

## COMPARATIVE EFFECTIVENESS OF 50G GLUCOSE CHALLENGE TEST AND RISK FACTOR BASED SCREENING IN DETECTION OF GESTATIONAL DIABETES MELLITUS IN IBADAN, NIGERIA.

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### ABSTRACT

**Context:** Gestational diabetes mellitus (GDM) complicates 3–5% of pregnancies. Prompt diagnosis helps to prevent its subsequent complications and one-step effective screening method is desirable for our environment.

**Objective:** To compare the effectiveness of 50g glucose challenge test (GCT) with risk factors alone in screening for GDM.

**Study Design:** Prospective study of booked, consenting pregnant women with no previous history of diabetes mellitus. Fasting sample of venous blood was obtained for plasma glucose, followed by administration of 50g oral glucose and collection of blood sample an hour later. The process was repeated after a week using 75g oral glucose; each patient serving as her own control. Threshold blood glucose of 140mg/dl was used for both post-ingestion tests. Statistical analysis was done using SPSS version 17.

**Results:** All the seventy-nine study participants completed the 2 arms. Mean maternal and gestational ages at recruitment were 30.8±1.2 years and 24.2±1.6 weeks respectively. Among the respondents, 35(44.3%) were nulliparous while 24(30.3%) had positive risk factors for GDM. The 50g GCT was abnormal in 10 patients (12.7%) while GDM was confirmed in 2 patients giving an incidence rate of 2.5%. The 50g GCT was normal in 89.6% of women with normal 75g OGTT and it was more predictive of GDM (Positive Predictive Value, PPV–20%) compared to risk factors only (PPV–11.1%).

**Conclusion:** Using 50g GCT will enhance selection of patients for confirmatory test for GDM as compared to risk factors alone. It would therefore be of great benefit in this environment.

**Keywords:** (50g Glucose Challenge Test, Gestational Diabetes Mellitus, Screening)

### INTRODUCTION

Gestational diabetes mellitus (GDM) is a metabolic disease that results from absolute or relative deficiency of insulin manifesting as hyperglycemia and its attendant complications diagnosed for the

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first time in an index pregnancy.<sup>1,2</sup> It is the most common endocrinological complication of pregnancy occurring in about 3-5% of pregnancies.<sup>1</sup>

<sup>2</sup>Its complications include congenital malformations, fetal macrosomia, unexplained intrauterine fetal death and neonatal hypoglycemia. Poorly controlled diabetes in pregnancy is often associated with high fetal morbidity and mortality rates while infants of diabetic mothers experience double the risk of birth injuries; triple the likelihood of caesarean delivery and quadruple the incidence of newborn intensive care unit admissions<sup>3</sup> when compared with infants of non-diabetic mothers.

The prevalence of gestational glucose impairment would depend on the characteristics of the population being studied. GDM carries risks for the mother and the neonate although not all adverse outcomes are of equal clinical importance and for most complications, there is no threshold for risk.<sup>3</sup> In the Hyperglycemia and Adverse Pregnancy Outcome (HAPO) study, it was demonstrated that the risk of adverse maternal, fetal, and neonatal outcomes continuously increased as a function of maternal glycaemia at 24–28 weeks, even within ranges previously considered normal for pregnancy.<sup>4,5</sup>

In general, the prevalence rate of GDM has continued to increase with time across different populations.<sup>5-12</sup>

The incidence in Ibadan, Nigeria has increased from 0.74% in 2003<sup>7</sup> to 1.6% per year in 2014 using the conventional risk factor assessment but a higher value of 4.9% when a strictly structured checklist was used.<sup>8</sup> In the United Kingdom, GDM affects between 2-5% of pregnant women which has been increasing with time in all ethnic groups.<sup>9</sup> It has also been estimated that, between 1980 and 2008, the rate of diabetes during pregnancy (both GDM and preexisting) increased from 5.0% to 8.7% among white women, and from 5.7% to 9.7% among African American women in the United States.<sup>10-12</sup>

Various methods had been employed in the past to detect GDM and the most common clinical approach was to screen women with risk factors such as obesity, previous history of diabetes, previous history of foetal macrosomia or unexplained intrauterine foetal demise.<sup>13</sup> This category of women were then subjected to the 75g oral glucose tolerance test (OGTT) for definitive diagnosis. Many countries have adopted a two-step approach to diagnosis in which only women with abnormal 50g glucose challenge test (GCT) are further tested with 100g GTT. The problem with this second approach is the rate of default from completing the test which has been reported to be as high as 23%.<sup>14</sup> This rate is likely to be worse with the nature and structure of our environment which is one of the reasons for using the one-step approach of 75g OGTT. However, it is desirable that patient selection for definitive diagnosis will be more objective than just reviewing the risk factors.

This study attempted to find out the effectiveness of 50g GCT as a screening test for GDM in this environment as compared to the risk factors with or without the corresponding fasting blood glucose level. Better or comparable effectiveness of the 50g GCT would contribute immensely to care of patients by ensuring that only appropriate patients are further tested. It was also hoped to establish a cut-off that will be diagnostic of overt diabetes without having to revert to the conventional OGTT thus reducing the time needed for intervention and treatment. The main thrust of this study was to determine whether universal screening of all pregnant women using 50g glucose challenge test would identify a higher number of women with GDM than risk factor-based screening.

## **MATERIALS AND METHODS**

This prospective study was conducted at the University College Hospital, Ibadan, which

provides tertiary level of obstetric care in the South Western part of Nigeria.

Seventy-three (73) pregnant women were required to determine a statistically significant difference between the blood glucose results using the 50g and 75g GCTs. Seventy-nine patients were however recruited into the study with each patient serving as her own control. This is because all the patients completed the 2 arms of the study and there was no attrition. Recruitment was done at the booking clinic of the hospital. After due counseling and voluntary consent, each patient's history was obtained in order to identify risk factors such as age (35 years or older), weight, height, body mass index  $\geq 27\text{kg/m}^2$ , family history of diabetes mellitus, previous macrosomic baby, recurrent pregnancy losses, previous intrauterine fetal death of no apparent cause and congenital malformation. These and other details about the patient and her pregnancy were collected using an interviewer administered questionnaire.

All pregnant women with no previous history of diabetes mellitus or gestational diabetes mellitus who booked or attended antenatal clinic between 20<sup>th</sup> and 28<sup>th</sup> weeks of pregnancy were considered eligible and counseled as such. Those who consented were selected and instructed to report for the 50g GCT after 8 – 12 hours of overnight fasting at a scheduled date. At presentation, 2mls of blood was collected for estimation of the fasting plasma glucose, then 50g of oral glucose was administered and blood sample taken 1 hour later. The process of overnight fasting and blood sample collection was repeated after a minimum of 2 days, but now using 75g oral glucose load. Samples collected were analyzed as determined by the laboratory physician. The 50g oral GCT screening was considered positive when the 1 hour post intake glucose level is more than 140mg/dl (7.8mmol/l). Regardless of the results from the screening tests, all the pregnant women also had the 75g OGTT which was considered positive when the

2hours post glucose level was more than 140mg/dl (7.8mmol/l).

Ethical approval was obtained from the University of Ibadan / University College Hospital Institutional Review Committee.

## RESULTS

Seventy nine pregnant women were screened using the risk factors, 50g and 75g GCTs. The incidence rate for GDM was 2.5% and these patients were treated appropriately in conjunction with the endocrinologists.

Demographic analysis showed that 72.5% of the pregnant women were > 30 years old with their mean age and length of gestation being 30.8 + 1.2 years and 24.2 + 1.6 weeks respectively at recruitment. The distributions of maternal and gestational ages are shown in Table 1. Thirty five (44.3%) of the women were nulliparous. The mean maternal weight and height were 70.80 + 5.24kg and 1.64 + 0.02m respectively while the mean body mass index (BMI) at the time of recruitment into the study was 25.97 + 1.87kg/m<sup>2</sup>. The interval between administering the 50g and 75g glucose loads was 3.8 + 1.5 days.

Twenty four (30.3%) of the participants had positive risk factors for gestational diabetes mellitus. The identified factors included positive history of diabetes mellitus among first degree relations (50%); past history of unexplained spontaneous abortion (16.2%) and recurrent abortions (6.3%). Of these 24 patients, 50g GCT and 75g OGTT were normal in 69 of them while only 54 of the participants without risk factors had normal 75g OGTT. There was only one patient that had an abnormal 75g OGTT with positive risk factors (multiple – maternal weight of > 90kg and history of diabetes in first degree relation). The remaining 23 patients have normal 75g OGTT. The 2 most common risk factors were maternal weight > 90kg

and history of previous macrosomic baby. 5 have multiple risk factors while the remaining 18 participants have single risk factor. Only 7.6% of the respondents had ever used oral contraceptive.

Fasting blood glucose was abnormal in 9 patients with positive risk factors (11.4%) while the 50g GCT was abnormal in 10 patients (12.7%). Among the patients with abnormal 50g GCT, 8(80%) had normal 75g OGTT while 2(20%) had an abnormal 75g OGTT. The 75g OGTT was normal in 77 subjects (97.5%) and confirmed GDM in 2 subjects (2.5%) with one of them having no prior risk factor for gestational diabetes mellitus. Of the patients with normal 75g OGTT, 89.6% had normal 50g GCT result while only 71.4% had no risk factors for GDM and this difference is statistically significant (Yates corrected chi square statistic,  $X^2 = 22.6$ ,  $p = 0.000019$ ) There was no difference in the mean fasting glucose for 50g and 75g OGTT ( $73.4 \pm 12.4$  mg/dl versus  $73.3 \pm 13.4$  mg/dl respectively,  $p = 0.96$ ). The mean values of 1 hour and 2 hours post glucose loads were  $107.2 \pm 23.3$  mg/dl and  $99.0 \pm 19.6$  mg/dl respectively (Table 2). There is however a statistically significant difference in the mean difference between the fasting glucose and one hour post glucose load levels but no difference in the two hour blood glucose levels.

The 50g GCT has a negative predictive value (NPV) of 100% and a positive predictive value of 20%. It is however more specific and more sensitive when compared to risk factors assessment or risk factors combined with fasting glucose screening (Table 3).

## DISCUSSION

GDM is a well-established medical condition in pregnancy and there are clear benefits derivable from effective screening and treatment. In our hospital, GCT is not done in pregnant women but women at risk of diabetes undergo 75g OGTT. Of the 79 women who underwent the 50g GCT, 10 women were found to have an elevated level of at least 140mg/dl

(7.8mmol/l) with 2 of them being confirmed to have GDM. The incidence of GDM was 2.5% and the diagnostic yield was 20%. One in five women with an elevated GCT and no risk factors was found to have GDM. In a study in Singapore, it was realized that the incidence of GDM among Singaporean women with no risk factors is not small and cannot be ignored.<sup>15</sup>

In 1973, O'Sullivan et al, proposed that a single glucose tolerance test done without dietary preparation could provide an acceptable screening test. Thus came about the 50g GCT. Based on their study involving a total of 19,798 women, O'Sullivan reported a sensitivity of 79% and specificity of 87% using a threshold value of 130 mg/dl (7.2mmol/l)<sup>16</sup> while in this study a threshold of 140mg/dl (7.8mmol/l) had a sensitivity of 66.7% and specificity of 87.3%. Ardawi et al also had a sensitivity of 88% and specificity of 84% when they studied 818 pregnant women following 50g GCT using a threshold of 140mg/dl.<sup>17</sup>

In their study using the threshold plasma glucose value of 130mg/dl (7.2mmol/l), 14 (17.7%) women were positive for 50g glucose challenge test and only 2 were found to have GDM with a diagnostic yield of 14.3% as compared to using the threshold plasma glucose value of 140mg/dl with 10 (12.7%) women being positive and only 2 were found to have GDM with a diagnostic yield of 20%. This shows that with the use of 140mg/dl as the value for the plasma glucose threshold a smaller number of women will need to undergo 75g OGTT with a higher diagnostic yield. This is similar to a study conducted in Singapore among 146 women with the incidence of gestational diabetes of 8.6%. Using the threshold plasma glucose level at 130mg/dl (7.2mmol/l), 53 women (36%) needed to undergo the 75g oral glucose tolerance test and 12 women were found to have gestational diabetes. The diagnostic yield was 22.6% while with 140mg/dl

(7.8mmol/l) as the threshold value, 28 women (20%) needed the oral glucose tolerance test and eight women with gestational diabetes were detected. The diagnostic yield was 28.6%.<sup>15</sup>In a review by Donovan et al, 50-g GCT with a cut-off point of 130 mg/dl (7.2mmol/l) had higher sensitivity compared with a cut-off point of 140 mg/dl (7.8 mmol/l); however, specificity was lower.<sup>12</sup>The interval between the administration of the 50g and 75g has no effect on the outcome as it has been documented that excess blood glucose is controlled within 48 hours.<sup>18</sup> In this study it was noticed that all the women who had the first screening test did attend the 75g OGTT. This might be due to detailed explanation and the involvement of our public health nurse colleague who was dedicated to the follow up of the patients. This further underscored the importance of collaborative, multidisciplinary approach to health care provision in ensuring a better outcome for the patient.

According to the American Diabetes Association (ADA) guidelines, patients should be screened for risk factors for GDM at their initial visit. The length and number of risk factors to be screened are cumbersome and some of the patients, especially in this environment, are either unaware of the predisposing conditions such as history of diabetes mellitus in the first degree relation or outrightly deny the existence of such conditions thereby inadvertently increasing the number of false negative results for risk factors. A structured checklist as adapted by Fawole et al<sup>8</sup> will require repeated training for validation and adaptation. Meanwhile, when it is considered that a far less number of women will require further confirmatory tests, it is more cost effective to screen all pregnant women with 50g GCT.

## CONCLUSION

GDM is a common medical problem that results from insulin resistance as well as an impairment of the compensatory increase in insulin secretion. Pregnancy, in essence, serves as a metabolic stress test and uncovers underlying insulin resistance and  $\beta$ -cell dysfunction. GDM is associated with a variety of maternal and fetal complications, most notably macrosomia.

The 50g GCT when performed on a low risk population appears to be a feasible and acceptable screening test. It is simple, convenient, cheap and easy to organize in the outpatient setting. It was well tolerated by all the patients. Screening with the GCT was helpful in overcoming the low sensitivity rates associated with historical or obstetrical risk factor screening. Thus 50 g GCT appears to identify a higher number of GDM patients than risk factor based screening in the population studied. The prime emphasis in the management of GDM should be focused on its early detection.

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**TABLE 1: DISTRIBUTION OF MATERNAL AGE, GESTATIONAL AGE AND PARITY AT RECRUITMENT**

Maternal Age (years)	Frequency	Percentage
20 – 29	22	27.8
30 – 39	55	69.7
40 – 49	2	2.5
<b>Total</b>	<b>79</b>	<b>100</b>

  

Gestational Age	Frequency	Percentage
Less than 20 weeks	4	5.1
20 – 23 weeks	22	27.8
24 – 28 weeks	53	67.1
<b>Total</b>	<b>79</b>	<b>100</b>

  

Parity	Frequency	Percentage
0	35	44.3
1	27	34.2
2	7	8.9
3	6	7.6
4	2	2.5
= 5	2	2.5
<b>Total</b>	<b>79</b>	<b>100</b>

**Table 2: MEAN DIFFERENCES BETWEEN 1 HOUR AND 2 HOURS RESULTS POST GLUCOSE LOAD**

Variables	Mean mg/dl	Standard deviation	Value Z	p-value
First Fasting Plasma Glucose	73.4	12.4	11.3	<0.05
One Hour Post Glucose Load	107.2	23.3		
Second Fasting Plasma Glucose	73.3	13.4	3.47	>0.05
Two Hour Post Glucose Load	99.0	19.6		

**TABLE 3: COMPARISON BETWEEN RESULTS OF 50g GCT; RISK FACTORS AND FASTING GLUCOSE AND RISK FACTORS ALONE**

PARAMETERS	SENSITIVITY (%)	SPECIFICITY (%)	PPV (%)	NPV (%)
50g GLUCOSE LOAD	100	89.6	20.0	100
RISK FACTORS + FASTING GLUCOSE	50.0	77.8	11.1	89.7
RISK FACTORS	51.9	70.5	4.1	98.2

**REFERENCES**

1. Savvidou MD, Anderson JM, Kaihura C, et al. Arterial stiffness in diabetic pregnancies. *Am J ObstetGynecol* 2010;203:274.e1-7.
2. Osman Sevket, SedaAtes, Omer Uysal, TanerMolla, RamazanDansuk, and SefaKelekci. To evaluate the prevalence and clinical outcomes using a one-step method versus a two-step method to screen gestational diabetes mellitus. *J Matern Fetal Neonatal Med*, 2014; 27(1): 36–41.
3. Moore, TR, Smith, CV, et al. Diabetes Mellitus and Pregnancy. 2014. Available at: <http://emedicine.medscape.com/article/127547-overview>. Accessed 12<sup>th</sup> March, 2015.
4. American Diabetes Association. Management of diabetes in pregnancy. Sec. 12. In *Standards of Medical Care in Diabetes – 2015*. *Diabetes Care* 2015;38 (Suppl. 1):S77–S79.
5. Metzger BE, Lowe LP, Dyer AR, Trimble ER, Chaovarindr U, Coustan DR et al. Hyperglycemia and adverse pregnancy outcomes. *N Engl J Med* 2008;358:1991–2002.
6. American Diabetes Association. Strategies

- for improving care. Sec. 1. In Standards of Medical Care in Diabetes – 2015. Diabetes Care 2015; 38 (Suppl. 1):S5–S7.
7. Oladokun A, Aimakhu C.O, Awolude O.A, Olayemi O, Adeleye J. Pregnancy outcome in diabetic patients at the University College Hospital, Ibadan. Trop J ObstetGynaecol, 2003;20(1);52–5.
  8. Fawole AO, Ezeasor C, Bello FA, Roberts A, Awoyinka BS, Tongo O et al. Effectiveness of a structured checklist of risk factors in identifying pregnant women at risk of gestational diabetes mellitus: A cross sectional study. Nig J ClinPract 2014; 17(4); 495–501.
  9. Dornhorst A and Williamson C. Diabetes and endocrine diseases in pregnancy. In: Edmonds DK (ed) Dewhurst's Textbook of Obstetrics and Gynaecology for Postgraduates. 7<sup>th</sup>Ed. Blackwell Publishing. 2007: 246–259.
  10. Committee opinion no. 504: Screening and diagnosis of gestational diabetes mellitus. ObstetGynecol 2011;118:751–3
  11. Moyer VA, Screening for Gestational Diabetes Mellitus: U.S. Preventive Services Task Force Recommendation Statement. Ann Intern Med. 2014;160:414-420. doi:10.7326/M13-2905.
  12. Donovan L, Hartling L, Muijs M, Guthrie A, Vandermeer B, Dryden DM. Screening tests for gestational diabetes: a systematic review for the U.S. Preventive Services Task Force. Ann Intern Med. 2013;159:115-22. [PMID: 23712349]
  13. Mires GJ, Williams FL, Harper V. Screening practices for gestational diabetes mellitus in UK obstetric units. Diabet Med 1999; 16: 138–141
  14. Sermer M, Naylor D, Gare DJ et al: the Toronto Tri-Hospital Gestational Diabetes Investigators. Impact of time since last meal on the gestational glucose challenge test: the Toronto Tri-Hospital Gestational Diabetes Project. Am J ObstetGynecol 1994; 171: 607–616.
  15. Ray R, Heng BH, Lim C, Ling SL. Gestational diabetes in Singaporean women: use of the glucose challenge test as a screening test and identification of high risk factors. Ann Acad Med Singapore 1995;25:504-508.
  16. O'Sullivan JB, Mahan CM, Charles D, Dandrow RV. Screening criteria for high risk gestational diabetic patients. Am J ObstetGynecol 1973; 116: 895-900.
  17. Ardawi MS, Nasrat HA, Jamal HS, Al-Sagaaf HM et al. Screening for gestational diabetes mellitus in pregnant females. Saudi Medical Journal 2000;21(92): 155-160.
  18. Wang P, Lu M-C, Yu C-W, Yan Y-H (2014) Influence of the Time of Day and Fasting Duration on Glucose Level following a 1-Hour, 50-Gram Glucose Challenge Test in Pregnant Women. PLoS ONE 9(11): e 1 1 2 5 2 6 . doi:10.1371/journal.pone.0112526.