A systematic review and meta-analysis of the prevalence and determinants of gestational diabetes mellitus in Nigeria

Taoreed Adegoke Azeez, Tamunosaki Abo-Briggs, Ayodeji Sylvester Adeyanju
Department of Medicine, Reddington Multi-Specialist Hospital, Lagos, 1Department of Obstetrics and Gynaecology, University College Hospital, Ibadan, Nigeria

Abstract

Background: Gestational diabetes mellitus (GDM) is any degree of glucose intolerance with onset or first diagnosis in pregnancy. GDM has numerous potential complications and it is important to estimate its burden and risk factors. The objective of the meta-analysis was to determine the pooled prevalence of GDM in Nigeria and identify its determinants. Methods: The study design was a meta-analysis; therefore the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed. Electronic databases (African Journal Online, PubMed, SCOPUS, and Google Scholar) and the gray literature were systematically searched. Statistical analysis was done with MetaXL using the random effect model. Heterogeneity was determined using the I^2 statistic and the publication bias was checked with the Doi plot. Results: The total sample size was 46,210. The prevalence of GDM in Nigeria was 0.5 – 38% and the pooled prevalence was 11.0% (95% CI 8-13). The F statistic was 99%. The Doi plot suggested some degree of bias. The most frequently reported determinants of GDM were previous macrosomic babies, maternal obesity, family history of diabetes, previous miscarriage, and advanced maternal age. Conclusion: The prevalence of GDM in Nigeria is high and efforts should be geared at modifying its risk factors so as to reduce its prevalence and prevent the associated complications.

Keywords: Gestational diabetes, meta-analysis, Nigeria, prevalence, risk factors

Introduction

Gestational diabetes mellitus (GDM) is defined as any degree of glucose intolerance whose onset or first diagnosis occurs during pregnancy.1,2 Pregnant women with pre-gestational type 1 or type 2 diabetes and (recently) overt diabetes in pregnancy are not included in GDM.2 The diagnosis of GDM implies an extra feto-maternal risk and a greater burden to the health system, especially in low-resource settings.3 The extra feto-maternal risk includes a higher incidence of Cesarean sections, pre-eclampsia, macrosomia, neonatal hypoglycemia, and jaundice.4 In the long term, such women with GDM have a higher risk of having type 2 diabetes and the babies from such pregnancies have a higher risk of developing obesity and type 2 diabetes later in life.4,5,6

The global prevalence of gestational diabetes was quoted as 1-28% and the wide range was due to differences in screening method, diagnostic criteria, ethnicity/race, and maternal age.7 In a meta-analysis, the pooled prevalence of GDM in Africa was reported as 13.6%.8,9 Kampmann et al.10 posited that data on the prevalence and risk factors of GDM in developing countries (such as Nigeria) are scanty due to paucity of research funds among others. This makes it difficult for health-care planners and governments to pay adequate attention to GDM.9 It is however remarkable that despite the huge burden of GDM, the prevalence is increasing due to the rise in its risk factors such as obesity.4,10 In separate meta-analyses on the determinants of GDM among Asians and Africans, the most common determinants were previous history of GDM, pre-gestational maternal obesity, and previous deliveries of macrosomic babies.8,11

Address for correspondence: Dr. Taoreed Adegoke Azeez, Department of Medicine, Reddington Multi Specialist Hospital, Lagos, Nigeria. E-mail: adegokegalaxy@yahoo.com

Submitted: 09-Jul-2021 Accepted: 24-Aug-2021 Published: 26-Oct-2021

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKLHRPmedknow_reprints@wolterskluwer.com

How to cite this article: Azeez TA, Abo-Briggs T, Adeyanju AS. A systematic review and meta-analysis of the prevalence and determinants of gestational diabetes mellitus in Nigeria. Indian J Endocr Metab 2021;25:182-90.
There is no universal consensus on the screening and diagnosis of GDM. Different diagnostic criteria have been proposed by various relevant bodies and associations. The various associations who have proposed different diagnostic criteria for GDM include the World Health Organization (WHO), International Association of Diabetes in Pregnancy Study Group (IADPSG), American Diabetes Association (ADA), European Association for the Study of Diabetes (EASD), Australian Diabetes in Pregnancy Society (ADIPS), American College of Obstetricians and Gynecologists (ACOG), and Japan Diabetes Society and the Canadian Diabetes Association (CDA). Pregnant women who present in the first trimester with risk factors for type 2 diabetes but who were previously undiagnosed to diabetes mellitus should be screened at the first contact with the healthcare provider. Such women are identified when the body mass index (BMI) is greater than or equal to 25.0 kg/m² in addition with another risk factor for type 2 diabetes such as sedentary lifestyle, family history of type 2 diabetes, high risk ethnic groups like Asian and Blacks, hypertension, or previous history of GDM.

It is recommended that GDM should be screened for between 24 and 28 weeks of gestation. Screening for GDM could involve the one-step or two-step approach. The one-step approach involves administering 75 g of glucose in an oral glucose tolerance test (OGTT) in the fasting state so as to determine the fasting plasma glucose, 1 hour and 2 hours’ postglucose load values. The IADPSG criteria involve this approach and the threshold values are shown in Table 1. At least one of the glucose values must be deranged. This has been adopted by the WHO (but still recommends a range to exclude overt diabetes), the Endocrine Society, and the International Diabetes Federation.

The two-step approach involves administration of 50 g of glucose in a nonfasting state and checking the random plasma glucose after 1 hour. This is termed the glucose challenge test (GCT). The threshold of 135 mg/dl is the most commonly referenced glucose level. Those who have positive GCT test are then administered the 3-hour 100-g OGTT test, which is done after 8-12 hours of overnight fast. The Carpenter and Coustan criteria are shown in Table 1. The National Diabetes Data Group (NDDG) criteria are also shown in Table 1. For the Carpenter and Coustan as well as the NDDG criteria, at least two glucose values must be deranged. The ADA and ACOG recommend that any of the approaches (either the one-step approach or the two-step approach) could be adopted in making a diagnosis of GDM.

In the past, WHO had recommended a set of criteria, often tagged the ‘WHO 1999 criteria,’ for the diagnosis of GDM. In the WHO 1999 criteria, GDM was diagnosed if FPG was greater than or equal to 126 mg/dl and/or the 2-hour postglucose load was greater than or greater than 140 mg/dl, following a 75-g OGTT. Subsequently, the WHO criteria were revised to what is known as the ‘WHO 2013 criteria’ due to the ambiguity of the 1999 criteria and the emerging evidence from the HAPO study. Using the WHO 2013 criteria, GDM would be diagnosed if the FPG is 92 – 125 mg/dl, and/or 1-hour postglucose load is greater than or equal to 180 mg/dl and/or the 2-hour postglucose load is 153 – 199 mg/dl after the administration of the 75-g OGTT test.

Lifestyle changes, including medical nutrition therapy and increased physical activity, as well as self-monitoring of blood glucose are the initial approaches to the management of GDM. The target glucose levels are – fasting plasma glucose <95 mg/dl, 1-hour postprandial glucose level less than 140 mg/dl, and 2-hour postprandial glucose level <120 mg/dl. When these targets are not achieved, there is a need for pharmacotherapy. The first line drug in the management of GDM is insulin. However, metformin and glibenclamide may also be used although they are known to cross the placenta and there is uncertainty about their long-term effects.

**Objectives**

The objectives of the study were to determine the pooled prevalence of GDM in Nigeria and to identify the associated risk factors.

**Methods**

The study is a meta-analysis and the articles used were obtained from a careful search of African Journal Online, PubMed, SCOPUS, and Google Scholar. The preprint database ‘medRxiv’ as well as the gray literature were also searched. The study was done in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The inclusion criteria were studies on GDM done in Nigeria, which also reported the prevalence of GDM and its associated determinants. In addition, the studies must have been done between 2000 and 2020. Studies on GDM done outside Nigeria or not including the frequency of GDM and/or its determinants were excluded from the meta-analysis. Studies done outside the stipulated period were also excluded. The search terms included “gestational diabetes,” “diabetes in pregnancy,” “risk factors,” “determinants,” “glucose intolerance in pregnancy,” “prevalence,” “macrosomia,” and

| Table 1: Diagnostic criteria for GDM |
|------------------------------------|
| **Criteria** | **Screening** | **FPG** | **1 h PGL** | **2 h PGL** | **3 h PGL** |
| IADPSG | None | ≥92 mg/dl | ≥180 mg/dl | ≥153 mg/dl | - |
| Carpenter and Coustan | ≥130 mg/dl or ≥135 mg/dl or ≥140 mg/dl | ≥95 mg/dl | ≥180 mg/dl | ≥155 mg/dl | ≥140 mg/dl |
| NDDG | Same as Carpenter and Coustan | ≥105 mg/dl | ≥190 mg/dl | ≥165 mg/dl | ≥145 mg/dl |
The authors independently scrutinized the abstracts as well as the main texts of the studies. The decision to include the relevant studies was based on the eligibility criteria and independent endorsement by the majority of the authors. The Excel spreadsheet was employed for the initial data extraction, collation, and scrutiny. The outcome variables of interest were the prevalence of GDM, the identified risk factor, the sample size, the geographic region, and the type of study. The quality of the studies were independently assessed by the authors using the NIH study quality assessment tools for cohort, cross-sectional, and case-control studies. Ratings that were 50% and above were considered fair/good and were selected for the meta-analysis. This was arrived at by asking research-based questions appropriate for the respective study type.\(^{[11]}\) Risk of bias was assessed using the Cochrane risk of bias tool, which was done independently by the authors.

The meta-analysis was done by using Meta XL version 5.3 (EpiGear International Ltd.), a meta-analysis add-in software for Microsoft Excel. The DerSimonian Laird random effect model was utilized in the meta-analysis. I\(^2\) statistic and the Cochran’s Q test were the indicators of heterogeneity of the studies. Publication bias was assessed with the LFK index and Doi plot. Subgroup analysis was also done using the DerSimonian Laird random effect model. This was used to determine the prevalence of GDM in the various geopolitical regions and the prevalence rate using different diagnostic criteria. The PRISMA flow diagram is shown in Figure 1 below.

**Figure 1:** The PRISMA Flow diagram for selection of studies for the meta-analysis

---

**RESULTS**

The number of studies that met the eligibility criteria and were selected for the meta-analysis was 36. The studies are shown in Table 2 below. All the studies were of fair or good quality based on the criterion stated above. The total sample size was 46,210. The prevalence of GDM in Nigeria was 0.5 – 38%. The pooled prevalence of GDM in Nigeria was 11.0% (95% CI 8-13). Figure 2 shows the types of studies found eligible for the meta-analysis. They were mostly prospective studies, although a significant portion of the studies was retrospective in nature.

The forest plot of the meta-analysis is shown in Figure 3 below. Heterogeneity was tested with the F statistic and the Cochran’s Q, which were 99% and 2548 (\(P < 0.001\)), respectively. This suggests that the selected studies were heterogeneous. The LFK index was 6.85 and the Doi plot is shown in Figure 4 below. The asymmetry suggests that there must have been some degree of publication bias.

In terms of diagnostic criteria for GDM, the WHO 2013 criteria were the most commonly used diagnostic criteria accounting for about 42% of the diagnostic criteria employed in the eligible studies. About 29% of the studies utilized the IADPSG criteria for the diagnosis of GDM in their studies. The Carpenter and Coustan criteria were the least favored criteria reported among studies on GDM in Nigeria representing a paltry proportion of 4%.

Table 3 shows the results of the subgroup analysis of the meta-analysis. The prevalence of GDM varies slightly from one geo-political zone to the other. Prevalence of GDM is the highest (16%) in the North central zone (the Federal Capital Territory, Abuja is included) and the lowest (7%) in the South-south. Similarly, the prevalence of GDM depended on the diagnostic criteria used. The prevalence ranges from 5.0% (using the WHO 1999 criteria) to 20.0% (using the IADPSG criteria).

Figure 5 shows the determinants of GDM reported in various studies across Nigeria. The most commonly reported determinants of GDM in Nigeria were previous macrosomic babies, maternal obesity, family history of diabetes mellitus, advanced maternal age, and previous miscarriage(s).
Discussion

The prevalence of GDM in Nigeria, from this meta-analysis, is 0.5 – 38%. The range is quite wide partly because of the differences in the characteristics of the participants and the diagnostic criteria used in the selected studies. Jiwani et al.[63] have also quoted the global prevalence of GDM as 1-28% and the wide variation was also attributed to the disparities in the characteristics of the women, screening approach, and diagnostic criteria. The maternal characteristics that tend to vary from one study to the other include age, pregestational body mass index, parity, and previous obstetric histories.

The pooled prevalence of GDM in Nigeria as found in this meta-analysis is 11.0%. This is similar to the pooled prevalence of GDM (13.6%) in Africa as reported from a meta-analysis.[8] In addition, it is similar to the pooled prevalence of GDM in Asia (10.6%) as reported in a meta-analysis by Nguyen et al.[7] However, the prevalence of GDM in Nigeria found in this meta-analysis (11.0%) is higher than the pooled prevalence of GDM in Europe (5.4%) and the USA (7.6%).[64,65] The present meta-analysis does not explain the difference in the GDM prevalence between Nigeria and the developed Europe and America. However, it has been documented that these discrepancies may be partly explained by socioeconomic
Table 2: The characteristics of the studies selected for the analysis

| Studies                        | Year | Geopolitical zone | Study design | Prevalence (%) | Sample size |
|-------------------------------|------|-------------------|--------------|----------------|-------------|
| Adegbola and Ajayi[27]        | 2008 | South-West        | C            | 5.4            | 222         |
| Anzaku and Musa[29]           | 2009 | North-Central     | C            | 8.1            | 253         |
| Ewenighi et al.[39]           | 2010 | South-East        | C            | 4.8            | 250         |
| Kuti et al.[30]               | 2011 | South-West        | R            | 13.9           | 765         |
| John et al.[31]               | 2012 | South-South       | P            | 0.7            | 101         |
| Okeh and Okoro[32]            | 2012 | South-East        | P            | 3.7            | 1301        |
| Imoh[33]                      | 2013 | North-Central     | C            | 20.0           | 150         |
| Chukwunyere et al.[34]        | 2013 | South-West        | C            | 1.13           | 3624        |
| Oga et al.[35]                | 2014 | South-South       | R            | 3.3            | 837         |
| Fawole et al.[36]             | 2014 | South-West        | C            | 4.9            | 530         |
| Nwaokoro et al.[37]           | 2014 | South-South       | C            | 19.0           | 100         |
| Ajayi et al.[38]              | 2014 | South-West        | R            | 23.2           | 1204        |
| Bello et al.[39]              | 2015 | South-West        | P            | 2.5            | 79          |
| Salami et al.[40]             | 2015 | North-Central     | R            | 0.5            | 4755        |
| Oriu et al.[41]               | 2015 | South-South       | R            | 5.85           | 3589        |
| Askariju[42]                  | 2015 | North-East        | C            | 11.2           | 250         |
| Ugege et al.[43]              | 2015 | South-South       | C            | 3.3            | 182         |
| Agefure et al.[44]            | 2015 | South-South       | R            | 2.59           | 23996       |
| Akhidue et al.[45]            | 2015 | South-South       | P            | 15.2           | 132         |
| Olagbui et al.[46]            | 2015 | South-West        | P            | 8.6            | 1059        |
| Imoh et al.[47]               | 2016 | North-Central     | P            | 21.5           | 130         |
| Haladi[48]                    | 2017 | North-West        | C            | 21.2           | 193         |
| Atiba et al.[49]              | 2017 | South-West        | C            | 29.1           | 79          |
| Ajiboye[49]                   | 2017 | North-Central     | C            | 9.0            | 215         |
| Adefsan et al.[51]            | 2017 | South-West        | P            | 7.4            | 281         |
| Abbey & Kasso[52]             | 2017 | South-South       | R            | 21.2           | 288         |
| Oriti et al.[53]              | 2017 | South-South       | P            | 14.9           | 235         |
| Adeke et al.[54]              | 2018 | North-West        | P            | 7.7            | 207         |
| Inuku et al.[55]              | 2018 | South-West        | P            | 13.9           | 345         |
| Oga et al.[56]                | 2018 | North-Central     | C            | 8.1            | 124         |
| Awofisoye & Osaji[27]         | 2019 | North-Central     | C            | 35.6           | 180         |
| Chukwunyere et al.[57]        | 2019 | South-West        | C            | 29.0           | 100         |
| Okunowo et al.[59]            | 2019 | South-West        | P            | 24.0           | 90          |
| Olumodeji et al.[60]          | 2019 | South-West        | P            | 7.7            | 117         |
| John et al.[61]               | 2019 | South-South       | R            | 10.5           | 105         |
| Onyenekwe et al.[62]          | 2019 | South-East        | C            | 38.0           | 142         |
| Pooled                        |      |                   |              | 11.0           | 46210       |

C - Cross-sectional study, P - Prospective study, R - Retrospective study

Factors, ethnic/racial influences, and lifestyle differences.[7] Furthermore, differences in screening and diagnostic criteria as well as possible childhood exposure of Nigerian girls to undernutrition, which has been hypothesized to influence the development of GDM later in adulthood, may also explain some aspect of the differences in GDM prevalence between the developing Nigeria and the developed Europe and the USA.[66,67]

This study showed that the prevalence of GDM clearly depends on the diagnostic criteria used. The IADPSG criteria detect a higher prevalence when compared with the WHO 2013 criteria. Also, the WHO 2013 criteria are able to predict a higher prevalence when compared with the Carpenter and Coustan criteria. Previous authors have also made similar observations.[7,8,68,69] There are no universal criteria for the diagnosis of GDM. However, previous studies have reported that the IADPSG criteria has a better sensitivity than the other criteria and can detect more women with GSM.[70,71] Similarly, the one-step criteria (IADPSG and WHO 2013 criteria) have been documented to diagnose more women with GDM when compared with Carpenter and Coustan criteria that depend on the two-step approach.[18]

Over a period of about two decades, only 36 studies met the eligibility criteria for the meta-analysis. This suggests that the studies on the prevalence of GDM and its determinants are quite few in Nigeria. This is rather surprising because studies done outside sub-Saharan Africa have reported that the Black race/ethnicity seems to confer a higher risk of GDM on women and it would be expected that a large number of studies would be carried out to explore this observation further.[72]
In comparison with systematic statistic was 99%).

99%

97%

11.0

10.0‑23.0

Celen

5.0‑23.0

5.0

5.0‑11.0

Insulin resistance in


data, and previous miscarriage. The prevalence rate would

macrosomic babies, maternal obesity, family history of
diabetes, and previous miscarriage. Other determinants
include advanced maternal age (above 35 years), previous
diagnosis of GDM, hypertension, and multiparity. Studies
done in various parts of the world have also documented
similar determinants of GDM.[8,80,81] Insulin resistance in
the mother leads to excess blood glucose, which crosses
the placenta to the baby thereby stimulating the fetal
pancreas to produce excess insulin.[82] Insulin is an anabolic
hormone that encourages accumulation of subcutaneous fat
leading to macrosomia of the baby with attendant potential
complications such as shoulder dystocia and increased rate
of Cesarean delivery. Muche et al.[8] have also posited that
previous GDM has four times increased risk of GDM in
subsequent pregnancies. Maternal obesity and advancing
maternal age predispose to insulin resistance, which is also
necessary for the development of GDM.[83]

Table 3: Prevalence of GDM in the geopolitical zones and
according to the diagnostic criteria

| Subgroup analysis                                      | Prevalence (%) | 95% CI  | I² statistic |
|--------------------------------------------------------|----------------|---------|-------------|
| Prevalence across the geo-political zones               |                |         |             |
| South-west                                             | 11.0           | 5.0‑19.0| 99%         |
| South-south                                            | 7.0            | 5.0‑11.0| 99%         |
| South-east                                             | 12.0           | 10.0‑23.0| 97%       |
| North-west                                             | 13.0           | 5.0‑23.0| 99%         |
| North-central & Abuja                                  | 16.0           | 8.0‑25.0| 99%         |
| North-east                                             | 11.0           | 7.0‑16.0| 99%         |
| Prevalence of GDM using different criteria             |                |         |             |
| Carpenter & Coustan[151]                               | 5.4            | 2.8‑8.8 | 99%         |
| WHO (1999)                                             | 5.0            | 3.0‑8.0 | 97%         |
| WHO (2013)                                             | 9.0            | 4.0‑15.0| 99%         |
| IADPSG criteria[79]                                    | 20.0           | 12.0‑29.0| 95%       |

Moreover, it has been documented that the risk of developing
type 2 diabetes following the diagnosis of GDM is relatively
higher among black women. So, the expectation would be
that researches on GDM should be widespread in Nigeria as
it has the highest population of black women in the world.[73,74]
However, the scarcity of researches in an important topic as
GDM in Nigeria may be partly explained by inadequacy
of research funds, logistics, and expertise and these have been
alluded to by Baro et al.[75]

Similarly, in this meta-analysis, a significant portion
of the selected studies were found to be retrospective
studies (40%). Retrospective studies are known to be
associated with multiple flaws such as low quality of
evidence, lack of adequate representation of the studied
population, and bias.[76] In comparison with systematic
review and meta-analyses reported from other parts of the
world, retrospective studies do not usually constitute the
largest portion of the selected studies.[8,77,78] Again, this
may be connected with funds, logistics, and expertise as
retrospective studies are relatively cheaper to conduct and
the logistics are somewhat easier when compared with
prospective studies or trials.[76]

Furthermore, there was significant heterogeneity among
the selected studies for the heterogeneity (the I² statistic was 99%).
This could be due to the differences in socio-demographics
of the participants and the study designs. More importantly,
there is a wide variation in the diagnostic criteria employed
by the various authors of the selected studies. The WHO
2013 and the IADPSG criteria were the most commonly
applied criteria (42% and 29%, respectively) whereas the
Carpenter and Coustan criteria were the least favored (about
4%) among the Nigerian studies. The wide variation is
not unexpected because there are no universal criteria
recommended for the diagnosis of GDM.[12] Studies on
the prevalence of GDM in sub-Saharan Africa tend to apply
the one-step approach (WHO or the IADPSG criteria) rather
than the two-step approach (required for the Carpenter and
Coustan criteria).[19] Celen et al.[79] have posited that the one-step
approach is more cost-effective, simpler, and more sensitive
and this may explain why the studies tend to prefer the one-step
approach for the diagnosis of GDM.

The determinants of GDM in this meta-analysis are previous
macrosomic babies, maternal obesity, family history of
diabetes, and previous miscarriage. Other determinants
include advanced maternal age (above 35 years), previous
diagnosis of GDM, hypertension, and multiparity. Studies
done in various parts of the world have also documented
similar determinants of GDM.[8,80,81] Insulin resistance in
the mother leads to excess blood glucose, which crosses
the placenta to the baby thereby stimulating the fetal
pancreas to produce excess insulin.[82] Insulin is an anabolic
hormone that encourages accumulation of subcutaneous fat
leading to macrosomia of the baby with attendant potential
complications such as shoulder dystocia and increased rate
of Cesarean delivery. Muche et al.[8] have also posited that
previous GDM has four times increased risk of GDM in
subsequent pregnancies. Maternal obesity and advancing
maternal age predispose to insulin resistance, which is also
necessary for the development of GDM.[83]

Conclusions
The prevalence of GDM in Nigeria is 11.0%. The most
common determinants of GDM in Nigeria are previous
macrosomic babies, maternal obesity, family history of
diabetes, and previous miscarriage. The prevalence rate would
help policymakers to plan on how to allocate appropriate
resources to address the problems of GDM. It would also help
Diabetologists and Obstetricians to appreciate the enormosity
of the burden of GDM and to plan for future research works
in GDM.

Strengths of the study
To the best of the authors’ knowledge, this is the first systematic
review and meta-analysis of the prevalence and determinants
of GDM in Nigeria. The number of selected studies for the
meta-analysis is relatively large when compared to similar meta-analyses on GDM in African nations.

Limitations
The heterogeneity of the studies is quite substantial due to the differences in participants’ characteristics and diagnostic criteria.

Abbreviations
ACOG - American College of Obstetricians and Gynaecology
ADA - American Diabetes Association
ADIPS - Australian Diabetes in Pregnancy Society
BMI - Body mass index
CDA - Canadian Diabetes Association
CI – Confidence Interval
EASD - European Association for the Study of the Diabetes
FGP - Fasting plasma glucose
GCT - Glucose challenge test
GDM – Gestational diabetes mellitus
IADPSG - International Association of Diabetes in Pregnancy Study Group
NDDG - National Diabetes Data Group
OGTT - Oral glucose tolerance test
PRISMA - Preferred Reporting Items for Systematic Reviews and Meta-Analyses
WHO - World Health Organization

Ethical approval and consent to participate
Not applicable.

Financial support and sponsorship
Self-funded.

Conflicts of interest
There are no conflicts of interest.

REFERENCES
1. Larebo YM, Ermola NO. Prevalence and risk factors of gestational diabetes mellitus among women attending antenatal care in Hadiya Zone Public Hospitals, Southern Nation Nationality people region. BioMed Res Int 2021;2021:e5564668.
2. Schaefer-Graf U, Napoli A, Nolan CJ, the Diabetic Pregnancy Study Group. Diabetes in pregnancy: A new decade of challenges ahead. Diabetologia 2018;61:1012–21.
3. Association AD. 2. Classification and diagnosis of diabetes: Standards of medical care in diabetes—2021. Diabetes Care 2021;44(Suppl 1):S15–33.
4. Kampmann U, Madsen LR, Skaja GA, Iversen DS, Moeller N, Ovesen P. Gestational diabetes: A clinical update. World J Diabetes 2015;6:1065–72.
5. Noctor E, Dunne FP. Type 2 diabetes after gestational diabetes: The influence of changing diagnostic criteria. World J Diabetes 2015;6:234–44.
6. Sheiner E. Gestational diabetes mellitus: Long-term consequences for the mother and child grand challenge: How to move on towards secondary prevention? Front Clin Diabetes Healthc 2020. doi: 10.3389/fcldhe.2020.546256.
7. Nguyen CL, Pham NM, Binns CW, Duong DV, Lee AH. Prevalence of gestational diabetes mellitus in Eastern and Southeastern Asia: A systematic review and meta-analysis. J Diabetes Res 2018;2018:e6536974.
8. Muche AA, Olayemi OO, Gete YK. Prevalence and determinants of gestational diabetes mellitus in Africa based on the updated international diagnostic criteria: A systematic review and meta-analysis. Arch Public Health 2019;77:36.
9. Nielsen KK, de Courten M, Kapur A. Health system and societal barriers for gestational diabetes mellitus (GDM) services-lessons from World Diabetes Foundation supported GDM projects. BMC Int Health Hum Rights 2012;12:33.
10. Lawrence RL, Wall CR, Bloomfield FH. Prevalence of gestational diabetes according to commonly used data sources: An observational study. BMC Pregnancy Childbirth 2019;19:349.
11. Lee KW, Ching SM, Ramachandran V; Yee A, Hoo FK, Chia YC, et al. Prevalence and risk factors of gestational diabetes mellitus in Asia: A systematic review and meta-analysis. BMC Pregnancy Childbirth 2018;18:494.
12. Agarwal MM. Consensus in gestational diabetes MELLITUS: Looking for the holy grail. J Clin Med 2018;7:123.
13. Garrison A. Screening, diagnosis, and management of gestational diabetes mellitus. Am Fam Physician 2015;91:460–7.
14. Pippitt K, Li M, Gurgel HE. Diabetes mellitus: Screening and diagnosis. Am Fam Physician 2016;93:103–9.
15. Kim K-B, Shin Y-A. Males with obesity and overweight. J Obes Metab Syndr 2020;29:18–25.
16. Moyer VA. U.S. Preventive Services Task Force. Screening for gestational diabetes mellitus: U.S. Preventive Services Task Force recommendation statement. Ann Intern Med 2014;160:414–20.
17. Capula C, Chieftari E, Vero A, Arcidiacono B, Iiritano S, Puccio L, et al. Gestational diabetes mellitus: Screening and outcomes in Southern Italian pregnant women. ISRN Endocrinol 2013;2013:e387495.
18. BergHELLA V, CaissUTI C, SaCCONE G, KhalifiTH A. The one step approach for diagnosing gestational diabetes is associated with better perinatal outcomes than the two step approach: Evidence of randomized clinical trials. Am J Obstet Gynecol 2019;220:562–4.
19. Rani PR, Begum J. Screening and diagnosis of gestational diabetes mellitus, where do we stand. J Clin Diagn Res 2016;10:QE01-4.
20. Kautzky-Willer A, Harreiter J, Winhofer-Stöckl Y, Bancher-Todesca D, Berger A, Repa A, et al. [Gestational diabetes mellitus (Update 2019)]. Wien Klin Wochenschr 2019;131(Suppl 1):91–102.
21. Karagiannis T, Bekiari E, Manolopoulos K, Paletas K, Tsapas A. Gestational diabetes mellitus: Why screen and how to diagnose. Hippokratia 2010;14:151–4.
22. Berggren EC, Boggess KA, Stuebe AM, Funk MJ. National diabetes data group versus carpen ter-coustan criteria to diagnose gestational diabetes. Am J Obstet Gynecol 2011;205:253.e1-7.
23. Lu M-C, Huang S-S, Yan Y-H, Wang P. Use of the National Diabetes Data Group and the Carpenter-Coustan criteria for assessing gestational diabetes mellitus and risk of adverse pregnancy outcome. BMC Pregnancy Childbirth 2016;16:231.
24. Gilbert L, Gross J, Lanzi S, Quansah DY, Puder J, Horsch A. How diet, physical activity and psychosocial well-being interact in women with gestational diabetes mellitus: An integrative review. BMC Pregnancy Childbirth 2019;19:60.
25. Association AD. 14. Management of diabetes in pregnancy: Standards of medical care in diabetes—2021. Diabetes Care 2021;44(Suppl 1):S200–10.
26. Guo L, Ma J, Tang J, Hu D, Zhang W, Zhao X. Comparative efficacy and safety of metformin, glyburide, and insulin in treating gestational diabetes mellitus: A meta-analysis. J Diabetes Res 2019;2019:e9804708.
27. Adegbola O, Ajayi GO. Screening for gestational diabetes mellitus in Nigerian pregnant women using fifty-gram oral glucose challenge test. West Afr J Med 2008;27:139–43.
28. Anzaku AS, Musa J. Prevalence and associated risk factors for gestational diabetes mellitus in Jos, North-central, Nigeria. ISRN Endocrinol 2013;2013:e387495.
29. Ewenighi O, Nwanjo U, Uche D, Oneyansusi C, Nnattuanya I, M OLU, et al. Prevalence Of gestational diabetes mellitus; risk factors among pregnant women (In Abakaliki Metropolis, Ebonyi State Nigeria.). Natl J Integr Res Med 2013;4:57–62.
30. Kuti MA, Abyeyesuka FM, Akinlade KS, Akinosun OM, Adeapo KS, Adeleye JO, et al. Oral glucose tolerance testing outcomes among women at high risk for gestational diabetes mellitus. J Clin Pathol
Ade‑Ojo IP, Ghazalli SM, et al. The prevalence of and risk factors for undernutrition among children aged 6 to 23 months in Nigeria. J Adv Med Med Res 2019;31:1–16.

Adefisan AS, Olagbaju BN, Adeniyi AA, Ade‑Ojo IP, Ghazalli SM, Olofinbiiyi BA. Diagnostic accuracy of random plasma glucose and random blood capillary glucose in detecting international association of diabetes and pregnancy study groups defined hyperglycemia in early pregnancy. Niger J Clin Pract 2020;23:1087.

Abby M, Kasso T. First trimester fasting blood glucose as a screening tool for diabetes mellitus in a teaching hospital setting in Nigeria. Asian J Med Health Sci 2021;4:71–8.

Oga E, Egboro C, Lucius C. Profile of risk factors in relation to the outcome of screening for gestational diabetes mellitus (GDM) among pregnant women in Jos University Teaching Hospital (JUTH), Jos. Res Obstet Gynecol 2018;6:64–6.

Awofisoye O, Osaji N. Glycated haemoglobin and obstetric outcomes among patients with gestational diabetes mellitus: A single center study. In: Endocrine Abstracts. Bioscientifica; 2019. Available from: https://www.endocrine-abstracts.org/ea/0065/ea0065p211. [Last accessed on 2021 Jul 04].

Chukwunyere CF, Awonuga DO, Igwe U. Gestational diabetes in a tertiary healthcare centre at Abeokuta, South Western Nigeria: A five year retrospective review. Int J Trop Dis Health 2015;7:23–31.

Ogu RN, John CO, Maduka O, Chimenye S. Screening for gestational diabetes mellitus: Findings from a resource limited setting of Nigeria. J Adv Med Med Res 2017;20:1–8.

Fawole AO, Ezeasar 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. Niger J Clin Pract 2014;17:495–501.

Nwaokoro JC, Emerole CO, Ibe SN, Amadi AN, Dozie IN. Risk factors associated with gestational diabetes among pregnant women in Owerri Municipal Council, Southeastern Nigeria. Asian J Med Sci 2014;5:39–46.

Ajayi G, Adegbola O, Oseni O. Prevalence of gestational diabetes using 50 gram glucose challenge test 1 hour result in 1204 cases in Lagos. Z Geburtshilfe Neonatol 2015;219:P05 6. doi: 10.1055/s-0035-1566621.

Bello OO, Olusawosoa TA, Adeleye JO, Adedapo KS, Maxwell O. Odukogbe A-TA. Comparative effectiveness of 50g glucose challenge test and risk factor based screening in detection of gestational diabetes mellitus in Ibadan, Nigeria. Trop J Obstet Gynecol 2015;32:28–34.

Salami AH, Aghoghormosa CO, Momoh JA. The prevalence and risk factors for gestational diabetes and pregnancy outcome in a tertiary hospital in Abuja, Nigeria. Trop J Obstet Gynecol 2015;32:65–72.

Oruru I, Nwose E, Nwose E, Bwittit P, Nwose NE, Igumbor E, et al. Screening for gestational diabetes: Evaluation of prevalence in age-stratified subgroups at Central hospital Warri Nigeria. Int J Reprod Contraception Obstet Gynecol 2017;6:63–8.

Askariju I. An assessment of the prevalence of gestational diabetes mellitus in Nigeria: A study of pregnant women in Maiduguri Metropolis. Available from: https://www.academia.edu/14218487/AN_ASSESSMENT_OF_THE_PREVALENCE_OF_GESTATIONAL.Diabetes_IN_NIGERIA_A_STUDY_OF_PREGNANT_WOMEN_IN_MAIDUGURI_METROPOLIS. [Last accessed on 2021 Jul 03].

Ugwochukwu IA, Uwadia N, Utuk N. The prevalence of gestational diabetes among antenatal attendees in a tertiary hospital in south south Nigeria. Int J Med Health Res 2015;5(1):72-9.

Agoufe O, Odjimooho S, Okandeji Barry OR, Glasgow I. Prevalence of gestational diabetes mellitus among pregnant women attending antenatal care services in Dette Koki memorial hospital, Opolo Bayelsa state, Nigeria. Int J Reprod Contracept Obstet Gynecol 2019;8:802–7.

Akhibude K, Akhibude D, Alikor C. Risk Factors associated with Diabetes in Pregnancy: The Nigerian perspective using the new World Health Organization (WHO) criteria. J Med Res 2020;6:38–43.

Olagbaju BN, Atiba AS, Olofinbiiyi BA, Akintayo AA, Awoleke JO, Ade‑Ojo IP, et al. Prevalence of and risk factors for gestational diabetes using 1999, 2013 WHO and IADPSG criteria upon implementation of a universal one-step screening and diagnostic strategy in a sub-Saharan African population. Eur J Obstet Gynecol Reprod Biol 2015;189:27–32.

Imoh L, Ogunkuye O, Isichei C, Gadzama A, Ekwemph C. Combining the IADPSG criteria with the WHO diagnostic criteria for gestational diabetes mellitus optimizes predictability of adverse pregnancy outcome. Trop J Obstet Gynecol 2016;33:185–9.

Haladu H. Evaluation of serum fructosamine as a screening test for the detection of gestational diabetes mellitus. Faculty of Pathology. 2016. Available from: https://www.dissertation.npmcn.edu.ng/index.php/FMCOG/article/view/1185. [Last accessed on 2021 Jul 04].
68. Behboudi-Gandevani S, Amiri M, Bidhendi Yarandi R, Ramezani Tehrani F. The impact of diagnostic criteria for gestational diabetes on its prevalence: A systematic review and meta-analysis. Diabetol Metab Syndr 2019;11:11.
69. Akgöl E, Abuşoğlu S, Günl Ünlü A. Prevalence of gestational diabetes mellitus according to the different criteria. Turk J Obstet Gynecol 2017;14:18–22.
70. Shang M, Lin L. IADPSG criteria for diagnosing gestational diabetes mellitus and predicting adverse pregnancy outcomes. J Perinatol 2014;34:100–4.
71. Brown FM, Wyckoff J. Application of one-step IADPSG versus two-step diagnostic criteria for gestational diabetes in the real world: Impact on health services, clinical care, and outcomes. Curr Diab Rep 2017;17:85.
72. Bower JK. Racial/ethnic differences in diabetes screening and hyperglycemia among us women after gestational diabetes. Prev Chronic Dis 2019;16:E145.
73. Kaba AJ. Explaining the rapid increase in Nigeria’s sex ratio at birth: Factors and implications. Afr J Reprod Health 2015;19:17–33.
74. Xiang AH, Li BH, Black MH, Sacks DA, Buchanan TA, Jacobsen SJ, et al. Racial and ethnic disparities in diabetes risk after gestational diabetes mellitus. Diabetologia 2011;54:3016–21.
75. Baro EE, Bosah GE, Obi IC. Research funding opportunities and challenges: A survey of academic staff members in Nigerian tertiary institutions. Future Sci OA 2017;30:47–64.
76. Anthonisen NR. Retrospective studies. Can Respir J 2009;16:117–8.
77. Prutsky GJ, Domecq JP, Sundaresh V, Elrakayah T, Nahhan M, Prokop LJ, et al. Screening for gestational diabetes: A systematic review and meta-analysis. J Clin Endocrinol Metab 2013;98:4311–8.
78. Gao C, Sun X, Lu L, Liu F, Yuan J. Prevalence of gestational diabetes mellitus in mainland China: A systematic review and meta-analysis. J Diabetes Investig 2019;10:154–62.
79. Celen S, Yildiz Y, Kahyaoglu S, Kaymak O, Ozel M, Timur H, et al. Cost-effectiveness analysis of one-step versus two-step screening for gestational diabetes. Eurasian J Med 2012;44:84–7.
80. Xu X, Liu Y, Liu D, Li X, Rao Y, Sharma M, et al. Prevalence and determinants of gestational diabetes mellitus: A cross-sectional study in China. Int J Environ Res Public Health 2017;14:1532.
81. Egbe TO, Tsaku ES, Tchounzou R, Ngowe MN. Prevalence and risk factors of gestational diabetes mellitus in a population of pregnant women attending three health facilities in Limbe, Cameroon: A cross-sectional study. Pan Afr Med J 2018;31:195.
82. Ke K, Shaya S, Zhang H. Gestational diabetes mellitus and macrosomia: A literature review. Ann Nutr Metab 2015;66(Suppl 2):14–20.
83. Plows JF, Stanley JL, Baker PN, Reynolds CM, Vickers MH. The pathophysiology of gestational diabetes mellitus. Int J Mol Sci 2018;19:3342.