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■ Original Research Article

Abnormal Oral Glucose Tolerance Test among Pregnant Women in Ushafa Community: Comparison of WHO and IADPSG Criteria.

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ABSTRACT

Background: The prevalence and impact of gestational diabetes mellitus (GDM) is growing worldwide. Its management depends on the diagnostic criteria used and there is no consensus on screening methods and diagnostic criteria. In order to reduce adverse maternal and neonatal outcomes associated with hyperglycemia, including the mild forms, the International Association for Diabetes in Pregnancy Study Group (IADPSG) proposed diagnostic criteria and encourages its adoption worldwide, as against the previously used World Health Organization criteria. **Objectives:** This study aimed to compare abnormal oral glucose tolerance results using the WHO and IADPSG criteria among pregnant women in the Ushafa community, a rural community in FCT Abuja, North Central Nigeria. **Methodology:** This was a cross-sectional study involving recruiting 150 pregnant women using the cluster sampling method. Eligible participants were women between 24 and 28 weeks of pregnancy, while those with pregestational diabetes mellitus, gestational diabetes mellitus, or who opted out of the study were excluded. Each participant underwent a 75-gram oral glucose tolerance test (OGTT). The diagnosis of gestational diabetes mellitus (GDM) was established for each participant based on the WHO (1999) and IADPSG criteria, and then compared. Outcome measures included the prevalence of GDM according to both the WHO and IADPSG criteria, as well as associated sociodemographic and clinical risk factors. Data analysis was conducted using the Statistical Package for the Social Sciences (SPSS) software, version 23.0 for Windows. **Result**: The prevalence of gestational diabetes mellitus (GDM) according to WHO 1999 and IADPSG criteria was 9.3% and 15.3%, respectively. Approximately 6.7% of women met both criteria, while 18% met either one or both criteria. Using multivariable analysis, age >34 years, BMI >25kg/$m^{2,}$ and previous history of macrosomia were significantly associated with GDM. Approximately 35% of GDM cases would have been missed if a selective screening strategy had been employed instead of universal screening, which was done. **Conclusion**: There is an increase in the prevalence of GDM when the IADPSG criteria is compared to the WHO 1999 criteria. Missed opportunities for diagnosis and management exist with the use of the WHO 1999 criteria and selective screening approach. There is a need for reappraisal and uniformity on the diagnostic approach and criteria to be used when managing GDM in Nigeria.

Keywords: Gestational Diabetes, Oral Glucose Tolerance Test, World Health Organization, Pregnancy Study Groups, Hyperglycemia, Adverse Pregnancy Outcome, Diagnosis, Prevalence, Community.

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INTRODUCTION

The overall prevalence of hyperglycemia in pregnancy is rising globally. This has been influenced by the screening method employed, diagnostic criteria used, and the population tested.[1] The criteria for the diagnosis of GDM, as proposed by the International Association of Diabetes and Pregnancy Study Group (IADPSG) in 2010, are based on the results of the Hyperglycemia and Adverse Pregnancy Outcomes (HAPO) study.[2]

The criteria for the diagnosis of GDM has evolved over the years with different organizations reviewing their criteria in response to the latest research. The HAPO study correlated adverse pregnancy outcomes to levels of hyperglycemia noted during pregnancy. The study demonstrated that adverse maternal and perinatal outcomes could occur at levels of hyperglycemia that were thought not to be sufficiently elevated enough to merit a diagnosis of GDM. [3-6]

Following recommendations by the IADPSG, there has been research around the world, especially in Western countries studying; the prevalence, decision to treat or not to treat mild hyperglycemia, which therapy to implement, maternal and fetal outcomes, especially for mild hyperglycemia, and cost-effectiveness of adopting the IADPSG criteria. [7-9]

The capacity for adopting and implementing the IADPSG criteria is critical for healthcare services all over the world. This is more so in low and medium-income countries like Nigeria, with very limited resources for screening and treatment. One of the difficulties of managing hyperglycemia in pregnancy is the absence of local guidelines backed by evidence from local studies.[10]

There is, therefore, the need for community-based surveys to evaluate abnormal oral glucose tolerance in pregnancy in the general population that will involve both the booked and un-booked pregnant women.

The aim of this study was to compare abnormal oral glucose tolerance results using the WHO and IADPSG criteria amongst pregnant women in Ushafa community, a rural community.

METHODOLOGY

Study Area

Ushafa is a rural community in Bwari Area Council, Abuja FCT, Nigeria. The population of Ushafa has been put at 25,000 of which 5,500 are females of age 15 to 49 years. Bwari is one of the 6 area councils in the Federal Capital territory with a population of 229,274 (National Census 2006).[11] The Federal Capital Territory Abuja is located, in the North central geopolitical region of Nigeria, occupying a land area of 7,315 square kilometers with a population of 1,406,239 of which 673,067 are females.[11] Abuja falls within latitude 8.25^0 and 9.2^0 north of the equator and longitude 6.45^0 and 7.35^0 east of the Greenwich meridian.

Study Design

This was a cross-sectional study carried out among pregnant women in Ushafa community between December 2019 and March 2020. Participants in the study were selected using cluster sampling method. Each woman in the study was allotted to one of the five social classes based on the scoring system designed by Olusanya et al.[12]

Consenting pregnant women in Ushafa community within the gestational age of 24-28 weeks who were permanent residents in Ushafa community were included in the study. Pregnant women excluded from the study were those who declined consent to participate, women with pre gestational diabetes mellitus, women already diagnosed with GDM, women who opted out of the study, women on certain medications: steroid therapy, highly active retroviral medication. Ethical clearance was obtained from the Health Research and Ethics Committee of the Federal Capital Territory, Abuja with number NERC/01/02/004.

Sample Size Determination

The sample size was calculated using the statistical formula of Fischer: n=2z2 pq/d2 [20], where:

n = the desired sample size,
z = the standard normal deviation, usually 1.96, which corresponded to the 95% confidence interval,
p = best estimate of prevalence in the target population expressed as a fraction of 100%. In this case, prevalence from the study in Jos (20.2%), Nigeria [10] which is close to the study area, was taken.
Therefore, P = 0.202.
q = complementary proportion, (1-p) which is 1- 0.202 = 0.798.
d = degree of accuracy desired (absolute precision) = 0.1.

The sample size was adjusted to compensate for an attrition rate of 10%, to 136. This was rounded up to 150 to increase the strength of the study. Therefore, a total of 150 pregnant women were recruited for the study.

Specimen Collection and Processing

During the survey, following the completion of the questionnaire by each participant, the 75-g standard OGTT test was performed with the use of an anhydrous glucose drink taken in the morning, after an overnight fast for a minimum of 10 hours. Each woman was appropriately counseled to maintain her normal diet 3 days before the OGTT and not ingest any drink or food

during the duration of the OGTT. Venous blood samples for glucose profiles were collected in fluoride-oxalate bottles at FBS, and 1 and 2 h post-ingestion. All the samples were subsequently racked and coded according to identification numbers on the questionnaires and transported in ice packs after completion of fieldwork for that day, to the chemical laboratory in Garki Hospital, Abuja for analysis.

The samples were analyzed using a standardized laboratory protocol based on the glucose oxidase enzymatic method. In this process, glucose is oxidized to glucuronic acid and hydrogen peroxide, catalyzed by glucose oxidase. Subsequently, peroxidase reduces hydrogen peroxide to water and oxygen. The released oxygen is then absorbed by a chromogen, resulting in a colour change to purple, which indicates the presence of glucose. To perform the analysis, 1ml of glucose reagent was added to each 10ul of standard and sample. These were then mixed and incubated at 37ºC for 10 minutes. The absorbance is measured at 505nm by the spectrophotometer (EMP 168 Biochemical Analyzer).[13] After field and laboratory work, extracted data from the questionnaire was collated in a spreadsheet for analysis.

Our primary outcome measure was the proportion of women diagnosed with an abnormal OGTT for any of the diagnostic criteria comprising 1999 WHO,[14] and IADPSG criteria.[2] The WHO 1999 diagnostic criteria defined GDM as either a fasting plasma glucose (FBS) level of 7 mmol/l and/or 2-h glucose level 7.8 mmol/l. The IADPSG criteria define GDM as values of (5.1mmol/l, 10mmol/l, 8.5mmol/l) for fasting, 1-hour, and 2-hour OGTT glucose concentration respectively.[2]

Data Analysis

Data was analysed using the Statistical Package for Social Sciences (SPSS) computer software version 23.0 for Windows. Categorical (quantitative) variables were presented in frequencies and percentages. Independent t-test, Chi-square test, logistic regression, and correlation analysis were applied. Figures were presented in Venn diagrams, tables, and scatter diagrams. The level of significance $P<0.05$ was considered statistically significant.

RESULTS

A total of one hundred and fifty pregnant women were recruited into the study and completed the 75g oral glucose tolerance test. The general profile of the study population is depicted in Table 1. The mean age was 29.9 ±4.2 years (95% CI: 29.2 – 30.6 years) with a range of 20-41 years. Mean gestational age was 26.5 ±1.3 weeks with a range 24-28 weeks. Mean gravidity, parity 2.86 ± 1.39 (range of 0-6). Only 30.7% of the participants registered for antenatal care. A larger proportion of the population (61.3%) had no risk factor for GDM, while 24%, 9.3% and 5.3% had one risk factor, two risk factors and three risk factors respectively.

Table 2 shows the prevalence of abnormal oral glucose tolerance test for the diagnosis of GDM according to the WHO (1999) and IADPSG diagnostic criteria. The results show that a total of 14 women (9.3%) and 23 women (15.3%) had GDM according to WHO (1999) and IADPSG diagnostic criteria respectively. There was no significant difference between the two criteria in detecting GDM ($P>0.05$). The odds ratio- OR= 1.759 (95% CI: 0.868 – 3.568). Ten women (6.7%) met the criteria for GDM using both the IADPSG and WHO criteria, whereas a total of 27 (18.0%) participants had GDM with any of the two criteria.

Among the 14 women who met the WHO 1999 criteria for detecting GDM, 5 (35.7%) had no risk factor, while another 5 (35.7%) and 4 (28.6%) had one and two risk factors, respectively. In comparison, of 23 women who met the IADPSG criteria, 8 (34.8%) had no risk factors, 11 (47.8%), 3(13%) and 1(4.3%) had one risk factor, two risk factors and three risk factors respectively, Table 3.

Among the 23 participants who met the IADPSG criteria in detecting GDM, 9 (39.1%) had a history of previous macrosomia, 4 (17.4%) family history of diabetes, 2 (8.7%) had weight greater or equal to 90kg, 3 (13%) had BMI greater or equal to 30kg/m^2, 1 (4.3%) each had glycosuria and recurrent miscarriages. Of the 14 who met the WHO criteria 6 (42.9%) had a history of macrosomia, 2 (14.3%) had weight greater or equal to 90kg, 3 (21.4%) had BMI greater or equal to 30, 1 (7.1%) each had glycosuria and family history of diabetes. There was no premorbid history of polyphagia, polydipsia, polyuria, weight loss, previous unexplained stillbirth, previous GDM, and previous babies with anomaly among the GDM participants in the study, Table 3.

The multivariate logistic regression analysis showed that only age greater than 34 years was a predictive risk factor after a 75gram, oral glucose tolerance test for GDM. The odds ratio was compared against those < 25 years. An odds ratio of 0.229 (0.099-0.900) indicates that the odds of having elevated GDM was 77.1% less likely in the age group less than 25 years than those > 34 years P=0.032, Table 4.

Incidence of previous macrosomia was a significant risk factor (OR=2.838; 95% CI: 1.101-7.315; P=0.031). This means that the odds of having GDM was 2.838 times or 83.8% more likely among pregnant women with a history of previous macrosomia. BMI ≥ 30.0kg/m^2 was also noted to be a significant risk factor, (OR=1.416; 95% CI: 1.055-1.902; P=0.021). This means that the odds of having GDM were 1.461 times or 83.8% more likely among pregnant women with BMI ≥ 30.0kg/m^2. Of note, the odds of GDM were higher among women with recurrent miscarriages, weight ≥90kg, and those with family history of diabetes (OR: 6.327; 95%CI: 0.375 –

Table 1: General Profile Of The Study Population

Variable	Statistic
Age (years); Mean± SD [Frequency]	29.9 ± 4.2 [150]
Gestational age (weeks); Mean± SD [Frequency]	26.5 ±1.3 [150]
Gravidity; Mean ± SD [Frequency]	2.86 ±1.39 [150]
Parity; Mean ± SD [Frequency]	1.72 ± 1.23 [150]
No. of children alive; Mean ± SD [Frequency]	2.00 ± 1.00 [121]
Duration of stay in the community in years; Median; (IQR) [Frequency]	4.00 (2.00 – 7.00) [150]
Educational status	
Basic/Primary; Frequency (%)	36 (24.0)
Secondary; Frequency (%)	81 (54.0)
Tertiary; Frequency (%)	33 (22.0)
Religion	
Christianity; Frequency (%)	88 (58.7)
Islam; Frequency (%)	62 (41.3)
Social class	
I; Frequency (%)	0
II ; Frequency (%)	0
III; Frequency (%)	40 (26.7)
IV; Frequency (%)	95 (63.3)
V; Frequency (%)	15 (10.0)
Antenatal care booking	
No; Frequency (%)	104 (69.3)
Yes; Frequency (%)	46 (30.7)
No risk factor	102 (68.0)
One risk factor; Frequency (%)	41 (27.3)
Two risk factors; Frequency (%)	5 (3.3)
Three risk factors; Frequency (%)	2 (1.3)

Table 2: Comparison of the Prevalence of Abnormal Oral Glucose Tolerance Against Normal Patients Using The IADPSG and WHO Criteria in the Study

Parameter	Gestational Diabetes Miletus		Odds Ratio (95% CI)	Fisher's exact p value
	WHO criteria N (%)	IADPSG criteria N (%)		
Elevated	14 (9.3)	23 (15.3)	OR= 1.759 (95% CI: 0.868 – 3.568)	0.079
Normal	136 (90.7)	127 (84.6)		
Total	150 (100.0)	150 (100.0)		

Table 3: Frequency of Risk Factors in Women with Abnormal Oral Glucose Tolerance Test Results.

Risk factors	Gestational Diabetes Miletus		
	WHO criteria (N=14) N (%)	IADPSG criteria (N=23) N (%)	P value
None	5 (35.7)	8 (34.8)	
One risk factor	5 (35.7)	11 (47.8)	
Two risk factors	4 (28.6)	3 (13.0)	
Three risk factors	0 (0.0)	1 (4.3)	
Parameter			
Previous macrosomia	6 (42.9)	9 (39.1)	0.439
Glycosuria	1 (7.1)	1 (4.3)	
Family history of diabetes	1(7.1)	4 (17.4)	0.180
Recurrent miscarriages	0 (0.0)	1 (4.3)	
Weight ≥90 kg	2 (14.3)	2 (8.7)	
BMI ≥ 30.0Kg/m^2	3 (21.4)	3 (13)	

Table 4: Multivariate logistics regression analysis between the socio-demographic factors, clinical risk factors and abnormal OGTT

Parameter	B	Exp (B) Odds ratio	(95% CI)	P value
Age (>34years)	-1.207	0.299	0.099-0.900	0.032**
Mother's Education	0.534	1.367	0.468 – 4.198	0.550*
Mother's occupation	-0.231	0.794	0.615- 1.024	0.075*
Ethnic group	0.178	1.195	0.736 – 1.941	0.472*
Religion	-0.705	0.495	0.189- 1.294	0.151*
Social class	1.044	2.842	0.805 -10.320	0.405*
Duration of stay	0.218	1.244	0.388- 3.989	0.713*
Marriage type	-0.013	0.987	0. 874– 1.115	0.838*
Previous macrosomia	1.043	2.838	1.101-7.315	0.031**
Recurrent miscarriages	1.845	6.327	0.375 – 106.720	0.201*
Family history of diabetes	0.374	1.455	0.422- 5.012	0.554*
Glycosuria	-0.051	0.950	0.103-8.763	0.969*
Weight ≥90kg	0.460	1.583	0.399-6.286	0.514*
BMI≥ 30.0Kg/M^2	0.348	1.416	1.055-1.902	0.021**

**P differences statistically significant at P<0.05; *P differences not statistically significant at P> 0.05 Variables documented as at the time of OGTT

106.720, OR: 1.583; 95%CI: 0.399 – 6.286 and OR: 0.374; 95%CI: 0.422- 5.012) respectively but it was not statistically significant (P>0.05), Table 4.

Comparative analysis of predictive risk factors among GDM patients using IADPSG criteria and WHO criteria, demonstrated only BMI was seen to be significant when comparing WHO 1999 and IADPSG criteria and their association with risk factors. When compared to patients with normal BMI using IADPSG, the relative risk of OGTT increased with BMI. The risk of elevated glucose plasma level was 2.229 (95%CI: 0.289-30.150; *P*=0.048) times more among patients with a BMI 25.0-29.9(kg/m^2) and 3.654 (95%CI: 0.317-42.138; *P*=0.030) times more ≥30 (kg/m^2) when compared with those with BMI < 25 kg/m^2.

DISCUSSION

In this study, we aimed to address the growing burden of gestational diabetes mellitus (GDM) by comparison of two diagnostic criteria—the WHO 1999 and the IADPSG—in detecting abnormal oral glucose tolerance test (OGTT) results among pregnant women in the rural Ushafa community of North-central Nigeria. Our principal findings indicate the overall prevalence of GDM using either or both of the WHO 1999 and IADPSG criteria was 18%, the prevalence of GDM was increased when using the IADPSG criteria (15.3%) compared to the WHO 1999 criteria (9.3%).

The prevalence using the IADPSG criteria was similar to that found in the HAPO study, which was 17.8%.[5,15] The finding was less prevalent when compared to other similar studies,[10,16] Imoh and colleagues had a prevalence of 15.9% and 20.2% for WHO 1999 and IADPSG criteria respectively,[10] this was in tandem with another study conducted by Imoh and colleagues.[16] This increase in prevalence could be accounted for, by the conduct of their studies in an urban center with an already preselected group of women who do not represent the general population.

The increase in the prevalence of women diagnosed with GDM using the IADPSG criteria as compared to the WHO criteria in this study was similar to findings from other studies.[10,17] Statistical analysis performed showed that this difference was not significant, the odds ratio- OR= 1.759 (95% CI: 0.868 – 3.568) [p = 0.139]. The increase found was mainly because of the reduced fasting blood glucose level of 5.1 mmol/L used in the IADPSG criteria.

This increase in the frequency of GDM due to a reduction in the fasting blood glucose levels with the IADPSG criteria was also described by Olagbuji and colleagues where 7.4% of the diagnosis of GDM using the IADPSG criteria was made with the fasting blood glucose level as against 0.9% with the WHO 1999 criteria.[17] Using the IADPSG criteria in this study, the diagnosis of GDM was made exclusively using the fasting blood glucose in 11.3% of cases. The prevalence of GDM in this study using the IADPSG criteria was 1.6 times higher than the prevalence with the WHO criteria.

Regarding the role of universal screening which is recommended by the IADPSG[2] as against selective screening, which is widely practiced in Nigeria[1] and recommended by DAN[19], a significant proportion of women who met one or both criteria did not have risk factors for GDM. About 5 (35.7%) and 8 (34.8%) women did not have risk factors and were diagnosed with WHO 1999 and IADPSG criteria respectively. This finding underscores the relevance of universal screening in our obstetric population. This is similar to findings by Olagbuii and colleagues, where 20% of the women who were diagnosed using universal screening strategy would have been missed on selective screening.[17] However the values in this study are larger than those gotten in Olagbuji and colleagues' study, this maybe on account of a smaller number of participants in this study and the poor utilization of antenatal care by women in rural communities. Therefore, women would not be aware if they had GDM in previous pregnancies, and testing for glycosuria will also not be possible.

The socio-demographic profile of patients with elevated plasma glucose criteria was comparable using IADPSG/WHO criteria (*P* > 0.05). Age was the only socio-demographic factor that had a significant relationship with abnormal OGTT results. The mean age was 29.9 ±4.2 years. The multivariate logistic regression analysis showed that only age ≥35years was a predictive risk factor after a 75gram, oral glucose tolerance test. The odds ratio was compared against those < 25years. An odds ratio 0.229 (0.099-0.900) indicates that the odds of having elevated GDM was 77.1% less likely in this age group than those greater than 34 years *P*=0.032. This is similar to other studies where age >30 years has been to shown to be a risk factor for GDM.[20,21]

Gestational diabetes mellitus was more common among multiparous women 65.2% vs. 78.6% using IADPSG criteria vs. WHO criteria. This is similar to findings from other studies where multiparity has been associated with an increased risk of GDM.[7,22] The mean gestational age was 26.5 ±1.3, there was no statistical significant difference between the gestational age of women who met the WHO 1999 and IADPSG criteria.

This study shows that risk factors associated with gestational diabetes mellitus, based on the WHO 1999 or IADPSG criteria are significantly higher in women with previous history of macrosomia, increased BMI (>25kg/m^2), recurrent miscarriages, family history of diabetes and glycosuria. These increased risks persisted in women with, increased BMI and macrosomia after adjustment on multivariable regression analysis. In addition, when the WHO 1999 and IADPSG criteria were compared, increased BMI was the only independent risk factor for gestational diabetes in the study population who met the IADPSG criteria.

Incidence of previous macrosomia was a significant risk factor using both criteria, with OR=2.838. This means that the odds of having GDM was 2.838 times or 83.8% more likely among pregnant women with a history of previous macrosmia. The risk factors associated with GDM in this study was similar to findings in other studies.[16,17,20,21]

The findings suggest that adopting the IADPSG criteria over the WHO 1999 criteria for diagnosing GDM could lead to improved detection and capturing more cases that might otherwise go untreated. Implementing the IADPSG criteria and universal screening could help standardize GDM diagnosis, improving early intervention efforts. Universal screening, as demonstrated in this study, would help to reduce the rate of missed GDM cases, which is especially relevant in populations with a growing burden of diabetes and limited healthcare access. This is critical, as undiagnosed GDM is associated with increased risks of adverse outcomes.

The strengths of the study include the study's sample size which enhances the generalizability of its findings, reducing the impact of random variation. Participants were chosen using cluster sampling methodology, reducing bias error. Additionally, the study addresses a significant gap in research by focusing on the implications of GDM diagnosis criteria in the general population in a rural community, avoiding the bias of a preselected population in a hospital setting. Therefore, the findings apply to the wider population. However, the limitations of the study include a single community survey, this may limit the generalizability of the findings to other settings or populations with different demographics and healthcare resources. The study did not address long-term maternal and neonatal outcomes, which would provide a fuller picture of the benefits of early GDM diagnosis. In summary, while the study is well-designed and offers actionable insights, future research in diverse populations, ideally with prospective and multicenter/community approaches, would further validate these findings and address its limitations.

CONCLUSION

This study showed an increase in the prevalence of abnormal oral glucose tolerance tests when comparing IADPSG to WHO 1999 criteria. This data most likely reflects the true estimate of maternal hyperglycaemia in our region, a unified diagnostic approach is essential in streamlining care. This consensus is a step towards standardized care, reducing variability in diagnosis and treatment across different healthcare settings.

Approximately 35% of GDM cases would have been undiagnosed if selective screening was utilized. This suggests that a universal screening-based approach would considerably prevent missed opportunities for the identification of gestational diabetes and the prevention of adverse outcomes. Similar community studies using larger population sizes should be conducted in different regions of the country to provide more data.

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