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Prevalence of Gestational Diabetes Mellitus and Maternal and Fetal Outcomes at the Rivers State University Teaching Hospital (RSUTH), Port Harcourt, Nigeria

D. H. John[1], P. A. Awoyesuku[1*], D. A. MacPepple[1] and N. J. Kwosah[1]

[1]Department of Obstetrics and Gynaecology, Rivers State University Teaching Hospital, 6-8 Harley Street, Old G.R.A, Port-Harcourt, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Author DHJ designed the study, performed the statistical analyses and wrote the first draft of the manuscript as a dissertation in fulfilment of the award of fellow West African College of Surgeons. Authors PAA and DAMP were supervising consultants for the dissertation and rewrote the manuscript for publication. Author NJK assisted in data collection managed the analyses of the study and literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Background: Gestational diabetes mellitus (GDM) is a common cause of hyperglycaemia in pregnancy accounting for about 90% of all diabetic pregnancies. Women with GDM are at increased risk of maternal and fetal morbidity and mortality which are preventable through early diagnosis and treatment.
Objective: The aim was to determine the prevalence of GDM, compare the maternal and neonatal complications among GDM and non-GDM pregnant women, and the risk factors associated with GDM.
Methodology: A prospective cohort study was carried out among 105 pregnant women attending the antenatal clinic of RSUTH between February and August 2017. They were interviewed using a

**Corresponding author: E-mail: pawoyesuku@yahoo.co.uk;*

pre-structured questionnaire that covered variables related to socio-demographic factors and family, medical, and social history. Fasting blood sugar (FBS) was done after an overnight fast. Women who had FBS less than 7 mmol/L had 75 g Oral Glucose Tolerant Test (OGTT) done. Those diagnosed with gestational diabetes mellitus were the exposed group while those negative for GDM were the non-exposed group. Both groups were followed up to delivery, and maternal and fetal outcomes were noted. Statistical analysis was carried out using SPSS version 20 and significance set at $p < 0.05$.

Results: The prevalence of GDM was 10.5%. Positive history of GDM in previous pregnancy was the only independent risk factor (p=0.04, Adj OR: 26.89, 95% CI 2.86 to 252.61). GDM mothers had a significantly higher risk of developing pre-eclampsia (RR=7.48; 95% CI =3.36 to 16.63). Neonates of GDM mothers were at increased risk of fetal macrosomia (RR =9.00; 95% CI=1.36 to 59.4) and neonatal admissions (RR=8.00; C.I =1.19 to 53.67).

Conclusion: The study revealed that the prevalence of GDM was high and that those with GDM were at increased risk of developing fetal and maternal complications. A history of GDM in previous pregnancy was an essential risk factor for subsequent GDM.

Keywords: Gestational diabetes mellitus; prevalence; risk factors; maternal and fetal outcome.

1. INTRODUCTION

Gestational diabetes mellitus (GDM) is a common complication of pregnancy and it is associated with significant maternal and perinatal morbidity [1]. Pregnancy confers a state of insulin resistance and hyper-insulinemia that may predispose some women to develop diabetes mellitus. Maternal Insulin Resistance leads to more use of fats than carbohydrates for energy by the mother and spares glucose circulating in the blood for the fetus. GDM occurs when a woman's pancreatic function is not sufficient to overcome the diabetogenic environment of pregnancy [2].

Gestational diabetes mellitus is defined by the American Diabetes Association (ADA) and the World Health Organization (WHO) as any degree of glucose intolerance with onset or first recognition during pregnancy [3,4]. This definition acknowledges the possibility that patient may have previously undiagnosed diabetes mellitus or may have developed diabetes mellitus coincidentally with pregnancy, however, it excludes diabetic women who become pregnant [4,5]. Gestational diabetes mellitus has been known since 1946 [5]. The main feature of gestational diabetes mellitus is increased insulin resistance in pregnancy. Insulin resistance during pregnancy is as a result of several factors, which include alterations in growth hormone and cortisol secretion, human placental lactogen secretion and Insulinase secretion [2]. Also, Oestrogen and Progesterone contribute to the imbalance in glucose-insulin metabolism. Insulin resistance is a normal phenomenon in pregnancy that starts in the second trimester of pregnancy [5]. It allows for more circulating blood glucose to get to the fetus.

Gestational diabetes mellitus is a growing health concern in many parts of the world [3]. Some studies have shown that gestational diabetes mellitus complicates about 1-16% of pregnancies depending on the population and diagnostic criteria used [3,5]. Globally, as at 2010 an estimated 285 million people had diabetes mellitus, with type 2 contributing about 90% of the cases [6]. Pregnancy complicated with gestational diabetes mellitus has high risk of developing type 2 diabetes mellitus in women and their children in future [3,7,8,9]. This will definitely contribute to the global burden of diabetes mellitus. Diabetes mellitus is increasing rapidly and has been estimated to double by 2030 hence prevention of gestational diabetes mellitus, early detection and treatment will help to reduce the incidence of diabetes mellitus [6].

It is not very clear why some women are unable to balance insulin needs in pregnancy and develop gestational diabetes mellitus. A number of explanations exist, like in the case of type 2 diabetes, such as auto-immunity, single gene mutation, obesity and others [5]. Any pregnant woman can develop gestational diabetes mellitus, however there are some risk factors associated with this condition. These include first degree family history of diabetes mellitus, obesity, previous history of fetal macrosomia, increased maternal age, increased parity, previous history of GDM, unexplained still birth in pervious pregnancy and smoking [3,8-12].

About 40-60% of women with gestational diabetes mellitus are asymptomatic hence some persons have advocated for screening of all pregnant women [5]. The Canadian Diabetes Association and the American College of Obstetricians and Gynecologists (ACOG) recommend universal screening [10]. However, the U.S Preventive Services Task Force (USPSTF) and the Cochrane Collaboration found insufficient evidence to recommend for or against screening or treating gestational diabetes [7]. The National Institute for Health and Clinical Excellence (NICE) guideline recommends screening for gestational diabetes mellitus using risk factors in a healthy population [3]. The incidence of gestational diabetes mellitus is said to be low in absence of associated risk factors, suggesting that selective screening may be cost effective [13]. WHO recommend a two stage screening during pregnancy; all pregnant women should be screened for diabetes mellitus during first antenatal visit by testing for glucosuria, a positive test is an indication for further assessment by a 75 grams OGTT.

Women with risk factors for gestational diabetes mellitus between 24-28 weeks of gestation should be screened with 75 g OGTT [3,14]. Ninety percent of gestational diabetes mellitus are associated with adverse maternal and fetal outcomes [1]. The maternal outcomes or complications of gestational diabetes mellitus include hypertension, candidiasis, genital injuries, obstructed labour, caesarean deliveries, polyhydramnios, abruptio placentae, type 2 diabetes mellitus [2,3,7,13,15]. Fetal and neonatal complications include fetal macrosomia, shoulder dystocia, birth injuries, unexplained fetal death, miscarriages, hypoglycaemia, birth asphyxia, respiratory distress syndrome, baby cot syndrome, childhood obesity and type 2 diabetes mellitus [3,11,13,15]. All complications of gestational diabetes mellitus are potentially preventable with early recognition, intense monitoring and treatment [1]. According to the hyperglycaemia and adverse pregnancy outcomes (HAPO) study, a large-scale multinational epidemiologic study, the risk of adverse maternal, fetal and neonatal outcomes continuously increases as a function of maternal glycaemia at 24-28 weeks [11]. Evidence shows that a good approach, to gestational diabetes mellitus with diagnosis between 24-28 weeks, is with dietary advice, self-monitoring of blood glucose and insulin therapy reduces adverse maternal and fetal complications [3].

As the prevalence of gestational diabetes mellitus is increasing in proportion to the ongoing epidemic of obesity and type 2 diabetes mellitus in women of childbearing age, understanding the associated risk factors both modifiable and non-modifiable, early detection and treatment of GDM will help to prevent the development of gestational diabetes mellitus and its adverse outcome. This study therefore aims to determine the prevalence of gestational diabetes mellitus, compare the maternal and neonatal complications among GDM and non-GDM pregnant women, and the risk factors associated with GDM. There has been no study on gestational diabetes mellitus among pregnant women in this hospital.

2. METHODOLOGY

2.1 Study Area

This study was conducted in the RSUTH, a tertiary hospital owned and funded by the Government of Rivers State, and patients are expected to pay directly for services (except few that participate in National Health Insurance Scheme). It provides emergency obstetric services to women referred from other centers, as well as providing antenatal care and delivery services for low and high-risk pregnant women booked with the hospital. The hospital is well equipped and has availability of qualified team comprising of Obstetricians, Pediatricians and Anaesthetist. There is availability of laboratory and blood bank services in the hospital. The subjects for this study were drawn from the antenatal clinic which holds every working day in the week, with about 20 new pregnant women registering for antenatal care every clinic day.

2.2 Study Design

This was a prospective cohort study that involved eligible antenatal care pregnant women at gestational ages of 24-28 weeks. The gestational age of each woman was calculated from their last menstrual period (LMP) or first trimester ultra- sound scan done in the hospital. The clients were counselled on the purpose of the study. They were assured of confidentiality and the consenting mothers were interviewed by trained research assistants using a pre structured standardized questionnaire. The questionnaire covered their socio-demographic characteristics, life style and the presence of risk factors known to be associated with GDM. The

mothers were booked for 75 g OGTT during the next visit and told to fast overnight before coming. Each mother's folder was tagged for easy identification.

The WHO 1999 criteria for diagnosis of diabetes (GDM) with 75 g oral glucose tolerance test was used [3,14]. A diagnosis of GDM was made when fasting plasma glucose was ≥7.0mmol/L and/or 2 hours post 75 g glucose drink was ≥7.8mmol/L. At the next ANC visit, mothers booked for the test were identified using the tag on their folders. Their weights and heights were measured and recorded. Venous blood sample was taken for the OGTT and put into Fluoride – Oxalate sample bottles. The blood was labelled as fasting with the woman serial number on it. Then each mother was given 75 g glucose dissolved in a glass of 200 ml water to drink and 2 hours later, venous blood was collected into similar sample bottles and labelled in the same way as 2 hours post glucose load blood sample. The samples taken were analyzed at the medical laboratory department of the hospital by the Glucose Oxidase method using Spectrophotometer, Screen master, Hospitex diagnostic, serial number 1131231, made in Italy.

The results were recorded in the questionnaire and subsequently entered into a Proforma spread sheet that had information for each mother. The cases were mothers with fasting blood glucose ≥7.0 mmol/L and/or 2 hours post 75 g glucose drink blood glucose level ≥7.8 mmol/L. The result of the blood test was made known to the women and the implications explained to them. The women with 2 hours glycaemia <11.1 mmol/L were given dietary advice and those with glycaemia >11.1 mmol/L and fasting glucose >7.0 mmol/L were started on insulin after confirmation of the results in conjunction with diabetes physicians.

Those women that met the WHO criteria were the GDM group while the remaining women served as the non-GDM group. The women were followed up and encouraged to deliver their babies in RSUTH. Five women (among the non GDM mothers) who delivered outside the hospital were followed-up through their phone numbers written on the questionnaires. They were asked to come back for post-natal clinic visit 6weeks after delivery for review. At follow-up, those who had GDM, had OGTT done and the result entered into the spread sheet. They were counselled and referred appropriately as necessary.

2.3 Calculation of Sample Size

Sample size desired for this study was with a degree of accuracy of 5% with a confidence interval of 95%. The power of analysis was based on previous study with prevalence of gestational diabetes of 6.8% [16]. The sample was determined by the following formula:

$$n = (Z^2 \, x \, PQ) / \, d2$$

Where n = desired minimum size; Z = score for confidence interval of 95% which is 1.96; P = proportion of women with gestational diabetes mellitus from previous study is 6.8%; Q = complementary proportion equivalent to one (1) minus P, Q = 1- 0.068=0.932; and d = degree of accuracy desired which is 5% = 0.05. Therefore, n = 97.4. Assuming a drop out of 10%, the minimum calculated sample size was 108 pregnant women, but there was attrition of 3 of the women giving a total of 105 that were followed up.

2.4 Method of Recruitment

Systematic sampling technique was used to recruit client for this study. The research assistants comprised of some nurses and resident doctors in the department who were trained for the purpose of the study. The number of eligible women recruited in a day was determined by dividing the estimated sample size by the number of working days in a month (which was the duration the recruitment of participants lasted). That is 108 ÷ 21 = 5.1. Therefore, five women were recruited per day till the required sample size was obtained.

2.5 Inclusion / Exclusion Criteria

Consenting pregnant women receiving antenatal care at RSUTH of gestational ages between 24-28weeks were included. Pregnant women who were known diabetics, those with tuberculosis, congestive cardiac failure and renal failure, those whose gestational ages cannot be calculated or was unknown, those with sickle cell disease, those who will not be able to complete OGTT due to vomiting, and those on salbutamol or other medication that will affect glucose tolerance, were excluded.

2.6 Data Management

All participants were followed-up until delivery. The mode of delivery, gestational age at delivery, birth weights, Apgar scores and status of the babies at discharged were entered into the spread sheet which also contained the mother's socio-demographic information, OGTT result, associated risk factors for gestational diabetes mellitus, form of treatment received and complications in the pregnancy. Five women who delivered their babies outside the hospital were followed up through their phone numbers given on the questionnaire while the remaining one hundred delivered in the hospital. All participants Proforma were collected at the end of each day from the labour ward and data entry errors checked at the labour ward before collation. The result of OGTT at six weeks postnatal visit was recorded and entered into the spread sheet. The forms were checked for completeness at the end of the study.

2.7 Data Analysis

Data entry and analysis were done using SPSS version 20. Variables were presented using frequency tables. Categorical variables were summarized using percentages, while numerical variables were summarized using mean and standard deviation. Chi- square was used to test associations between GDM and the potential risk factors, multiple logistic regression was used to remove effects of confounders and determine the risk factors associated with GDM. To determine the relative risks of the various outcomes, the cohort of GDM mother were carefully matched with controls for age and gravidity. The level of significance was set at $P<0.05$.

3. RESULTS

One hundred and eight respondents were recruited for the study however, three non-GDM mothers were lost to follow up. Hence 105 subjects were followed up in the study.

3.1 Prevalence of GDM and Socio-Demographic Characteristics of Respondents

The age range of respondents was 18-46 years. GDM was diagnosed in 11 of the 105 subjects giving a prevalence of 10.5%. The mean age of women with GDM was higher (34.6 ± 5.3) than women who were non-GDM (31.2 ± 5.1) although the difference was not statistically significant. Table 1 shows their socio-demographic characteristics.

3.2 Clinical Characteristics of Respondents

A higher percentage of GDM mothers had previous miscarriages compared to non- GDM mothers (36.4% vs 21.3%), a history of previous intrauterine fetal death compared to non-GDM mothers (27.3% vs 6.4%) and a family history of diabetes mellitus, although these were not statistically significant. See Table 2.

As regards medical history, a higher proportion of mothers with GDM were diagnosed to have been diabetic in previous pregnancy compared to non GDM mothers (45.5% vs 2.1%) and this was statistically significant ($p<0.001$) as shown in Table 3.

Most of the mothers with GDM were obese (81.8%). The mean B.M.I of mothers with GDM was significantly higher than that of non GDM mothers (34.2 ± 5.8 vs 29.3 ± 5.2; $p=0.004$). A higher proportion (81.8%) of GDM mothers had glycosuria and this was significant ($p<0.001$) as shown in Table 4.

3.3 Associated Risk Factors for GDM

Participants that were ≥ 40 years old were most likely (50.0%) to have GDM, followed by those that were 30-39 years old (11.3%) and 20-29 years old (5.3%). However, the differences were not statistically significant ($p = 0.094$). Participants with family history of DM were more likely (20.0%) to have GDM than those without family history of DM (6.7%). However, the difference was not statistically significant ($p = 0.078$).

There were a statistically significant association between being diagnosed to be diabetic in previous pregnancy ($p < 0.001$), being obese ($p=0.011$) and being diagnosed to be hypertensive ($p= 0.05$) with having GDM. Participants that were diagnosed to be diabetic in previous pregnancy were more likely (71.4%) to have GDM than those that were not diagnosed to be diabetic (6.1%). Participants that were diagnosed to be obese were more likely (19.1%) to have GDM than those that were not diagnosed to be obese (3.4%) as shown in Table 5.

Table 1. Socio-demographic characteristics of respondents

Variable	Frequency (%)			χ2	df	p-value
Age (year)	**GDM n = 11**	**No GDM n = 94**	**Overall n = 105**			
< 20	0 (0)	1 (1.1)	1 (1.0)	7.924	3	0.048
20 – 29	2 (18.2)	36 (38.3)	38 (36.2)			†0.094
30 – 39	7 (63.6)	55 (58.5)	62 (59.0)			
≥ 40	2 (18.2)	2 (2.1)	4 (38.0)			
Mean age	34.6 ± 5.3	31.2 ± 5.1	31.6 ± 5.2	Mann-	Whitney	U =337.5;
p-value = 0.060						
Marital status						
Married	11 (100)	91 (96.6)	102 (97.1)	0.361	1	0.548
Single	0 (0)	3 (3.2)	3 (2.9)			†1.000
Ethnicity						
Ijaw	3 (27.3)	35 (37.2)	38 (36.2)	1.567	1	0.667
Igbo	5 (45.5)	27 (28.7)	32 (30.5)			†0.729
Yoruba	0 (0)	3 (3.2)	3 (2.9)			
Others	3 (27.3)	29 (30.9)	32 (30.5)			
Religion						
Christianity	11 (100)	93 (98.9)	104 (99.0)	0.118	1	0.731
Islam	0 (0)	1 (1.0)	1 (1.0)			†1.000
Education						
Primary	1 (9.1)	1 (1.1)	2 (1.9)	3.400	2	0.138
Secondary	3 (27.3)	27 (28.7)	30 (28.6)			†0.260
Tertiary	7 (63.6)	66 (70.2)	73 (69.5)			
Occupation						
Housewife	2 (18.2)	12 (12.8)	14 (13.3)	0.674	3	0.879
Trading	4 (36.4)	29 (30.9)	33 (31.4)			†0.730
Professional	1 (9.1)	7 (7.4)	8 (7.6)			
Others	4 (36.4)	46 (48.9)	50 (47.6)			
Husband's education						
Secondary	6 (54.5)	26 (27.7)	32 (30.5)	3.360	1	0.067
Tertiary	5 (45.5)	68 (72.3)	73 (69.5)			†0.087
Husband's occupation						
Unemployed	0 (0)	1 (1.1)	1 (1.0)	7.956	3	0.047
Artisan	4 (36.4)	8 (8.5)	12 (11.4)			†0.069
Professional	1 (9.1)	22 (23.4)	23 (21.9)			
Others	6 (54.5)	63 (67.0)	69 (65.7)			

The proportion of participants with other risk factors for GDM was higher (90.9%) among the participants with GDM than those without GDM (35.1%). The commonest risk factor reported by participants with GDM were first degree relative with DM (40.0%) and previous macrosomic baby (40.0%), followed by recurrent Candidiasis (30.0%) and persistent glycosuria (20.0%) as shown in Table 6. After multivariate analysis, it was observed that the participants that were diagnosed to be diabetic in the previous pregnancy were 27 times more likely to have GDM than those that were not diagnosed to be diabetic in the previous pregnancy (OR = 26.89; 95% CI = 2.86 to 252.61) as shown in Table 7.

3.4 Maternal Outcome

Most (78.1%) of the deliveries were spontaneous vaginal births. The proportion of CS (36.4%) was higher among the participants with GDM than those without GDM (20.2%). However, the difference was not statistically significant (p =0.252). Most (78.3%) of the CS were emergency. The proportion of elective CS (50.0%) was higher among the participants with GDM than those without GDM (15.8%). However, the difference was not statistically significant (p = 0.194) as shown in Table 8.

The major indications for CS among mothers without GDM were pre-eclampsia (26.1%),

CPD (26.1%) and previous CS (21.7%), while the major indication among mothers with GDM was macrosomic baby (50.0%). Macrosomic baby (p = 0.016) and prolonged labour (p = 0.026) were significantly higher as indications for CS among mothers with GDM than those without GDM as shown in Table 9.

3.5 Fetal Outcome

The majority of the participants (80.0%) carried the pregnancy to term. However, there was no significant difference between the GA of those with GDM and those without GDM (p = 0.296). The majority of the babies (87.5%) had birthweight between 2.5 and 3.9 kg. The proportion of macrosomic babies (≥4kg) was higher in participants with GDM (81.8%) than those without GDM (2.2%).

The mean Apgar scores were significantly lower among babies of mothers with GDM than those without GDM. Babies of participants with GDM were more likely (72.7%) to be admitted in Special Care Baby Unit (SCBU) than the babies of those without GDM (11.7%). The difference was statistically significant (p <0.001). The major reason for admission in SCBU among the babies of mothers without GDM was asphyxia (72.7) while the commonest reasons among babies of mothers with GDM were asphyxia (25.0%) and macrosomic baby (25.0%) as shown in Table 10.

Table 2. Clinical characteristics of respondents

Variable	Frequency (%)			χ2	df	p- value
	GDM n = 11	No GDM n = 94	Overall n = 105			
Gravidity						
1	0 (0)	26 (27.7)	26 (24.8)	5.375	3	0.146
2-3	6 (54.4)	47 (50.0)	53 (50.5)			†0.077
4-5	4 (36.4)	18 (19.1)	22 (21.0)			
>5	1 (9.1)	3 (3.2)	4 (3.8)			
Had miscarriage before						
Yes	4 (36.4)	20 (21.3)	24 (22.9)	1.271	1	0.260
No	7 (63.6)	74 (78.7)	81 (77.1)			†0.269
Baby died in the womb before						
Yes	3 (27.3)	6 (6.4)	9 (8.6)	5.484	1	0.019
No	8 (72.7)	88 (93.6)	96 (91.4)			†0.051
Baby died within 24 hours of delivery						
Yes	0 (0)	2 (2.1)	2 (1.9)	0.239	1	0.625
No	11 (100)	92 (97.9)	103 (98.1)			†1.000
Family history of DM						
Yes	6 (54.5)	24 (25.5)	30 (28.6)	4.062	1	0.044
No	5 (45.5)	70 &4.5)	75 (71.4)			†0.072
History of tobacco use						
Yes	0 (0)	2 (2.1)	2 (1.9)	0.239	1	0.625
No	11 (100)	92 (97.9)	103 (98.1)			†1.000
How often exercise						
Not at all	6 (54.5)	31 (33.0)	37 (35.2)	3.023	2	0.221
<3 times a week	5 (45.5)	49 (52.1)	54 (51.4)			†0.235
>3 times a week	0 (0)	14 (14.9)	14 (13.3)			
Quantity of sugar drink per week						
None	1 (9.1)	9 (9.6)	10 (9.5)	0.495	3	0.920
< 3 bottles	7 (63.6)	51 (54.3)	58 (55.2)			†0.952
3-5 bottles	2 (18.2)	26 (27.7)	28 (26.7)			
> 5 bottles	1 (9.1)	8 (8.5)	9 (8.6)			

** Statistically significant; † Fisher exact p*

Table 3. Past medical history of respondents

Variable	Frequency (%)			χ^2	p-value
Diagnosed to be diabetic in previous pregnancy	**GDM n = 11**	**No GDM n = 94**	**Overall n = 105**		
Yes	5 (45.5)	2 (2.1)	7 (6.7)	29.710	< 0.001
No	6 (54.5)	92 (97.9)	98 (93.3)		†< 0.001*
Diagnosed of high blood pressure					
Yes	3 (27.3)	6 (6.4)	9 (8.6)	5.484	0.019
No	8 (72.7)	88 (93.6)	96 (91.4)		†0.051
Has recurrent candidiasis					
Yes	5 (45.5)	50 (53.2)	55 (52.4)	0.236	†0.627
No	6 (54.5)	44 (46.8)	50 (47.6)		
Treated for infertility as a result of PCOS					
Yes	1 (9.1)	5 (5.3)	6 (5.7)	0.260	0.610
No	10 (90.9)	89 (94.7)	99 (94.3)		†0.494

** Statistically significant df = 1; † Fisher exact*

Table 4. Physical examination and laboratory investigation of respondents

Variable	Frequency (%) GDM n = 11	No GDM n = 94	Overall n = 105	χ^2	df	p-value
Blood pressure:						
Normal	9 (81.8)	93 (98.9)	102 (97.1)	10.397	1	0.001
Abnormal	2 (18.2)	1 (1.1)	3 (2.9)			†0.028*
Fundal height:						
GA	8 (72.7)	*83 (88.3)*	91 (86.7)	4.097	2	0.129
FH< GA	1 (9.1)	1 (1.0)	2 (1.9)			†0.091
FH> GA	2 (18.2)	10 (10.6)	12 (11.4)			
BMI (kg/m^2):						
18.5-24.9	0 (0)	16 (17.0)	16 (15.2)	7.104	2	0.029
25.0-29.9	2 (18.2)	40 (42.6)	42 (40.0)			†0.038*
≥30 (Obese)	9 (81.8)	38 (40.4)	47 (44.8)			
Mean BMI		34.2±5.8	29.3±5.2	29.8±5.4	MU =245.0;	p=0.004*
Glycosuria:						
Absent		2 (18.2)	76 (80.9)	78 (74.3)	20.247 1	P< 0.001
Present		9 (81.8)	18 (19.1)	27 (25.7)		†<0.001*
Proteinuria:						
Absent	11 (100)	90 (95.7)	101 (96.2)		0.487 1	*P*=0.485
Present	0 (0)	4 (4.3)	4 (3.8)			†1.000
Fasting Glucose:						
<7	7 (63.6)	94 (100)	101 (96.2)	35.536	1	*P*< 0.001
≥7	4 (36.4)	0 (0)	4 (3.8)			†<0.001*
2Hours post 75 g Glucose (Mmol/l)	**N=7**	**N=94**	**N=101**			
<7.8	0(0)	87(92.6)	94(93.1)			
≥7.8 – 11	0(0)	7(7.4)	7(6.9)			
≥11.1	7(100)	0(0)	7(6.9)			

** Statistically significant; † Fisher exact*

Table 5. Showing association of GDM with sociodemographic variables and clinical characteristics

Variable	Has GDM (%)			χ2	df	p-value
	Yes n = 11	No n = 94	Total n = 105			
Age (year)						
< 20	0 (0)	1 (100)	1	7.924	3	0.048
20 – 29	2 (5.3)	36 (94.7)	38			†0.094
30 – 39	7 (11.3)	55 (88.7)	62			
≥ 40	2 (50.0)	2 (50.0)	4			
Marital status						
Married	11 (10.8)	91 (89.2)	102	0.361	1	0.548
Single	0 (0)	3 (100)	3			†1.000
Education						
Primary	1 (50.0)	1 (50.0)	2	3.400	2	0.183
Secondary	3(10.0)	27 (90.0)	30			†0.260
Tertiary	7 (9.6)	66 (90.4)	73			
Obese						
Yes	9 (19.1)	38 (80.9)	47	6.821	1	0.009
No	2 (3.4)	56 (96.6)	58			†0.011*
Diabetic in previous pregnancy						
Yes	5 (71.4)	2 (28.6)	7	29.710	1	< 0.001
No	6 (6.1)	92 (93.9)	98			†< 0.001*
Diagnosed of high BP						
Yes	3 (33.3)	6 (66.7)	9	5.484	1	0.019
No	8 (8.3)	88 (91.7)	96			†0.051
Family history of DM						
Yes	6 (20.0)	24 (80.0)	30	4.062	1	0.044
No	5 (6.7)	70 (93.3)	75			†0.078

** Statistically significant ; †Fisher exact p*

Table 6. Table showing other associated risk factor for GDM

Associated risk factor for GDM	Frequency (%)			χ2	p-value	Fisher exact p
	GDM n = 11	No GDM n = 94	Overall n = 105			
Had associated risk factor						
Yes	10 (90.9)	33 (35.1)	43 (41.0)	12.681	< 0.001	0.001*
No	1 (9.1)	61 (64.9)	62 (59.0)			
Type of associated risk	**n = 10**	**n = 33**	**n = 43**			
Previous miscarriage	1 (10	11 (33.3)	12 (27.9)	2.077	0.150	0.237
First degree relative has DM	4 (40.0)	7 (21.2)	11 (25.6)	1.423	0.233	0.248
Previous macrosomic baby	4 (40.0))	5 (15.2)	9 (20.9)	2.863	0.091	0.177
Persistent glycosuria	2 (20.0)	6 (18.2)	8 (18.6)	0.017	0.897	1.000
Recurrent Candidiasis	3 (30.0)	3 (9.1)	6 (14.0)	2.794	0.095	0.127
Previous IUFD	1 (10)	3 (9.1)	4 (9.3)	0.008	0.931	1.000
Tobacco use	0 (0)	1 (3.0)	1 (2.3)	0.310	0.578	1.000

*Multiple responses; * Statistically significant*

To determine the relative risks of the various outcomes, the cohort of GDM mothers were carefully matched with controls for age and gravidity. It was observed that participants with GDM were 7 times more likely to have pre-eclampsia than those without GDM (RR = 7.48; 95% CI = 3.36 to 16.63). Participants with GDM were 9 times more likely to have macrosomic baby than those without GDM (RR = 9.00; 95% CI= 1.36 to 59.4). Babies of mothers with GDM were 8 times more likely to be admitted in SCBU than babies of mothers without GDM (RR = 8.00; 95% CI = 1.19 to 53.67). All the GDM mothers had normal post-partum OGTT.

Table 7. Multiple logistic regression of GDM on associated factors

Independent variables	p-value	Adjusted Odds Ratio	95% CI Lower	95% CI Upper
Age of participant (year)	0.091	1.18	0.97	1.43
Obese (Yes/No)	0.062	7.18	0.90	57.02
Family history of DM (Yes/No)	0.344	2.23	0.42	11.71
Diagnose diabetic in previous pregnancy (Yes/No)	0.004*	26.89	2.86	252.61
Diagnose hypertensive (Yes/No)	0.484	2.07	0.27	15.96

** Statistically significant*

Table 8. Maternal outcomes of GDM

Variable	Frequency (%) GDM n = 11	No GDM n = 94	Overall n = 105	χ2	df	p-value
Pre-eclampsia						
Yes	7 (63.3)	8 (8.5)	15 (14.3)	24.439	1	0.001
No	4 (36.4	86 (91.5)	90 (85.7)			†<0.001*
Mode of delivery						
Vaginal (spontaneous)	7 (63.6)	75 (79.8)	82 (78.1)	1.502	1	0.220
Caesarean section	4 (36.4)	19 (20.2)	23 (21.9)			†0.252
Type of caesarean section	**n = 4**	**n = 19**	**n = 23**			
Emergency	2 (50.0)	16 (84.2)	18 (78.3)	2.273	1	0.132
Elective	2 (50.0)	3 (15.8)	5 (21.7)			†0.194
Perineal tear						
Yes	1 (9.1)	0 (0)	1 (1.0)	8.628	1	0.003
No	10 (90.9)	94 (100)	104 (99.0)			†0.105
Post-partum hemorrhage						
Yes	0 (0)	1 (1.1)	1 (1.0)	0.118	1	0.731
No	11 (100)	93 (98.9)	104 (99.0)			†1.000

** Statistically significant ; † Fisher exact p*

Table 9. Indication for CS

Variable	Frequency (%) GDM (n = 4)	No GDM (n = 19)	Overall (n = 23)	χ2	p-value	Fisher exact p
Pre-eclampsia	0 (0)	6 (31.6)	6 (26.1)	1.709	0.191	0.539
CPD	0 (0)	6 (31.6)	6 (26.1)	1.709	0.191	0.539
Previous CS	1 (25.0)	4 (21.1)	5 (21.7)	0.030	0.862	1.000
Macrosomic baby	2 (50.0)	1 (5.3)	3 (13.0)	5.831	0.016*	0.069
Prolonged labour	1 (25.0)	0 (0)	1 (4.3)	4.966	0.026*	0.174
Unfavorable cervix	0 (0)	2 (10.5)	2 (8.7)	0.461	0.497	1.000
Breech presentation	0 (0)	2 (10.5)	2 (8.7)	0.461	0.497	1.000
Fetal distress	0 (0)	2 (10.5)	2 (8.7)	0.461	0.497	1.000
Previous IUFD	0 (0)	1 (5.3)	1 (4.3)	0.220	0.639	1.000
PROM	0 (0)	1 (5.3)	1 (4.3)	0.220	0.639	1.000
Grand multi-parity	0 (0)	1 (5.3)	1 (4.3)	0.220	0.639	1.000
Placenta previa	0 (0)	1 (5.3)	1 (4.3)	0.220	0.639	1.000
GDM in previous pregnancy	0 (0)	1 (5.3)	1 (4.3)	0.220	0.639	1.000

Multiple responses; Statistically significant; df = 1*

Table 10. Fetal outcomes

Variable	Frequency (%)			χ2	Df	p-value
	GDM n = 11	No GDM n = 94	Overall n = 105			
Gestational age at delivery						
Pre-term	0 (0)	4 (4.2)	4 (3.8)	3.072	2	0.215
Term	11 (100)	73 (77.7)	84 (80.0)			†0.296
Post date	0 (0)	17 (18.1)	17 (16.2)			
Method of determination of GA						
LMP	6 (54.5)	76 (80.9)	82 (78.1)	3.984	1	0.046*
Ultrasound	5 (45.5)	18 (19.1)	23 (21.9)			†0.060
Birthweight (kg)						
< 2.5	0 (0)	2 (2.1)	2 (1.9)	66.691	2	< 0.001
2.5 – 3.9	2 (18.2)	90 (95.8)	92 (87.5)			†< 0.001*
≥ 4.0	9 (81.8)	2 (2.1)	11 (10.5)			
Mean birthweight	4.3 ± 0.4	3.4 ± 0.4	3.5 ± 0.5			
Apgar score at 1 minute						
≤ 6	3 (27.3)	6 (6.4)	9 (8.6)	5.920	2	0.052
7 – 8	7 (63.6)	67 (71.3)	74 (70.5)			†0.051
9 – 10	1 (9.1)	21 (22.3)	22 (21.0)			
Mean Apgar score at 1 minute	4.5 ± 2.5	7.9 ± 1.0	7.7 ± 1.3			
Apgar score at 5 minutes						
≤ 6	2 (18.2)	1 (1.0)	3 (2.9)	15.691	2	< 0.001
7 – 8	4 (36.4)	12 (12.8)	16 (15.2)			†0.002*
9 – 10	5 (45.4)	81 (86.2)	86 (81.9)			
Mean Apgar score at 5 minutes	7.7 ± 2.9	9.0 ± 0.8	8.9 ± 1.3			
Admission in SCBU						
Yes	8 (72.7)	11 (11.7)	19 (18.1)	24.744	1	< 0.001
No	3 (27.3)	83 (83.3)	86 (81.9)			†< 0.001*
Reason for admission in SCBU	**n = 8**	**n = 11**	**n = 19**			
Asphyxia	2 (25.0)	8 (72.7)	10 (52.6)	8.334	6	0.215
Macrosomic baby	2 (25.0)	0 (0)	2 (10.5)			†0.075
Hypoglycemia	1 (12.5)	1 (9.1)	2 (10.5)			
Sepsis	1 (12.5)	1 (9.1)	2 (10.5)			
Low birth weight	0 (0)	1 (9.1)	1 (5.3)			
Jaundice	1 (12.5))	0 (0)	1 (5.3)			
Poor glycemic control	1 (12.5)	0 (0)	1 (5.3)			
IUFD						
Yes	1 (9.1)	0 (0)	1 (1.0)	8.628	1	0.003
No	10 (90.9)	94 (100)	104 (99.0)			†0.105

** Statistically significant; † Fisher exact p*

4. DISCUSSION

The prevalence of GDM in this study was 10.5% using the 1999 WHO criteria. This was within the range quoted for Sub Saharan Africa [3]. The high prevalence could be accounted for by the rise in obesity, adoption of Western lifestyle and urbanization. Earlier studies in Nigeria have shown that the prevalence of GDM is on the increase. The work of Wokoma et al. [4] in Port Harcourt reported a prevalence of 0.298%, Ozumba et al. [17] reported a prevalence of 1.7% diabetes in pregnancy for which GDM accounted for 61%, Ewenghi et al. [5] reported a prevalence of 4.3, Anzaku et al. [18] reported a prevalence of 8.3% and Kuti et al. [19] found a 13.9% prevalence of GDM with progressively ncreasing prevalence with time. The prevalence of GDM is also dependent on the screening criteria used. Higher prevalence has been obtained using the new WHO criteria. This could be due to the lower cut off values of the new criteria. This assertion was supported by the higher prevalence of 15.2% obtained by recent study by Akhidue et al. [20] in Port Harcourt.

Several studies [5,12,13] have reported an association between GDM and age. These have supported the assertion that a woman's risk factor for GDM increases as she gets older. Glucose tolerance is a function of insulin sensitivity, insulin secretion and pancreatic beta cell function and insulin sensitivity falls with age. The present study found a higher mean age for mothers with GDM (34.6 ± 5.3 vs 31.2 ±5.1) compared to those without GDM. It also reported an increased likelihood of developing GDM with increasing age from 5.3% to 11.3% to 50.0% in mothers with age 20-29, 30-39 and > 40 respectively. However, this was not statistically significant (P= 0.095). This was corroborated by some studies [3,18] who also found insignificant association between GDM and age.

The present study found the diagnosis of GDM in previous pregnancy as an independent risk factor (Adjusted OR 26.89; C.I – 2.86-252.61 P= 0.004) for GDM. This confirms the assertion that women who are diagnosed with GDM are at increased risk of GDM in future pregnancy. This was corroborated by Getahun et al. [21] who found that women with GDM in their first pregnancy had a 41% risk of GDM in second pregnancy compared with 4% among women without GDM in their first pregnancy. A similar report of increased incidence of recurrence of GDM in subsequent pregnancy was found by Ehrlich et al. [22] who found that 38% had GDM in subsequent pregnancy compared with 3.5% among women without GDM in first pregnancy. Other studies [12,23] also found previous history of GDM in previous pregnancy as an independent risk factor.

In the present study obesity was found to be a significant risk factor for GDM (P = 0.011). This may be due to increased demands on maternal metabolism during pregnancy from excess weight resulting in the imbalances in carbohydrate hormonal regulatory mechanisms and insulin sensitivity. However, some studies [24,25] found an insignificant association between obesity and GDM. As regards family history of diabetes mellitus (DM), the present study found no significant association between family history of DM and GDM. This finding does not agree with the work of Khan et al. [12] in Pakistan who found that a positive family history was present in 84.5% of the GDM mothers. It also disagrees with Bener et al. [26] who reported that a positive family history of DM was a significant risk factor in development of GDM. It however agrees with the study by Ewenighi et al 2013 that obesity is a risk factor [5].

Some studies [3,18] found a history of previous fetal macrosomia as a significant risk factor for GDM. In the present study a history of previous macrosomic baby was one of the commonest reported risk factors although there was no significant association with GDM. Similarly, Ali et al. in Yemen [24] found that previous macrosomic baby was not an independent risk factor for GDM. Also, Kew et al. [27] concluded that a prior pregnancy that resulted in a macrosomic baby is not necessarily presumptive evidence of undiagnosed GDM but may be a result of the influence of other predictors such as obesity. In the present study most of the historic risk factors were not statistically significant supporting the assertion that most GDM mothers do not have associated risk factors hence the need for universal screening.

In the present study, fetal macrosomia was a significant outcome of GDM. It demonstrated that the proportion of macrosomic babies was higher in participants with GDM (81.2%) than those without GDM (2.1%) and that participants with GDM were 9 times more likely to have macrosomic babies than those without GDM. Fetal macrosomia may be accounted for by the increased insulin resistance in the mother with a higher amount of blood glucose passing through the placenta into the fetal circulation. This largely manifest in the third trimester leading to overgrowth. This was similar to the report in a Turkish study by Erem et al. [28] which reported that the proportion of macrosomic babies among mothers with GDM was 88.9% as against 11.1% of non GDM mothers. Bener et al. [26] reported that the neonates of GDM mothers were significantly macrosomic (10.3% vs 5.9%; p=0.01). Also, a high incidence of fetal macrosomia was reported by John et al. [29] who demonstrated 49% of fetal macrosomia among GDM mothers. However, theirs was a retrospective study with attendant inadequacy of data which may account for the lower proportion. The report of the present study was in contrast to reports by Varghese et al. [30] who demonstrated no significant association between the incidence of fetal macrosomia and GDM in their study.

As regards admission of neonates into SCBU, the present study demonstrated a significant tendency for babies of GDM mothers (72.7%) to be admitted in SCBU than babies of non GDM

mothers (11.7%). Babies of GDM mothers are 8 times more likely to be admitted in SCBU than babies of mothers without GDM. This could be explained by the fact that GDM is associated with multiple neonatal morbidity necessitating admission. This was corroborated by a study in Southern India [31] which demonstrated a significant increase in neonatal admission among babies of GDM mothers. A similar report of high incidence of admission into SCBU was reported in another study by John et al. [29]. However, Augusto et al. [32] reported that there was no significant increase in the neonatal admission of babies of GDM mothers.

Regarding the presence of birth asphyxia as assessed with Apgar scoring, the present study demonstrated that the Apgar scores were significantly lower among babies of mothers with GDM than those without GDM. This may be accounted for by increased risk of perinatal asphyxia due to increased cases of macrosomia particularly with the risks of shoulder dystocia. Also, maternal and fetal hyperglycaemia before delivery leads to fetal hypoxemia. Another study by Rashid et al. [33] also found birth asphyxia to be significantly higher in mothers with GDM (20%) as compared to that of non-diabetic mothers (6%). However, this was in contrast to the reports by Augusto et al. [32] who observed no significant increase in birth asphyxia among babies from mothers with GDM. In the same vein, Deryabina et al. [34] in a case-control study of perinatal outcomes in pregnancies complicated with GDM demonstrated that asphyxia in the new-born did not depend on the presence or absence of GDM.

In this study, there was no incidence of congenital malformation. However, this is not surprising as the Fourth International Workshop Conference on GDM suggested that since onset of hyperglycaemia occurs late in pregnancy when organogenesis is complete, it is not associated with increased incidence of congenital abnormalities [13]. However, Sobande et al. [35] in their study found congenital malformation as a common fetal outcome in diabetes in pregnancy. But their study was not specific to GDM hence the pregestational component of the disease in the study population would have accounted for this outcome. Other outcomes of interest were IUFD, prematurity and perinatal death. However, these were not reported in the present study probably because the women were treated and monitored.

As regards maternal outcomes in this study, pre-eclampsia was significantly associated with GDM. Similar findings of higher proportion of pre-eclampsia among GDM mothers was reported by Chanu et al. [36]. Also, significant association between pre-eclampsia and GDM were reported by other studies [28]. In contrast however, Uma et al. [37] reported no significant difference in pregnancy complications such as pre-eclampsia among GDM and non GDM mothers. As regards the incidence of caesarean section, this study reported a higher incidence of CS among GDM mothers though the difference was not statistically significant. It however reported the major indication for CS in mothers with GDM to be due mainly to macrosomic babies and prolonged labour than in controls. This observation further explains the fact that macrosomia was a single complication from which many other complications arises. Some studies [13,37] did not find any significant association between C/S and GDM. However, other studies [26,29] reported significant association with operative delivery.

5. CONCLUSION

The study showed that the prevalence of GDM among pregnant women at RSUTH was 10.5%. History of GDM in previous pregnancies was an independent predictor of GDM. It also reported that GDM is associated with adverse maternal and fetal outcomes like pre-eclampsia, macrosomic babies and Neonatal admissions. The need for universal screening of all women during pregnancy for GDM is advocated for. This will help in the diagnosis of GDM even in women with no risk factors. Further community-based studies should be carried out with longer follow up to determine the true burden of the condition and the long-term consequences of GDM such as development of type 2 diabetes mellitus and its sequelae on the children of diabetic mothers.

6. LIMITATIONS OF THE STUDY

The study was hospital based and may not reflect the true situation of the general population.

Data on risk factors of the respondents were gathered through self-report and may be wrong. The period of follow up was limited to the puerperium and as such long-term complications of GDM could not be ascertained.

DISCLAIMER

The materials and drugs used in the study were provided by the first author with no aid from the manufacturers or distributors.

CONSENT AND ETHICAL APPROVAL

Ethical approval for the study was obtained from the Rivers State Health Research and Ethics Committee in Port Harcourt Nigeria. Participation was voluntary as Informed & written consent to participate and withdraw from the study was obtained and strict confidentiality was assured. No participant was made to pay for the materials or tests or drugs used for the study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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