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Screening of Gestational Diabetes Mellitus in a West African Population: A Comparison of Systematic vs. Targeted Approaches

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Abstract

Background: Gestational diabetes mellitus (GDM) is a growing global health concern, with early detection plays a crucial role. The International Association of Diabetes and Pregnancy Study Groups (IADPSG) has established threshold values for the diagnosis of GDM. However, the choice between targeted or systematic screening is left to each country's discretion based on local prevalence rates. The main objective of our study was to assess the most suitable screening strategy in a West African population. **Methods:** We conducted a single-center, retrospective study on GDM screening among pregnant women attending prenatal care in the gynecology department of the National Hospital Center Dalal Jamm (CHNDJ) from January 1, 2023, to December 31, 2023. Inclusion criteria were patients who performed at least one prenatal consultation at CHNDJ and GDM screening using either fasting plasma glucose (FPG) or oral glucose tolerance test (OGTT). Non-inclusion criteria were FPG ≥ 126 mg per deciliter (6.93 mmol per liter). Patients on group 1 had at least one of the following risk factors: age ≥ 35 years, BMI ≥ 25 kg per m^2 , personal or first-degree family history of diabetes, or birth weight ≥ 4000 grams. Patients without risk factors listed above were in group 2. **Results:** 326 patients were included in the final analysis among them 92 realized a double screening with PFG followed by OGTT, 208 patients did only the PFG test and 26 patients the OGTT. Prevalence of GDM was 24% in group 1 and 7% in group 2 (p = 0.003). Regarding, FPG test, 37 (24.8) patients attended pathologic values in group 1 versus 13 (8.6) patients, (p = 0.003). For the OGTT test, 13 (22.4) patients were diagnosed in group 1 versus 2 (2.3) patients in group 2, (p = 0.001). The cost per positive case for PFG was 13 USD in group 1 and 37 USD in group 2. Regarding OGTT, the cost was respectively 71 USD and 488 USD. **Conclusion:** In a West African population, systematic screening using FPG

during the first trimester, followed by targeted OGTT screening, appears to be a reasonable compromise, effectively balancing benefits and risks.

Keywords

Gestational Diabetes Mellitus, Screening, Senegal

1. Introduction

Gestational diabetes mellitus (GDM) is a condition revealed by pregnancy. It is defined by the World Health Organization (WHO) as any degree of glucose intolerance leading to hyperglycemia of varying severity, which begins or is first diagnosed during pregnancy, regardless of the required treatment or postpartum outcomes [1].

Hyperglycemia is responsible for both maternal and fetal complications, with a linear association [2]. The Hyperglycemia and Adverse Pregnancy Outcomes (HAPO) study demonstrates that increasing maternal plasma glucose levels are associated with a higher risk of birth weight above the 90th percentile for gestational age, primary cesarean delivery, neonatal hypoglycemia, and maternal conditions such as preeclampsia among others [2].

The diagnostic criteria for gestational diabetes mellitus (GDM) have evolved over the years, leading to an increase in its prevalence and establishing it as a significant public health concern [3] [4]. The International Association of Diabetes and Pregnancy Study Groups (IADPSG) established diagnostic thresholds for GDM, based on the results of the HAPO study [5]. Screening and diagnosis play a crucial role in GDM management, however, there is still no global consensus or standardization regarding the most appropriate screening method [5] [6]. Over time, GDM screening guidelines have shifted from systematic screening to a more targeted approach, utilizing either a one-step or two-step method [7]. For women at high risk of GDM, most guidelines recommend screening during the first trimester using an oral glucose tolerance test (OGTT) or fasting plasma glucose (FPG). In low-risk population, most of the guidelines recommend a one-step screening strategy [7].

However, in low and middle-income countries, GDM screening remains a challenge, particularly due to limited healthcare resources and restricted access to diagnostic tests [6] [8]. A 2014 study conducted at the Endocrinology and Diabetology Department of the National Hospital Center of Pikine in Senegal reported a GDM prevalence of 34.3% using IADPSG criteria [9]. Given these challenges, the need for a context specific screening strategy tailored to local epidemiology and healthcare infrastructure is now indisputable. The key question remains which screening strategies is most suitable for our population between targeted and systematic screening.

We conducted a retrospective study to evaluate GDM screening based on the

presence of risk factors, following the recommendations of the French National College of Gynecologists and Obstetricians (CNGOF). This approach was compared to screening without risk factors among pregnant women who received prenatal care at the National Hospital Center Dalal Jamm between January 1, 2023, and December 31, 2023. The main objective was to assess the prevalence of GDM and determine the most efficient screening strategy between targeted and systematic screening, using FPG and the OGTT 75 grams.

2. Methods

We conducted an observational, retrospective, cross-sectional and single-center study within the Gynecology-Obstetrics Department of the Dalal Jamm National Hospital Center in Senegal, West Africa. The study period extended from January 1, 2023, to December 31, 2023. All patients meeting the following criteria were included in the study: having attended at least one prenatal consultation at CHNDJ, and undergone GDM screening through FPG measurement and/or an OGTT with 75 grams of glucose. The non-inclusion criteria was FPG ≥ 126 mg per deciliter (6.93 mmol per liter).

The included patients were divided into two groups, the first group consisted of patients with at least one of the following risk factors: age ≥ 35 years, body-mass index (BMI) ≥ 25 kg per m^2 , personal history of GDM or previous delivery of a newborn weighing > 4000 grams, first-degree family history of diabetes. The second group included patients without any identified risk factors among those listed above.

Data were anonymously extracted from the e-Gynecologie® database, which is used in our unit. This prospective database is currently used during consultations to record clinical data. We collected socio-demographic data, personal and obstetric history, first-degree family history of diabetes, screening results (FPG and OGTT values), gestational age at the time of testing and pregnancy and neonatal outcomes in Excel 2019. The data were analyzed using RStudio ®. Mean ± standard deviation (SD) are reported for continuous variables, and number and percentage are reported for categorical variables. Groups comparisons were conducted using the Mann-Whitney test for continuous variables. Pearson's Chi-Square Test or Fisher's Exact Test was used depending on the sample size for qualitative variables. The global cost per positive case was calculated by dividing the total screening cost by the number of positive cases. The threshold for statistical significance was set to $p < 0.05$.

3. Results

A total of 508 patients attended at least one prenatal care during the study period. Among the patients, data for the GDM screening were unavailable for 180 patients because they did not undergo the necessary test. 328 patients were included. Two patients met the non-inclusion criteria as they had FPG superior to 126 mg per deciliter. Consequently, 326 patients were included in the final analysis, 92 pa-

tients realized a two-step screening with PFG performed in first trimester followed by OGTT between 24 - 28 weeks of gestation. Two hundred and height patients did only the PFG test and 26 patients the OGTT (Figure 1).

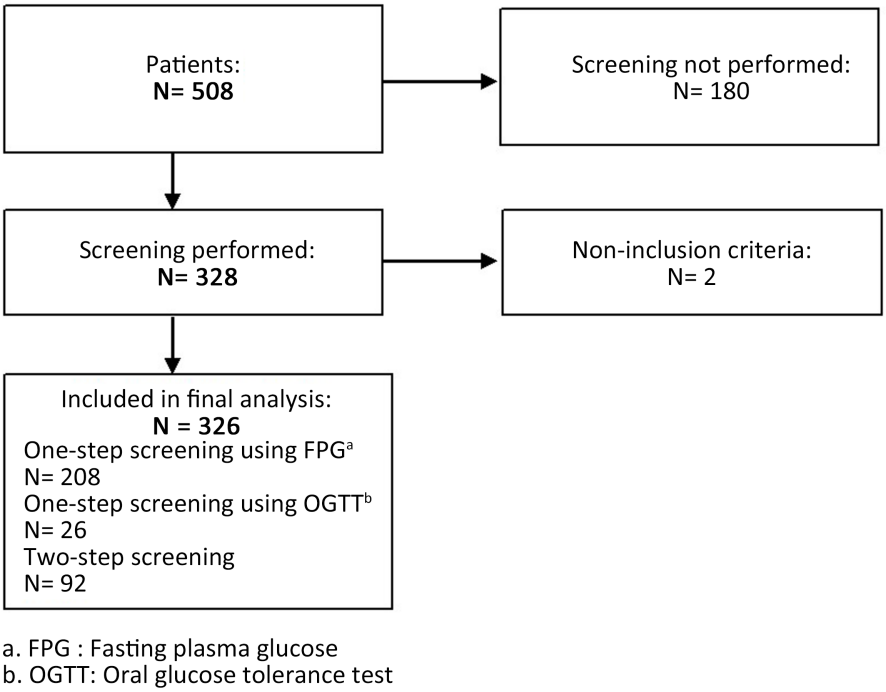

Figure 1. Flow chart of the study.

3.1. Socio-Demographic Characteristics

Table 1 summarizes the epidemiological characteristics of patients. Seventy-one (21.8) were aged greater or equal to 35 years, 111 (34) had a BMI greater or equal to 25 kg per $m^2$and 3 (0.9) had a personal history of GDM. A first-degree family history of diabetes was found in 35 patients (10.7). Fifty-seven (17.5) patients had 2 or more identified risk factors of GDM (Table 1).

Table 1. Epidemiological characteristics

Characteristics	Participants N = 326
Age, mean ± SD	29 ± 6
Years ≥ 35, n (%)	71 (21.8)
Body-mass index, mean ± SD	24 ± 5
Body-mass index ≥ 25, n (%)	111 (34)
Family history of diabetes, n (%)	35 (10.7)
Personal history of GDM[a] n (%)	3 (0.9)
Hypertension, n (%)	6 (1;8)
Identified risk factors ≥ 2 n (%)	57 (17.5)

a. GDM: gestational diabetes mellitus.

3.2. Comparison of Targeted versus Systematic Screening Using Fasting Plasma Glucose Analysis

A total of 300 patients underwent screening using FPG, including 149 in Group 1 and 151 in Group 2 (Table 2). Among those screened in Group 1, 37 patients (24.8) had GDM versus 13 (8.6) patients in Group 2 (p = 0.003). However, the mean FPG among patients diagnosed with GDM did not differ significantly between groups (Table 2).

Regarding GDM management, 6 (16.3) patients in Group 1 required insulin therapy. Whereas, no patients in Group 2 required insulin therapy (p = 0.01). The prevalence of cesarean section was higher in Group 1 (35%) compared to Group 2 (p = 0.01). There was no significant difference in neonatal outcomes between the two groups (Table 2).

Table 2. Comparison of targeted versus systematic screening using fasting plasma glucose.

Variables	Participants N = 300		
	Groupe 1 N = 149	Groupe 2 N = 151	p value
FPG[a] ≥ 92 mg per deciliter n (%)	37 (24.8)	13 (8.6)	**0.003**
FPG[a] ≥ 92 mg per deciliter mean ± SD	0.98 ± 0.06	0.95 ± 0.02	NS[b]
Insulin therapy n (%)	6 (16.3)	0	**0.01**
GDM[c] patients			
Week of gestation at delivery mean ± SD	38 ± 2	38.4 ± 1	NS[b]
Caesarean delivery due to diabetes n(%)	13 (35)	0	**0.01**
Preterm delivery n (%)	3 (8)	0	NS[b]
Weight of birth >90th n (%)	2 (5)	0	NS[b]
Weight of birth mean ± SD	2981 ± 801	2738 ± 644	NS[b]

a. FPG: Fasting Plasma Glucose; b. NS: non significative; c. GDM: Gestational Diabetes Mellitus.

3.3. Comparison of Targeted versus Systematic Screening Using Oral Glucose Tolerance Test

Fifty-eight patients underwent OGTT in group 1 and 61 patients in group 2. Values was pathologic for 13 (22.4) patients in Group 1 compared to 2 (3.2) patients in Group 2, (p = 0.001). There was no statistically significant difference in maternal and neonatal outcomes for patients diagnosed with GDM by OGTT (Table 3).

Table 3. Comparison of targeted versus systematic screening using oral glucose tolerance test.

Characteristics	Participants N = 118		
	Groupe 1 N = 58	Groupe 2 N = 61	p value
OGTT[a] pathologic n (%)	13 (22.4)	2 (3.2)	**0.001**

Continued

Insulin therapy n (%)	2 (15.3)	0	NS[b]
GDM[c] patients			
Week of gestation at delivery mean ± SD	38.1 ± 1	39 ± 1	NS[b]
Ceasarean delivery due to diabetes n (%)	4 (30.7)	0	NS[b]
Preterm delivery n (%)	1	0	NS[b]
Weight of birth > 90th n (%)	1	0	NS[b]
Weight of birth mean ± SD	3206 ± 564	3089 ± 354	NS[b]

a. OGTT: Oral Glucose Tolerance Test; b. NS: Non Significative; c. GDM: Gestational Diabetes Mellitus.

3.4. Prevalence and Cost Analysis of Screening

In our study, the overall GDM prevalence was 20%. For patients in Group 1, the prevalence was 24%, compared to 7% in Group 2, (p = 0.003) (Table 4).

The cost of FPG was 3.2 USD, the cost per positive case was 13 USD for patients with GDM risk factors and 37 USD for patients without identified risk factors. The cost of the OGTT cost was 16 USD, resulting in a cost per positive case of 71 USD for patients in group 1 and 488 USD for patients in group 2 (Table 4).

Table 4. Cost analysis of screening and prevalence of gestational diabetes mellitus.

Characteristics	Participants N = 326		
	Groupe 1	Groupe 2	p value
Cost per positive case for FPG[a] (USD[b])	13	37	-
Cost per positive case for OGTT[c] (USD[b])	71	488	-
Prevalence of gestational diabetes mellitus	24	7	0.003

a. FPG: Fasting Plasma Glucose; b. USD: United States Dollars; c. OGTT: Oral Glucose Tolerance Test.

4. Discussion

4.1. Mains Findings

Our study compared the effectiveness and medico-economic impact of GDM screening depending on risk factors. We highlighted the benefit of targeted screening compared to systematic screening with an acceptable cost-effectiveness balance.

4.2. Interpretation

The overall prevalence of GDM in our study-population was 20%, which aligns with reported GDM prevalence data in sub-Saharan African region [8] [10]. Wang *et al.* estimated the prevalence to 14.2 (14.0 – 14.4) in Africa with the IADPSG criteria and universal OGTT strategy [3]. The evolution and adoption of IADPSG

criteria increased the prevalence of GDM [4] [11] [12]. Nevertheless, the significant prevalence observed in our study may be influenced by the fact that our unit is a reference center for obstetric care. In our study-population, we accessed the effectiveness of targeted screening compared to systematic screening. Thirteen (8.6%) patients were diagnosed with GDM through systematic screening using FPG analysis, while 3.2% were diagnosed using OGTT. The high prevalence of GDM diagnosed by FPG among patients without identified risk factors suggests the need to adapt risk factor criteria to each population. Natamba *et al.* identified tailored risk factors for sub-Saharan African populations, finding that women older than 25 years had a relative risk of 1.7 (1.2 - 2.4), the most impacting risk factors were history of GDM, history of stillbirth and macrosomia [13]. Less than 1% of patients had a personal history of GDM, which could be explained by undiagnosed GDM in previous pregnancies due to lack of formalized guidelines in our context. Our population is at high risk of GDM, 34% had a BMI greater than 25 kg per m^2, and 21.8% were aged 35 years or older. It appears that the prevalence of GDM increases with maternal age, and BMI [14]. Makgoba *et al.* found that the odds ratios for GDM were increased for white Europeans older than 30 years ($p < 0.001$), while for black Africans, the risk increased for women older than 25 years ($p < 0.001$) [15]. However, further studies are needed to confirm the low incidence of complications in systematically diagnosed GDM using IADPSG criteria. Therefore, it is urgent to define adjusted and adapted cut-off values for risk factors. So, it would be interesting in further study to determine the most predictive factors of GDM. Identifying risk factors for GDM helps refine screening strategies and improve effectiveness.

Patients diagnosed with GDM despite having no identified risk factors did not experience significant complications. Notably, GDM management in these patients did not require the use of insulin. In fact, GDM-related complications are correlated with glucose levels [2]. Regarding neonatal outcomes, macrosomia appears to be the primary complication, particularly in cases of inadequate management [16]. Most of these patients were diagnosed using the FPG test. The IADPSG established diagnostic criteria using FPG for earlier pregnancy by consensus. However, further studies are needed to confirm the low incidence of complications in GDM cases diagnosed systematically using the IADPSG criteria.

These results raise questions about the cost-effectiveness and impact of OGTT screening in low-risk patients. Moreover, OGTT is not only expensive but also poorly tolerated, making its systematic use less relevant. Most current guidelines adopt targeted screening to improve diagnosis while maintaining acceptable costs [7]. The integration of medico-economic data is essential in determining the most appropriate screening strategy. The cost of OGTT for patients without risk factors is significant compared to its low benefit-risk balance. Our study showed that in this population, even in cases of GDM, complications are minimal and can be effectively managed with lifestyle and dietary measures.

Based on our findings, further studies are necessary to develop high-quality

guidelines for GDM screening. Considering our results, we recommend a two-step approach: systematic screening during the first trimester using FPG, followed by targeted screening with a 75-grams OGTT between 24 - 28 weeks of gestation.

4.3. Strengths and Limitations

GDM screening is systematically performed in our department, which enabled us to conduct this study. However, its retrospective nature remains a limitation due to missing data and potential biases related to data collection. Additionally, most patients in our study had to pay for prenatal care, this explains that the two-step approach was not possible for all. Nonetheless, given the lack of data on GDM in our population, our study provides valuable insights into its prevalence and may help refine local screening strategies.

5. Conclusion

The diagnosis of GDM is a challenging step. A combined strategy with a two-step approach could be interesting in our context. A systematic first-trimester screening using fasting plasma glucose, followed by a targeted screening with an oral glucose tolerance test appears to be an optimal compromise in terms of the benefit-risk and cost-effectiveness balance for our population.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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