

# Comparative Study of Fasting Plasma Glucose Concentration and Glucose Challenge Test for Screening Gestational Diabetes Mellitus

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## ABSTRACT

**Background:** To compare the sensitivity and specificity of fasting plasma glucose (FPG) with that of standard glucose challenge test (GCT).

**Materials and methods:** Eighty-nine eligible pregnant women underwent GCT between 24th and 28th gestational week, followed by a diagnostic 3 hours 100 gm oral glucose tolerance test within 1 week. Out patient clinic in Father Muller Medical College Hospital, Mangalore. Data was analyzed for significance by chi-square test.

**Results:** Fasting plasma glucose concentration at a threshold value of 90 mg/dl and GCT at recommended standard threshold of 140 mg/dl yielded sensitivities of 66.7% and 100% respectively and specificities of 87.3% and 46.5% respectively. Reducing the threshold value of FPG to 80 mg/dl increased the sensitivity of test to 91.7% with specificity of 54.9% which was comparable to standard GCT, in our study.

**Conclusion:** Measuring FPG concentration using a cut-off of  $\geq 80$  mg/dl is an easier, tolerable and more cost effective procedure than GCT for detecting more severe cases of GDM, i.e. the diabetes mellitus group. In resource poor settings with population belonging to average risk or high risk category, FPG at a cut-off of 90 mg/dl can be used to screen GDM.

**Keywords:** Gestational diabetes mellitus, Fasting plasma glucose concentration, Glucose challenge test, Screening, Sensitivity, Specificity.

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## INTRODUCTION

Gestational diabetes which accounts for 90% of diabetes during pregnancy, is defined as glucose intolerance of varying severity with onset or first diagnosed during pregnancy.<sup>1</sup> It is generally asymptomatic and is defined by either routine or selective screening of pregnant women. It is associated with increased incidence of fetal macrosomia and cesarean section in pregnancy.<sup>2</sup>

Identifying women susceptible to gestational diabetes is particularly important not only to prevent perinatal morbidity but also to improve long-term outcomes for mother and her child. Type 2 diabetes develops in 30 to 50% of women with gestational diabetes who are followed up long-term.<sup>3</sup>

Much confusion surrounds the topic of screening for glucose intolerance-hyperglycemia during pregnancy in terms of who should be screened how to screen, and management of those with positive results.<sup>4-6</sup>

If the aim is to detect the more severe cases of gestational diabetes mellitus (GDM), the diabetes mellitus (DM) group, a screening program resulting in a low rate of performed oral glucose tolerance test (OGTT) and a high sensitivity is desirable. With serious conditions, the screening program should have a high sensitivity test. In the case of screening for GDM, it may be justifiable to advocate a test with high specificity in order to avoid including a large number of women to OGTT,<sup>7</sup> especially in resource poor settings.

## MATERIALS AND METHODS

All pregnant women with singleton pregnancy between 24th and 28th gestational week, attending the antenatal clinic in Father Muller Medical College Hospital (over a study period of 16 months, January 2007-May 2008) were taken for the study. Pregnant women with preexisting diabetes and those with unknown dates were excluded from the study. One hundred and three eligible women gave informed oral consent to participate in the study.

All eligible women were given a standard, 1 hour, 50 gm glucose challenge test (GCT) between 24th and 28th gestational week, with a venous plasma blood glucose measurement 1 hour later. However, time of last food intake was noted. The challenge was performed irrespective of the time

of last food intake. Fourteen women had to be excluded after the initial GCT due to vomiting following glucose intake.

Regardless of the results of the challenge, rest of 89 participants were asked to return for 3 hours, diagnostic, 100 gm oral glucose tolerance test within the next week.

The tolerance test was performed in the morning after 12 hours overnight fast.

Fasting plasma glucose and subsequent 3 hours post glucose load test results were documented.

**Cut-off Values**

Recommended cut-off value of  $\geq 140$  mg/dl was taken for glucose challenge test.

Cut-off value of  $\geq 90$  mg/dl was taken for fasting plasma glucose.

Gestational diabetes was diagnosed if 2 or more values of the tolerance test equated or exceeded the thresholds proposed by Carpenter and Coustan as adopted by the fourth international workshop conference on gestational diabetes.

**BIOCHEMICAL ANALYSIS**

Venous plasma glucose concentration was determined by glucose oxidase-peroxidase method.

**STATISTICAL ANALYSIS**

Data was analyzed for significance by chi-square test.

Sensitivity, specificity and p-value were calculated for each modality.

Receiver operating curves were used to construct a graphic representation of relation between sensitivity and specificity of laboratory test over all possible diagnostic cut off values.

**RESULTS**

Altogether 103 eligible women gave informed oral consent to participate in the study. After the initial glucose challenge test 14 women had to be excluded due to vomiting following glucose intake. Intolerance to oral glucose was therefore seen in 13.5% of study group.

**Occurrence of Gestational Diabetes Mellitus**

Gestational diabetes was diagnosed in 12 women (13.5%). Mean age in the study group was 25 years.

Eight of 12 cases of GDM were diagnosed in the age group between 25 and 30 years ( $p < 0.001$  very highly significant).

Gestational diabetes mellitus was equally diagnosed in both primi's and multi's and there was no correlation between parity and occurrence of GDM.

Eleven of the 12 cases of GDM were detected in average risk category group.

**Fifty gram Glucose Challenge Test**

Standard cut-off value  $\geq 140$  mg/dl, yielded sensitivity of 100% and specificity of 46.5% ( $p = 0.005$ , highly significant) (Table 1).

**Fasting Plasma Glucose**

Fasting plasma glucose at a cut-off of  $\geq 90$  mg/dl yielded sensitivity of 66.7% and specificity of 66.7% ( $p < 0.001$  very highly significant) (Table 2).

Receiver operating curves (Fig. 1 and Table 3) were used which showed that the best cut-off value for screening with fasting plasma glucose was 80.5 mg/dl that yielded a sensitivity of 91.7% and specificity of 54.9% that was comparable

**Table 1: Comparison of GCT with GTT**

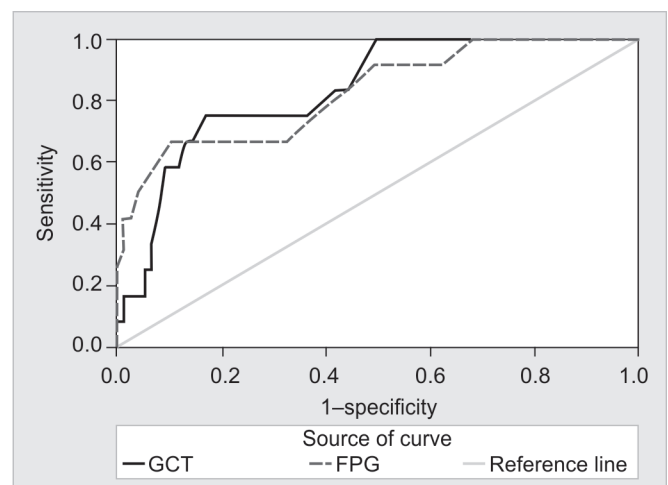
	GTT			Total
	Abnormal	Impaired	Normal	
Abnormal	12 100.0% <sup>a</sup>	5 83.3%	38 53.3%	55 61.8%
Normal	0 0%	1 16.7%	33 46.5% <sup>b</sup>	34 38.2%
Total	12 100.0%	6 100.0%	71 100.0%	89 100.0%

<sup>a</sup>Sensitivity = 100%; Specificity = 46.5%; <sup>b</sup> $\chi^2 = 10.657$ ;  $p = 0.005$ , highly significant; Cut-off value  $\geq 140$  mg/dl

**Table 2: Comparison of FPG with GTT**

	Diagnosis			Total
	Abnormal	Impaired	Normal	
Abnormal	8 66.7% <sup>a</sup>	9 12.7%	2 33.3%	19 21.3%
Normal	4 33.3%	62 87.3%	4 66.7% <sup>b</sup>	70 78.7%
Total	12 100.0%	71 100.0%	6 100.0%	89 100.0%

<sup>a</sup>Sensitivity = 66.7%; Specificity = 66.7%; <sup>b</sup> $\chi^2 = 18.371$ ;  $p < 0.001$ , very highly significant; Cut-off value  $\geq 90$  ml/dl



**Fig. 1: ROC curves**

**Table 3:** Coordinates of the curve

Test result variable(s)	Positive if greater than or equal to A	Sensitivity	1—specificity	
GCT	61.00	1	1	
	68.50	1	0.974	
	78.50	1	0.961	
	82.00	1	0.948	
	87.50	1	0.922	
	89.50	1	0.909	
	92.50	1	0.896	
	95.50	1	0.883	
	98.00	1	0.870	
	103.00	1	0.844	
	112.00	1	0.831	
	119.00	1	0.818	
	120.50	1	0.792	
	123.00	1	0.779	
	127.00	1	0.766	
	131.00	1	0.753	
	133.00	1	0.714	
	134.50	1	0.701	
	135.50	1	0.688	
	137.00	1	0.662	
	138.50	1	0.636	
	141.00	1	0.571	
	143.50	1	0.545	
146.50	1	0.506		
147.50		0.917	0.494	
148.50		0.833	0.468	
149.50		0.833	0.442	
150.50		0.750	0.416	
152.50		0.750	0.384	
154.50		0.780	0.325	
155.50		0.750	0.234	
157.50		0.750	0.195	
159.50		0.750	0.182	
160.50		0.667	0.169	
162.50		0.667	0.143	
165.50		0.583	0.130	
168.50		0.583	0.117	
169.50		0.583	0.104	
171.00		0.417	0.091	
175.00		0.333	0.065	
179.50		0.250	0.078	
181.50		0.250	0.052	
184.50		0.167	0.052	
187.50		0.167	0.026	
193.00		0.167	0.013	
207.00		0.083	0.013	
217.50		0.083	0	
220.00		0	0	
FPG	67.00	1	1	
	69.00	1	0.987	
	70.50	1	0.974	
	71.50	1	0.961	
	72.50	1	0.831	
	73.50	1	0.805	
	75.00	1	0.688	
	76.50	1	0.675	
	77.50		0.917	0.623
	78.50		0.917	0.597
79.50		0.917	0.532	

Contd...

Contd...

80.50	0.917	0.494
81.50	0.833	0.442
82.50	0.750	0.377
83.50	0.667	0.325
85.00	0.667	0.286
86.50	0.667	0.273
87.50	0.667	0.247
88.50	0.667	0.182
89.50	0.667	0.156
90.50	0.667	0.130
91.50	0.667	0.104
92.50	0.500	0.039
94.00	0.417	0.026
96.00	0.417	0.013
98.00	0.333	0.013
107.00	0.250	0
136.00	0.167	0
161.00	0.083	0
166.00	0	0

**Table 4A:** Area under the curve

Test result variable(s)	Area
GCT	0.835
FPG	0.827

**Table 4B:** Case processing summary

GTT diagnosis	Valid N (listwise)
Positive <sup>a</sup>	12
Negative	77

<sup>a</sup>The positive actual state is 2

to sensitivity and specificity obtained from GCT at a cut-off of  $\geq 140$  mg/dl.

Receiver operating characteristics of two different screening procedures for gestational diabetes (fasting plasma glucose concentration and 50 gm glucose challenge test), shows that the area under the curve is 0.835 for GCT and 0.827 for FPG (Table 4A).

**Test Result Variable(s)**

GCT, FPG has at least one tie between the positive actual state group and the negative actual state group (Table 4B).

Larger values of the test result variable(s) indicate stronger evidence for a positive actual state.

**DISCUSSION**

Much confusion surrounds the topic of screening for glucose intolerance during pregnancy<sup>4-6</sup> in terms of should the condition be screened and if yes who should be screened and how to screen. The new recommendation for screening of GDM are based on an initial clinical assessment of individual risk in all pregnant patients as laid down by IVth international conference on GDM addition.<sup>1</sup> It is argued that screening to identify someone at risk of subsequent non-insulin dependent

diabetes provides a window of opportunity to identify women who are at risk of subsequent diabetes while they are still young and to modify the natural history of non-insulin dependent diabetes mellitus.<sup>8</sup>

As noted by Sermer et al,<sup>9</sup> commonly used 50 gm GCT has several limitations, it is relatively expensive and considered unpleasant by many women. It is also affected by the time of the last meal, and Sacks et al<sup>10</sup> added to this by stating that it has poor reproducibility and that reliance cannot be placed on a single normal test result particularly among patients with risk factors.

The increased sensitivity and low specificity for GCT in our study was probably due to fact that even though the test was conducted in all subjects without regard to time of last meal, almost all women were in post absorptive state >2 hours at the time of study, which is known to increase the tests sensitivity owing to Straub-Trargott effect.<sup>11</sup>

Screening every pregnant woman for gestational diabetes as widely recommended for average risk and high-risk individuals in spite of its limitations, strains the health care system excessively, especially in resource poor setting, and Peruchini et al<sup>12</sup> following their study had concluded that fasting plasma glucose is an easier screening procedure with a better sensitivity compared to GCT. In our study, fasting plasma glucose had increased specificity in comparison to sensitivity at a cut-off of 90 mg, with a false positive rate of only 12.7%. When the cut-off of 80 mg/dl was obtained from ROC curves the sensitivity was 91.7% and specificity was 54.9%, which is comparable to GCT with sensitivity of 100% and specificity of 46.5% that was obtained for standard recommended cut-off of  $\geq 140$  mg/dl.

In resource poor settings with population belonging to average risk category, we propose universal screening with fasting plasma glucose at a cut-off of 90 mg/dl with specificity of 87.3% and sensitivity of 66.7% to screen GDM, in order to avoid exposing a large number of women to costly and cumbersome diagnostic oral glucose tolerance test and, at the same time, it can be used to reduce the burden of future diabetes by early detection and hence modification of

natural history of diabetes by life style adjustments, will be possible, where as using a cut-off of  $\geq 80$  mg/dl is an easier tolerable and more cost affective procedure than GCT, with sensitivity comparable to GCT for detecting more severe cases of GDM, i.e. diabetes mellitus group.

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