconsistent with reports by other investigators.¹⁸

Pregnant women with past histories of GDM have an increased risk of having positive OGCTs and developing GDM.¹⁹ Previous GDM is one of the strongest predictors of future GDM.¹⁶

In this study, we found positive OGCTs in 54.5% of women with previous GDM, but the incidence was 22.3% in women without previous GDM ($P = 0.02$). The incidence of GDM in women with previous GDM was 27.3% compared to 2.9% in women without previous GDM ($P = 0.007$).

There is a positive relationship between family history (first-degree relatives) of DM and GDM.²⁰ A family history of diabetes is a strong independent risk factor for GDM.¹³

Positive OGCTs were seen in 34.9% of women with previous family histories of DM but the incidence was 22.3% in women without family histories of DM ($P = 0.02$). The incidence of GDM in women with family histories of DM was 14.6% compared to 2.9% in women without family histories of DM ($P = 0.005$).

Conclusion

Maternal age and pre-pregnancy BMI have profound impacts on the incidences of positive OGCTs and GDM in our population. A previous history of GDM and a family history of DM are the main predicting factors of both a positive OGCT and GDM.

Based on the results of this study, it can be suggested that, among pregnant women with positive OGCTs, only those

aged >30 years, with $BMI > 25$, and with previous GDM and family histories of DM should be offered the OGTT because only 28% (23/83) of cases will result in GDM (which would enable further reductions in the cost of resources).

Authors' contribution

ATA created the idea of this research, wrote the research proposal before submission to the hospital ethics committee. MRA and MAA reviewed the proposal and made the necessary changes and the proposal was approved by all authors. Data were collected by all the authors from their respected clinic. MRA wrote the first draft and was reviewed by ATA and MRA and was approved by all authors before submitting the manuscript to the journal.

Conflict of interest

The authors have no conflict of interest to declare.

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How to cite this article: Abu-Heija AT, Al-Bash MR, Al-Kalbani MA. Effects of maternal age, parity and pre-pregnancy body mass index on the glucose challenge test and gestational diabetes mellitus. *J Taibah Univ Med Sc* 2017;12(4):338–342.