

# Screening for gestational diabetes by measuring fasting plasma glucose levels

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## قياس مستوى السكر عند الشخص الصائم كطريقة لإجراء المسوح العامة لاكتشاف مرضى السكر الحوامل

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**المستخلص: الهدف:** أ- اختبار حساسية ونوعية مستوى السكر عند الشخص الصائم كاختبار لاكتشاف مرضى السكر الحوامل. ب- مقارنة قدره التنبؤ بوجود السكر الحوامل بواسطة اختبار مستوى السكر عند الصائم ومقارنته بالفحص التقليدي للكشف عن السكر الحوامل (أي إعطاء المريضة غير الصائمة ٥٠ جرام من الجلوكوز ثم اختبار نسبة السكر في بلازما المريضة بعد مرور ساعة واحدة). **الطريقة:** في هذه الدراسة تم تجميع ١٦٠٠ امرأة حامل من المراكز الصحية وعيادات الحوامل في مجمع السلمانية الطبي وذلك لإختبار السكر الحوامل بواسطة الفحص التقليدي (٥٠ جرام من الجلوكوز ثم فحص نسبة السكر في بلازما المريضة بعد مرور ساعة واحدة) وقد وجد أن نسبة السكر الحوامل تعادل تقريباً ١٢%\* من جميع الحوامل. ثم وظفت ٢١٧ امرأة ثبت لديهن السكر الحوامل لقياس نسبة السكر بعد الصوم ثم إجراء اختبار منحنى السكر الكامل وذلك من أجل المقارنة والتأكد. كانت ٧٨% من اللاتي أجريت عليهن المسوح بحرينية و١٩% من الآسيويات و٢% من الجنسيات الأخرى أما وسيط السن فكان ٢٧,٢+٠,٢ سنة. وتمت عملية قياس الحساسية والنوعية لإستعمال السكر الصائم كطريقة للفحص عن السكر الحوامل ومقارنته بالطريقة التقليدية بإستعمال برنامج خاص يدعى منحنى استقبال المميزات. **النتائج:** وجد أن مستوى ٥,٦ و ٥,٤ مليمول / اللتر في السكر الصائم عند الحامل يعطي حساسية مقدارها ٩٤% ونوعية تصل إلى ٩٢% في قدرته على التنبؤ بتشخيص سكري الحمل ولا يحتاج إلى استعمال منحنى السكر الكامل إلا في ١٢% مقارنة ب ٣٢% إذا ما استعملنا الفحص التقليدي للسكر الحوامل اختبار سهل **الخلاصة:** إن اختبار مستوى ٥,٥٨ مليمول / اللتر من السكر عند الحوامل الصائمات هو اختبار سهل للكشف عن السكر الحوامل وله تقبل حسن ويفوق في الدقة اختبار السكر الحوامل التقليدي والذي يستعمل في الجلوكوز كما أنه أقل كلفة ويجنبنا استخدام فحص منحنى السكر الكامل في ٧٠% من الحالات. مفتاح الكلمات: السكر الحوامل المسوح استخدام نسبة السكر عند الصائمات.

**ABSTRACT. Objectives:** (a) To test the sensitivity and specificity of measuring fasting plasma glucose levels (FPG) as a screening test for gestational diabetes mellitus (GDM). (b) To compare predicting levels of FPG levels with the one-hour, oral 50g non-fasting glucose challenge test (GCT) for predicting GDM. **Methods:** One thousand and six hundred pregnant women from the Health Centres, antenatal clinics and Salmaniya Medical Complex were screened by the GCT after 50g of oral glucose during 26–32 weeks gestation, giving a 13.5% incidence of GDM (using the Third International Workshop cutoff values of 7.8 mmol/l). All patients also had an FPG estimation followed by the three-hour oral glucose tolerance test (oGTT). Seventy eight percent of the patients were Bahraini, 19% Asian and 3% other nationalities. Their mean age was 27.2±0.2 years. Receiver-operating curves (ROC) were used to test the ability of the FPG and the oGTT to differentiate patients with GDM and identify the cut off values for predicting a diagnosis of GDM. **Results:** FPG levels of 5.6 mmol/l and 5.4 mmol/l yielded sensitivities and specificities of 94% and 93% respectively. Measuring FPG as a screening test required a diagnostic oGTT in 32% compared with 13% when the GCT was used. **Conclusion:** Using FPG levels at a cutoff value of  $\geq 5.5$  mmol/l is an easier, more acceptable test for patients compared to the GCT. Using the FPG levels is also more cost effective and allows nearly 70% of women to avoid the oGTT.

**Key words:** gestational diabetes, pregnancy, screening, fasting plasma glucose levels.

THERE IS A WIDE DIVERSITY OF OPINION regarding the screening for gestational diabetes mellitus (GDM). There is no consensus on whether screening is justified,<sup>1</sup> who should be screened,<sup>2</sup> and what is the optimal method for management after diagnosis.<sup>3</sup> In Bahrain's Government Maternity clinics we have been following the recommendations of the Fourth International Workshop Conference<sup>4</sup> for the universal screening of all pregnant women between 26–32 weeks of gestation by use of the non-fasting 50 g oral glucose test (GCT). This is followed by the confirmatory 75 g

three-hour oral glucose tolerance test (oGTT) in cases of a positive screen which includes fasting plasma glucose levels (FPG). Because of the complexity of this test (which requires prior appointments, ingestion of oral glucose, prolonged waiting time and ever increasing costs and pressure on an already over-stretched laboratory service), a search for an easier and less expensive method has been studied.

In 1997, the American Diabetic Association<sup>5,6</sup> announced new criteria for screening diabetes in non-pregnant patients by measuring a fasting plasma glucose

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level (FPG) instead of the oral glucose tolerance test (oGTT). Between 1999 and 2001, progressive population studies by Peruccini et al<sup>7</sup> in Switzerland, Agarwal from the UAE<sup>8</sup> and Aguiar<sup>9</sup> from Brazil have reported successes in the screening of pregnant women for GDM using the measurement of lower FPG levels.

Our study aimed at evaluating the sensitivity and specificity of using FPG as a screening test for GDM compared to the 50g non-fasting glucose challenge test (GCT).

**METHODS**

With the purpose of determining a FPG value with good sensitivity and specificity that could identify pregnant women with GDM, we conducted a study between 1<sup>st</sup> January and 31<sup>st</sup> May 2002 in which 1,600 pregnant women were screened by GCT followed by oGTT. These women were drawn from outpatients and inpatients in Salmaniya Medical Complex, the major referral hospital in Bahrain. All patients who were diagnosed to have GDM (by GCT testing) had undergone the 75g oGTT which includes the FPG. The major ethnic distribution of the study was 78% Bahrainis, 19% Asians and 3% from other nationalities. The mean age distribution was 27.2 ± 0.2 years, ranging from 17–48.

We analysed the data using the Med/Calc statistical package. A receiver-operating characteristics (ROC) curve was constructed in order to compare the ability of the FPG against the GCT in discriminating patients with a diagnosis of GDM, and to determine the best cut-off value for FPG levels, which would have the best predictive value for need of oGTT.

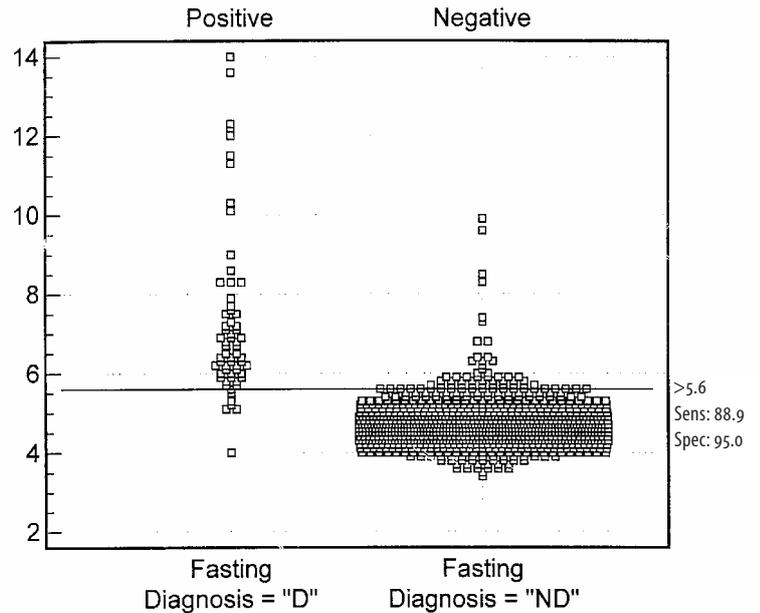
**RESULTS**

The incidence of GDM among the cohort of pregnant women in this study who had undergone the GCT followed by oGTT during 26–32 weeks of gestational age was 217 (13.5%) [Figure 1]. Analysis of the results of the GCT group was carried out and is reported in Table 1. Table 2 shows the analysis of the results of those tested with the FPG.

Figures 2 and 3 show the FPG level sensitivities and specificities of 94% and 93% respectively, along with the false positives encountered. The area under the curve in Figure 3 is 0.962 for FPG. The true positive rates (sensitivity) versus false positive rates (specificity) are plotted for determination of the cut-off value.

**DISCUSSION**

Gestational diabetes mellitus (GDM) is defined as any degree of glucose intolerance with onset or first recogni-



**Figure 1.** Distribution of negative and positive GDMs using fasting blood sugar testing under the receiving operating characteristics curve

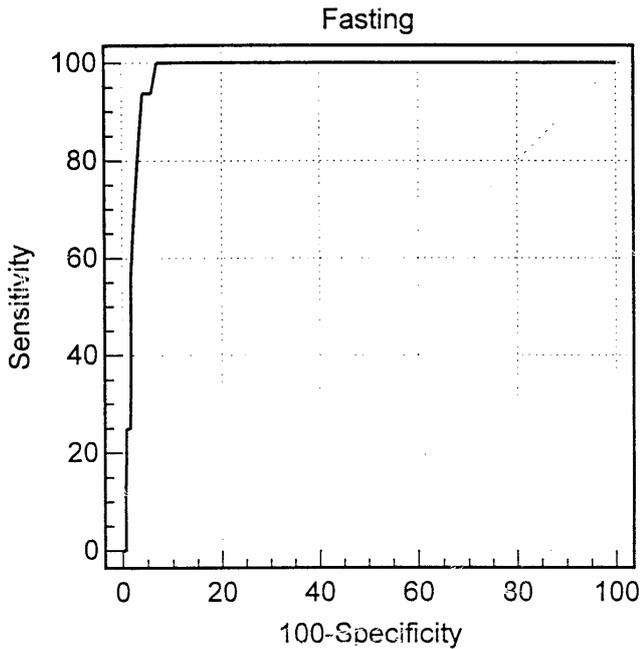
tion during pregnancy. This definition applies irrespective of whether insulin or only diet modification is used for treatment, and whether or not the condition persists after pregnancy. It does not exclude the possibility that unrecognized glucose intolerance may have antedated or begun concomitantly with the pregnancy.<sup>10</sup>

In Bahrain, testing pregnant women with 75g three-hour oGTT revealed that approximately 7.8% of all pregnancies are complicated by GDM.<sup>11</sup> Prior to year 2000,

**Table 1.** Analysis of results of the fasting plasma glucose group using a receiver operating characteristics curve

Positive Group	Diagnosis	"D"
Sample Size		207
Negative Group	Diagnosis	"ND"
Sample Size		1393
Area under ROC Curve		0.962
Standard error		0.017
95% Confidence interval		0.948–0.973
At 5.6 mmol/L:		
Sensitivity is 88.9		
Specificity is 95.0		

+ LR 14.48 positive likelihood ratio  
- LR 0.0 negative likelihood ratio



**Figure 2.** Sensitivity and specificity of fasting plasma glucose in detecting gestational diabetes mellitus

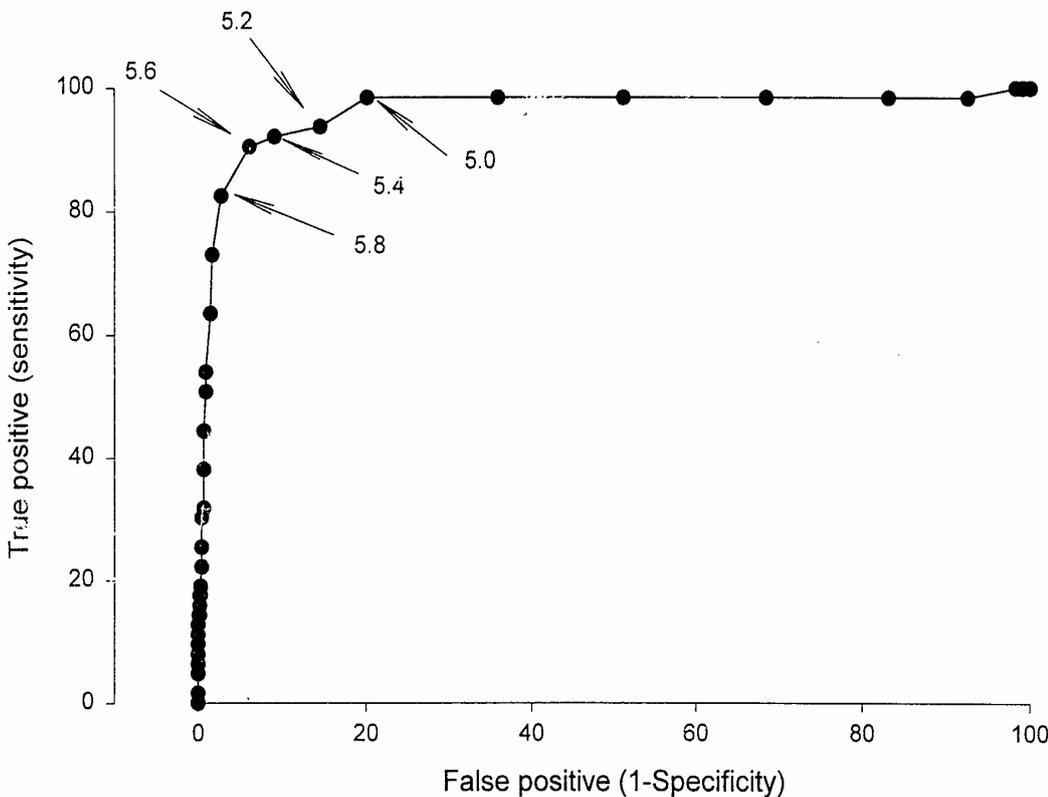
the use of the 50g GCT resulted in a higher yield of a 13.5% rate for GDM. Currently, approximately 900–1200 pregnant women are diagnosed annually to have GDM.<sup>12</sup> The prevalence may range from 7% to 14% of all pregnan-

**Table 2.** Analysis of the results of the glucose challenge test group using a receiver operating characteristics curve

Positive Group	217
Negative Group	1383
Area under ROC Curve	0.964–0.988
Sensitivity at 5.4	100%
Specificity	93.1%
Positive likelihood ratio	11.36
Negative likelihood ratio	0.00

cies based on the ethnic group studied and the diagnostic criteria employed.

In Bahrain’s Government antenatal clinics, the screening test currently used is the 50g GCT, performed between 26–32 weeks of gestation. This test involves a prior appointment, ingestion of glucose, nausea after the drink, a waiting time of one hour, and an ever increasing number of patients. More than 30% of those tested would eventually require a full oGTT. To explore new ways for reducing this burden on the laboratory, we should consider a test that is less expensive, more efficient, and more specific.



**Figure 3.** Receiver operating characteristics (ROC) curve of fasting plasma glucose concentration.

The other option would be the return to clinically selective criteria for patient screening. Obviously, the first choice is more attractive.

In 1997, the American Diabetic Association announced new diagnostic criteria for diabetic screening, abolishing the use of oGTT, and shifting diagnosis exclusively to the use of fasting glucose.<sup>12</sup> In 1998, Ramachandran et al<sup>13</sup> published a paper on using the new diagnostic criteria in an Asian population, suggesting the use of fasting glucose level as a screening

test for diabetes. There was some criticism to the use of fasting glucose instead of oGTT, based on observational studies of long term morbidity of GDM, showing that the glucose level is more accurate than fasting glucose levels in predicting future morbidity.<sup>14,15</sup>

The use of fasting blood sugar does not carry the same disadvantages, and will not obviate the need for a full GTT if this should be deemed necessary. A few studies on the use of fasting glucose levels in pregnancy have since been published, pointing to the favourable use of FPG as a screening test in obstetrics.<sup>16–19</sup>

In our series we utilized the receiver-operating curve to test the ability of the fasting plasma sugar and oGTT to identify patients with GDM and find out the cut off value which predicts a GDM diagnosis. Fasting plasma glucose levels at 5.6 mmol/l yielded sensitivity and specificity of 94% and 93% respectively. When fasting plasma glucose was used, 13% of the positives required further testing while 32% needed this when the glucose challenge test was used.

FPG at a value of 5.5 mmol/l is an easier, more acceptable test for patients compared with the 50g glucose challenge test. Using the FPG is more cost effective and allows 70% of women to avoid the challenge test. Future collaborative studies, pregnancy outcomes, and meta-analysis will answer all the questions related to the validity of this test.

### CONCLUSION

Using fasting plasma glucose levels at cut off values of  $\geq 5.5$  mol/l (99 mg/dl) as the higher FPG threshold to rule out GDM with a specificity of 95% is an easier, more acceptable test for patients than the 50g glucose challenge test. The fasting blood level test is more cost effective and allows 70% of women to avoid the challenge test. Furthermore, 13% more cases of GDM were diagnosed using the FPG criteria compared to the glucose challenge test.

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