Efficiency of gestational diabetes mellitus screening and socio-demographics of pregnant subjects attending antenatal care.

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Abstract

Background: Gestational diabetes mellitus (GDM) is a glucose intolerance of variable severity that can have devastating effect on the fetus.[1]

Aim: To determine the efficiency of GDM screening and the sociodemograhic variables of mothers among population at risk.

Methods: A cross-sectional study among pregnant women booked for antenatal care (ANC) at Federal Medical Centre Abeokuta, Nigeria. A multistage sampling technique was used to select 100 pregnant women attending ANC. The subjects were screened with World Health Organization (WHO) diagnostic criteria[2] for gestational diabetes mellitus using 75g Oral Glucose Tolerance Test (OGTT) with either fasting plasma glucose ≥ 5.1 mmol, or the 2 hour post glucose load ≥ 8.5 mmol or both. To determine if gestational diabetes is present in pregnant women, a standard OGTT was performed after overnight fasting (8–12 hours) by giving 75 g anhydrous glucose in 250–300 ml. The pregnant subjects that met the inclusion criteria were scheduled to have overnight fasting of between 8 to 12hours before fasting plasma glucose (FPG) testing, having done random plasma glucose (RPG) test at first presentation. Samples of venous blood were collected into sodium fluoride container.

The glucose oxidase method of estimation of plasma glucose was used to assay the samples[3]. It involved the use of the enzyme glucose oxidase that reacts with glucose, water and oxygen to form gluconic acid and hydrogen peroxide. The hydrogen peroxide produced oxidizes a chromogen (or the consumption of oxygen) which is measured to estimate the amount of glucose present.

Results: During this study, a total of 100 eligible pregnant women were screened for GDM using FPG, RPG and the 75-OGTT. The mean age ± standard deviation (sd) of the participants was 34.81±4.04 yrs; mean BMI was 31.46±7.29 kg/m^2 and modal parity was 1 (32%) (Table I). The majority of the pregnant subjects, 74 (74%) had tertiary level of education.

The RPG cut off values of ≥7.8 mmol/l gave PPV of 66% and NPV of 72.3% with PLR and NLR of 4.76 and 0.89 respectively. The efficiency of RPG ≥7.8 mmol/l in diagnosing GDM was 72%. Also increasing the cut-off point of RPG to ≥11.1 mmol/l gave efficiency of 72% while the highest efficiency was achieved using FPG of ≥5.1 mmol/l which gave the efficiency of 95%. The greatest positive predictive value of 100% was given by FPG value ≥7.0 mmol/l and RPG value of ≥11.1 mmol/l.

Conclusion: GDM screening with FPG revealed high efficiency of 95% at threshold of 5.1 mmol/l. Maternal age of 35-40 yrs had the highest incidence of GDM in our population.

Introduction

Gestational diabetes mellitus is defined as glucose intolerance of variable severity with onset or diagnosis made in the index pregnancy.

In spite of decades of research, several controversies remain in the criteria for diagnosis and classification of gestational diabetes mellitus. Among studies on screening methods for GDM, a handful of studies have been done on the use of random plasma glucose and fasting plasma glucose for GDM screening in our region and Nigeria at large despite the recent findings[1,2,3]. on the use of random plasma glucose and fasting plasma glucose as invaluable tools for GDM screening in the sub-saharan African region.

More studies on the accuracy of random and fasting plasma glucose testing, the sensitivity, and specificity, negative and positive predictive values are needed to determine their role in GDM screening. Coupled with the rising cases of gestational diabetes mellitus in our environment, there is need for a screening test that will be affordable, feasible, acceptable, safe, and cost effective among the pregnant population in our setting.

Therefore, there is need for studies on random plasma glucose and fasting plasma glucose in Nigeria and from our local settings that may give evidence towards formulation of protocols that can translate to better patient management. Available evidence suggests that screening for GDM within the pregnant population increases the detection of women affected by diabetes in pregnancy and thus improves maternal and perinatal outcomes.[12,13,14,15,16].

This study therefore aims at evaluating the possible efficiency of screening modalities for GDM in resource constrained setting.

Methodology

A cross-sectional study among pregnant women booked for antenatal care (ANC) at Federal Medical Centre Abeokuta, a tertiary healthcare centre in Nigeria. A multistage sampling technique was used to select 100 pregnant women attending ANC. The pregnant subjects that met the inclusion criteria were scheduled to have overnight fasting of between 8 to 12hours before fasting plasma glucose testing having done random plasma glucose test at first presentation. Samples of venous blood were collected into sodium fluoride container.

The glucose oxidase method of estimation of plasma glucose was done. It involved the use of the enzyme glucose oxidase that reacts with glucose, water and oxygen to form gluconic acid and hydrogen peroxide. The hydrogen peroxide produced oxidizes a chromogen or the consumption of oxygen measured to estimate the amount of glucose present. Ethical clearance for this study had been approved from the Health Research Ethics Committee of Federal Medical Centre, Abeokuta. The protocol number is **FMCA/470/HREC/10/2016/07. NREC ASSIGNED NUMBER: NHREC/08/10-2015. FEDERAL WIDE ASSURANCE: US/REG NO: FWA/Q0018660/02/28/2017.**

Results

Maternal age 35-40 yrs was observed to be high among the participants (Table I). Mild obesity had the highest frequency of 34% Table II. The results showing the accuracy of screening (Table III): sensitivity, specificity, and positive and negative predictive values for various FPG and RPG cut off values are presented. The FPG cut off values between 5.1 to 5.5 mmol/l classified 16-29% of the subjects as having positive test. The sensitivities decreased as cut off values for FPG were reduced from 90% at 5.1mmol/l to 43.3% at 5.5 mmol/l and 6.7% at 7.0mmol/l. Also, reducing the FPG cut off from 5.1 mmol/l to 5.5 mmol/l decreased the specificity from 97.1% to 95.7% while the efficiency of the test decreased from 95% to 80%. A high efficiency of the screening tests of 95% was obtained at FPG cut off value of 5.1 mmol/l.

Table I: Socio-demographic characteristics of subjects

Socio-demographic	Frequency or Percentage (Number)
Maternal Age (years)	
20-24	3 (3%)
25-29	11(11%)
30-34	20(20%)
35-40	58(58%)
>40	8 (8%)
Mean Age ±(Standard deviation)	**34.81 ±4.04 yr**
Parity	
0	26 (26%)
1	32 (32%)
2	25 (25%)
3	13 (13%)
4	3 (3%)
>4	1(1%)
Mean Parity ± (Standard daviation)	**1.38±1.15**

Table II: Socio-demographic characteristics of subjects

Socio-demographic	Frequency or Percentage (Number)
BMI	
Underweight (<18.5kg/m^2)	1 (1%)
Normal (18.5-24.9kg/m^2)	14 (14%)
Overweight (25-29.9kg/m^2)	27 (27%)
Mild Obesity (30-34.9kg/m^2)	34 (34%)
Moderate Obesity (35-39.9kg/m^2)	11 (11%)
Morbid Obesity (≥ 40 kg/m^2)	13 (13%)
Mean BMI (kg/m^2)	**31.46±7.29 kg/m^2**
Educational Status	
None	2 (2%)
Primary	8 (8%)
Secondary	14 (14%)
Tertiary	76 (76%)

Table III: Diagnostic Accuracy of RPG and FPG compared to OGTT in Screening for GDM

Screening Strategy	Sensitivity	Specificity	PPV	NPV	PLR	NLR	Efficiency
RPG (≥7.8 mmol/l)	**13.8%**	**97.1%**	**66.7%**	**72.3%**	**4.76**	**0.89**	**72%**
RPG (≥11.1 mmol/l)	**6.7%**	**100%**	**100%**	**71.4%**	**6.7**	**0.93**	**72%**
FPG (≥5.1 mmol/l)	**90%**	**97.1%**	**93.1%**	**95.8%**	**31**	**0.1**	**95%**
FPG (≥5.3 mmol/l)	**60%**	**97.1%**	**90%**	**85%**	**20.69**	**0.41**	**86%**
FPG (≥5.5 mmol/l)	**43.3%**	**95.7%**	**81.3%**	**79.8%**	**10.07**	**0.59**	**80%**
FPG (≥7.0 mmol/l)	**6.7%**	**100%**	**100%**	**71.4%**	**6.7**	**0.93**	**72%**

Discussion

The positive predictive value (PPV) found in the study was 100% and 93.1% using fasting plasma glucose (FPG) cut off ≥ 7.0 mmol/L and FPG cut off ≥ 5.1 mmol/L respectively (Table III). These PPV is

quite higher than the findings by Saeedi et al in Orebo university hospital, Sweden who found PPV of 78% at FPG cut-off value ≥ 5.2 mmol/L and PPV of 46% at FPG cut off value of 5.0 mmol/L. The negative predictive value (NPV) found in this study was 95.8% at fasting plasma glucose cut off threshold of ≥ 5.1 mmol/l and 85% at FPG cut off threshold of 5.3 mmol/l. This is lower than the NPV of 99% at FPG threshold of 5.0 mmol/l found by Saeedi et al in Sweden. The differences in the findings may be attributed to the larger population size of 4918 of eligible participants who were recruited in Orebo county which is larger than the subjects used in our study. In addition, the 75 g OGTT was done in this study between gestational ages of 24 weeks to 28 weeks while the Swedish study had the screening at GA 28 weeks to 32 weeks.

In another study by Khan et al[23] in a study at Karachi, between subjects with and without GDM. Nineteen subjects were diagnosed GDM using Carpenter and Coustan criteria while 13 met “NDDG” criteria using 100g OGTT. Fasting plasma glucose cut off of 5.1 mol/L was the most efficient investigation and gave PPV = 70%, NPP = 78.78%, positive likelihood ratio = 3.56, negative likelihood ratio = 0.41, efficiency = 75.47%. These findings are quite lower than the results reported by this study which found the PPV of 93.1% and NPV of 95.8% at FPG cut off 5.1 mmol/L. Khan et al also reported that at random plasma glucose cut-off 11.1 mmol/L, the PPV was 65.21% NPP, 1.25 positive likelihood ratio, 0.82 negative likelihood ratio and efficiency of 55.8%. The result of this study found that fasting plasma glucose is a better investigation for the screening of GDM than random plasma glucose or 50g GCT. The sample size analyzed was 53 subjects which is quite lower than the number of participants in our study. The samples collected in this study were run in duplicate and the average of the two readings taken as the final result. This will help in reducing error from outlier figures.

Al-Kindy et al in Kenya study found PPV of 52% which was lower than the PPV of 66.7% found in this study at same RPG threshold cut off 7.8 mmol/l. However, a higher NPV of 87% was found in Kenya study which was higher than NPV of 72.3% in this study at same RPG threshold of 7.8 mmol/l. The Kenyan study found Positive likelihood ratio and negative likelihood ratio of 3.71 and 0.52 respectively at RPG cut off ≥ 7.8 mmol/l while this study found a higher PLR of 4.76 and NLR of 0.86 at same threshold. Although Al-kindy et al used 50 g GCT for diagnosis with threshold of cut off ≥ 7.8 mmol while this study used RPG as screening test for the recruited subjects.

Reyes-Munoz in the Mexican study found PPV of 99.2% and NPV of 99.2% at FPG threshold of ≥ 5.1 mmol/L which is quite higher than the NPV found this study at same FPG threshold. The positive likelihood ratio was 884 while the NLR was 0.12. This is quite higher than the PLR of 31 and NLR of 0.1 found in this study. Although, the population from which the subjects were drawn were not the same, this study focused mainly on pregnant subjects with identifiable risk factors for GDM, who were considered to be at risk of development of gestational diabetes mellitus.

Mohan et al in an Indian study for screening of GDM using OGTT done in nonfasting (random) and fasting states, found PPV and NPV at threshold of 7.8 mmol/l to be 52.2% and 93.9% respectively. These findings are lower than the results reported by this study which found PPV and NPV of 66.7% and 72.3%

respectively. The accuracy reported by Mohan et al was 94.7% which is higher than the efficiency of 72% found in this study. Although both studies are similar, Mohan et al recruited 1400 study subjects from both urban and rural antenatal centres in Indian, which was quite large population.

Khan et al[23] found the mean age of the study subjects to be 29.90 ± 4.92 years which is quite lower than the mean age of 34.81 ± 4.04 yrs of the participants in this study.

The mean BMI in this study was 31.46 ± 7.29 kg/m^2 which is higher than BMI of 24.3 ± 3.6 kg/m^2 found by Reyes-Munoz in the Mexican population and that of

Makuve etal[12] in a cross-sectional study in Tanzania population found that only 29.9% of pregnant women are offered GDM screening of which random blood glucose comprised 56.8% while fasting plasma glucose was 32.8% while OGTT was 3.4%. The use of simple low cost tests such as RPG and FPG can increase screening in this population.

Pillay et al[12] in a meta-analysis found that available evidence on screening or no screening remains controversial and one vs two step approach was not significantly associated with improved outcomes. Khan R et al[13] in Pakistan population found among the socio-demographic factors that parity of GDM subjects were significantly higher risk of GDM ($P < 0.05$), but educational status or socioeconomic status was not associated with GDM.

In our study, maternal age 35–40 yrs was observed to be high among the participants (Table I). Li et al[14] in Chinese population found that the risk of GDM increases linearly with maternal age in the overall population at 7.9%. Abu-Heija et al[15] found that maternal age and BMI had the greatest influence on positive glucose tolerance test.

Recommendation:

FPG can be a valuable screening modality for gestational diabetes mellitus and should be considered for use in universal screening.

Conclusion

GDM screening using FPG revealed high efficiency of 95% at threshold of 5.1 mmol/l. Maternal age of 35–40 yrs had the highest frequency of GDM in our study population.

Declarations

Ethics approval and consent to participate:

A statement to confirm that all methods were carried out in accordance with relevant guidelines and regulations in accordance with the Declaration of Helsinki

The authors' state to confirm that all experimental protocols were approved by the Health Research Ethics Committee of Federal Medical Centre, Abeokuta. The protocol number is **FMCA/470/HREC/10/2016/07. NREC ASSIGNED NUMBER: NHREC/08/10-2015. FEDERAL WIDE ASSURANCE: US/REG NO: FWA/Q0018660/02/28/2017.**

The authors' state to confirm that informed consent was obtained from all subjects and/or their legal guardian(s).

Availability of data and materials: The data that support the findings of this study are available from **FMCA** but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of **FMCA.**

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Authors' contribution statement: Author Chibuike F chukwunyere conceptualized the research, wrote the proposal, carried out the research work and wrote the manuscript. Authors David O Awonuga was involved in design and supervision of the research. Author Olubiyi Adesina contributed in the methodology and supervision. Author Ifeoma C. Udenze was involved in the formulation of methodology and supervision.

Declared Consent for Publication: **Not Applicable**.

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