Original Research Article

Gestational diabetes mellitus and the incidence of Diabetes mellitus post-partum – A Prospective study

Abstract

Background: The progression rate of GDM to T2DM is alarming and it is expected to increase as the year goes by. The study is aimed at estimating the postpartum prevalence of DM amongst GDM women and predict possible risk factors.

Methodology: This was a prospective cohort study that was carried out at the University of Port-Harcourt Teaching Hospital, Rivers State, Nigeria. We recruited 101 women using the hospital record from 2018-2019, 46 of them had GDM while 55 did not have GDM. Needed medical information was extracted from the hospital records of the participants. The postpartum DM status of the participants was determined using 75 g oral glucose tolerance test (OGTT). DM was diagnosed using WHO criteria. All analysis was done using SPSS software version 21.0

Result: The postpartum prevalence DM (IGT and T2DM) was 72.9% amongst the GDM group compared with 9% of the nGDM group followed for longer than 24 months. The significant risk factors for GDM was family history of diabetes, prior diagnosis of GDM and having GDM during the pregnancy. The relative risk for DM was 4.29, which means that a GDM mother has a 4 times likelihood of developing DM.

Conclusion: Prompt diagnosis and follow-up of GDM women postpartum should be encouraged to curb is rising surge in T2DM.

Keyword: Gestational Diabetes Mellitus, Gestational hyperglycemia, Diabetes, Glycemia postpartum, Risk factors, Nigeria

Background

There is an upsurge in the prevalence of non- communicable disease such as obesity, diabetes and nutrition related chronic diseases (NRCDs). Diabetes is a chronic medical condition that affects the body making it unable to convert food to serve as energy. Diabetes mellitus (DM) is defined by World Health Organization (WHO) as a metabolic disorder of chronic hyperglycemia characterized by disturbances to carbohydrate, protein, and fat metabolism resulting from absolute or relative insulin deficiency with dysfunction in organ systems [1]. When the body cannot produce enough insulin or cannot make use of the insulin it makes such an individual can be considered diabetic. [2] Gestational diabetes mellitus, which is a type of diabetes has been defined by the WHO as any degree of glucose intolerance with onset, or first recognized during pregnancy. The International Diabetes Federation (IDF 2019) reveals that about 415million people are living with diabetes and estimated that 223 million of these figure are women (20-79 years) and it is expected to increase to 343 million by 2045 and over eighty percent of those affected are from low- and middle-income countries where access to maternal care is often limited and Nigeria not left out. [3]
There has been reported cases of increase in pooled prevalence of diabetes in sub-Saharan Africa from 2015 to 2019. [4] As there continues to be a change in the trend of socioeconomic activities across developing countries so also will the incidence of diabetes with a significant increase in the occurrence of both type 1 and type 2 diabetes which is the major contributor in the global diabetes figure [3, 5]
It is one of the leading cause of perinatal and maternal morbidity and mortality especially in African countries as it has both short and long term health consequences and puts two generations of people at risk of DM in the nearest future. [6] Women who had gestational diabetes mellitus are at a high risk of developing type 2 diabetes in later life. [7-9]

With different findings reported across the globe, it is therefore imperative that we determine the postpartum prevalence of diabetes and its risk factors amongst women who received antenatal care as there is a dearth of up to date figure in Port-Harcourt using a hospital based research findings to contribute to what is known globally about the subject of DM and take proactive measures to halt its rise through prompt postpartum screening time and management.

MATERIALS AND METHODS

This study prospectively analyzed data of GDM (diagnosed between 24-28 weeks gestation using WHO diagnostic criteria) and non-GDM (normal glucose tolerance test) women who registered at the Obstetrics and Gynaecology department of the University of Port-Harcourt Teaching Hospital from January 1st, 2018 and December 31st, 2019. Baseline information of the study participants was obtained from the hospital records. A total of 101 women made up both GDM and non-GDM subjects were recruited for the study using systematic random sampling technique. All women diagnosed as having GDM received dietary counselling and oral anti-diabetic therapy or insulin treatment and self-monitoring of blood glucose level was carried out for proper monitoring of glucose level. A total of 101 women were followed up for a period of 24 months and longer after delivery to assess for postpartum outcomes of GDM and its risk factors.

Women who had a history of diabetes or overt diabetes before pregnancy, multiple pregnancy, pre-existing hypertension, chronic health conditions such as renal failure, congestive heart failure, or on drugs that might affect their glucose tolerance and pregnancy as at the time of oral glucose tolerance test postpartum were excluded from the study.

A well-structured questionnaire was given to the participants to extract the quantitative data. The questionnaires was written in simple and easy to understand English language. The questions was closed-ended. The questionnaires answered questions on socio-demographics of the participants, some risk factors was also extracted such as history of GDM in previous pregnancies, obstetric history, family history of diabetes, parity, and body mass index as well as some information on follow-up. The participating mother was notified through telephone conversation and booked for face to face interview, anthropometric measurements and oral glucose tolerance test using the WHO 2013 diagnostic criteria for 75g.

The weight and height of the participants was measured to determine their body mass index (BMI). Weight was measured in light clothing with a Seca Scale balance to the nearest 0.1kg, height was measured using a well calibrated stadiometer without shoes to the nearest 0.5cm. Body mass index (BMI) was calculated as weight in kg divided by height in m2. For each participant an initial screening of fasting blood glucose (FPG) was done after a fasting period of 8 h using the Accu-Chek® Compact Plus glucometer (F. Hoffmann- La Roche AG, Basel, Switzerland) after which 75g glucose load was given, after 1hour, plasma glucose concentration was measured and a repeat was done 2hours later for all the study participants.

The diagnosis of diabetes was made using 75-g OGTT when one or more of the following results were recorded. Normal value: Fasting plasma glucose 60 to 100mg/dL, One-hour glucose level less than 200mg/dL, two-hour glucose level less than 140mg/dL; Impaired glucose tolerance: Fasting plasma glucose 100 to 125mg/dL, two-hour glucose level 140 to 200mg/dL; Diabetes: Fasting plasma glucose greater than 126mg/dL, two-hour glucose level greater than 200mg/dL. [10]

Ethics approval for the study was obtained from the Ethics Committee of the University of Port-Harcourt, Rivers State. Nigeria, permission was also sought from the Obstetrics and Gyneacology department of University of Port-Harcourt Teaching Hospital and written informed consent was obtained from all women.

The information elicited from the questionnaires were coded and entered numerically for quantitative data into the excel software. The frequency and percentage of the socio-demographic characteristics of the participants and the independent variables were determined using the descriptive statistical tool on Statistical Package for Social Sciences (SPSS) version 20.0 for Windows (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp). Data were expressed as counts and frequencies, means and standard deviation were used for analyzing descriptive statistics while frequencies was used to compare using chi square to determine the association that exists between the categorical variables of interest. P-value = 0.05 was used as the threshold for statistical significance.

Results

From January 1st, 2018, to December 31st, 2019, we identified and recruited 101women in Port-Harcourt using the inclusion criteria for our study.

The socio-demographic / baseline characteristics of the study participants is as shown in Table 1.

Table 1: Socio-demographics characteristics of the participants

Socio-demographics	Frequency	Per cent
Mother's age category		
21 - 30yrs	19	18.8
31 – 40yrs	74	73.3
41 – 50yrs	8	7.9
Parity		
Primipara	26	25.7
Multipara	59	58.4
Grandpara	16	15.8
Religion		
Christianity	96	95.0
Islam	5	5.0
Education		
No formal education	3	3.0
Primary	2	2.0
Secondary	21	20.8
Tertiary	75	74.3
Occupation		
Housewife	18	17.8
Civil servant	26	25.7
Farming/Artisan	4	4.0
Professional/Engineer/Nurse/Teacher	12	11.9
Business	37	36.6
Clergy	1	1.0
Offspring age group(months)		
24 – 29	25	24.8
30 – 35	26	25.7
36 -41	47	46.5
42 – 47	3	3.0

The most prevalent age category was 31 – 40yrs 74 (73.3%) as these represents a large chunk of the study participants; majority of the participants are multipara 59 (58.4%), Christians were more frequent 96(95.0%); participants who had tertiary education 75(74.3%) were more frequent; most of the participants were businesswomen 37(36.6%).

The mean BMI for the mothers, mean age in years for the mothers and offspring and the mean weight are presented in Table 2 below;

Table 2: Descriptive statistics of continuous variables

Variables	Mean(±)	Standard Deviation
Mother's BMI	30.1	5.116
Mother's Age (years)	34.0	4.780
nGDM Mothers mean age (years)	33.6	5.387
GDM Mothers mean age (years)	35.1	3.489
nGDM Mothers mean weight (Kg)	75.8	13.284
GDM Mothers mean weight (Kg)	78.6	13.741
Offspring mean age (months)	32.8	5.223

The average BMI of the mothers was 30.15±5.11 and mean age was 34.0 ± 4.78 for both study groups that is the GDM and nGDM group, the GDM mothers had a higher mean age of 35.1 ± 3.49 compared with the nGDM cohort.

The women were followed up for a minimum of 2 years and longer. From our study, the postpartum prevalence of diabetes mellitus is shown in Table 3

Table 3: Postpartum prevalence of gestational diabetes mellitus

	Postpartum diabetes n (%)				
GDM Status	Diabetes	Normal	Total	X^2	p-value
GDM	35(72.9)	13(27.1)	48(100.0)	32.054	0.001
Non-GDM	9(17.0)	44(83.0)	53(100.0)		

The development of diabetes postpartum were thus: At follow-up of GDM mothers, 35 mothers (72.9%) had Diabetes Mellitus [(15 prediabetes and 20 T2DM)] while 13 mothers (27.1%) returned back to normoglycemic state. For the nGDM mothers, 9 mothers (17.0%) had Diabetes [(7 prediabetes and 2 T2DM)] while a larger percentage of the mothers continued in their original state 44 (83.0%), 53(100.0)]. The result was significant statistically (X^2 =32.054, 95% CI $p < 0.001$) in the prevalence of diabetes postpartum and GDM in mothers.

The Relative Risk of developing diabetes mellitus postpartum is shown in Table 4

Table 4: Risk estimate of gestational diabetes and development of diabetes postpartum

Postpartum diabetes	Risk value	95% C.I.	
		Lower	Upper
Odds ratio for GDM status/ Postpartum diabetes	1.3162	5.046	34.337
For cohort Postpartum Diabetes	4.294	2.311	7.980
For cohort Postpartum Normal	0.326	0.202	0.527

The Relative Risk of developing postpartum diabetes from GDM was 4.29 which means that a GDM mother has a 4.29 likelihood of developing DM postpartum.

Table 5: Comparison of Risk Factors with Gestational Diabetes

GDM Status	**Mothers Oral Glucose status**			X^2	p-value
	Normal	Prediabetes	Diabetes		
nGDM	44(83.0)	7(13.2)	2(3.8)	34.333	**0.001***
GDM	13(27.1)	15(31.3)	20(41.7)		
	Previous history of diabetes				
	No	Yes			
nGDM	51(96.2)	2(3.8)		7.109	**0.001***
GDM	11(22.9)	37(77.1)			
	BMI				
	Normal	Overweight/Obese			
nGDM	8(15.1)	45(84.9)		0.566	0.452
GDM	10(20.8)	38(79.2)			
	Smoking				
	No	Yes			
nGDM	52(98.1)	1(1.9)		0.915	0.339
GDM	48(100.0)	0(0.0)			
	Family history of diabetes				
	No	Yes			
nGDM	38(71.7)	15(28.3)		5.003	**0.025***
GDM	24(50.0)	24(50.0)			

***-Significance, p<0.05**

In Table 5, the significant risk factors for Diabetes Mellitus were: Family history of Diabetes, Previous diagnosis of Diabetes, and Mother's Oral Glucose Tolerance ($p<.05$) while Body Mass Index, Smoking, Parity, Level of education and age were not statistically significant.

Discussion

Abnormal glucose tolerance has been widely reported postpartum by different researchers amongst gestational diabetic women which is same with our findings. With a constant spike in the trend of diabetes mellitus prevalence across the globe and its public health burden, it has been predicted that between 2010 and 2030, the largest percentage prevalence of DM will be reported in sub-Saharan Africa than any other region. [11] Nigeria having a pooled prevalence of DM as 2.2% in 1992 and an increase to 5.77% in 2018 with the highest prevalence amongst the south-south region of the country where our study is being carried out, it is therefore imperative that urgent attention be given to the rising trend. Gestational diabetes mellitus has been considered to be one of the risk factors of diabetes mellitus (T2DM) in later life [9,12]

From our findings the prevalence of DM (IGT and T2DM) was 72.9% postpartum amongst the GDM mothers compared with 9% amongst the control subjects. Our findings is similar though higher than what was reported by other prospective studies where Albreda et al., reported a prevalence of 56.2% amongst 766 Spanish women who were followed for a period of 11 years, Zhirong et al., recorded a prevalence of 53.7% amongst 321 women who were followed for a period of 5 years, Morimitsu et al., reported a prevalence rate of 44% amongst 34 Latino women followed for a period of 16-24 weeks postpartum, Chunmei et al., reported a prevalence of 18.6% amongst 156 women who were followed for a duration of 46 days. [13,14,15,16]

The variation in prevalence across different studies stated above could be as a result of differences in study population / sample size used for the studies ranging from 101 to 766 participants which can either have an overpower or underpower effect on the outcome [17], number of years of follow-up/ postpartum interval as these was buttressed by Kim C et al in a systematic review that the progressing to DM increases in the first 5 years postpartum [18], ethnicity/race [19] and also the diagnostic criteria used which is similar to what was reported in a systematic review where the prevalence varied between 2.6% to 70% across different study populations with different characteristics [18].

In Nigeria, especially in South-south region which presents a greater percentage of the current pooled prevalence of DM in the country, the role of some factors like socio-economics status, literacy of the study participants which affects informed decision making in terms of choice of meals or consumption of what may seem to be healthy diet, lack of engagement in physical activities, cultural acceptance of overweight as bigger is better, health and access to healthcare all contributes to the high prevalence of DM [12].

Several studies have identified modifiable and non-modifiable risk factors of GDM such as BMI, advanced maternal age, parity, hypertension, first degree relatives that are diabetic, ethnicity, prior diagnosis of GDM and gestational age at delivery [13, 14, 15, 16, 20, 21-23]. Having a prior diagnosis of gestational diabetes, family history of diabetes and also gestational diabetes in the current pregnancy were predictors of DM but no association was seen amongst parity, ethnicity, maternal age, smoking and educational level. Our finding is in line with what was reported in South India where there was no significant relationship between maternal age and development of T2DM [23].

A major limitation of our study is the difficulty in assessing the study participants as some booked for postpartum screening didn't turn up which is usually the case for postpartum care in our locality, also some risk factors of GDM was not included, BMI of the participants was assessed postpartum which could have an effect on our findings.

CONCLUSION

Having reported a high postpartum prevalence of DM as 72.9% which shows a quick change from GDM to DM, there is therefore a need for health care providers to encourage immediate and frequent testing and follow-up of GDM mothers to lower the incidence rate while women who had an abnormally high glucose test result during postpartum screening where immediately referred to the obstetricians for onward management. American Diabetes Association guidelines recommend that women with GDM be screened 6-8 weeks postpartum and subsequently

every 3 years [24]. Modifiable risk factors should be addressed through behavioral changes such as engaging in active physical activities, counseling on diet modification and control of BMI and non-modifiable risk factors should also be given attention through the use of some pharmacological options which are available and easy to access.

Ethics Approval

Approval to carry out the research was given by University of Port-Harcourt Ethics Committee in line with the rules of human subjects. Certificate can be made available on request.

Consent to participate

All participants were briefed about the study and the sample to be collected. A consent form was given to all to complete and only those who gave consent to participate in the study were recruited.

Data Availability statement

All important data for the study has been presented above as the data set contains some clinical information of participants which cannot be made public as a result of ethical law supporting confidentiality, any other data needed can be made available through the corresponding author.

REFERENCE

1. WHO. Definition, diagnosis and classification of diabetes mellitus and its complications, part 1. Geneva: WHO; 1999
2. Center for Disease Control (CDC), 2021. https://www.cdc.gov/diabetes/basics/index.html
3. Atlas D. *IDF Diabetes Atlas.* 9th ed. Brussels, Belgium: International Diabetes Federation; 2019. International Diabetes Federation.
4. Agbozo F, Abubakari A, Zotor F, Jahn A. Gestational Diabetes Mellitus per Different Diagnostic Criteria, Risk Factors, Obstetric Outcomes and Postpartum Glycemia: A Prospective Study in Ghana. *Clinical Practice*. 2021 May 7;11(2):257-271
5. Guariguata L, Whiting DR, Hambleton I, Beagley J, Linnenkamp U, Shaw JE. Global estimates of diabetes prevalence for 2013 and projections for 2035. *Diabetes Research Clinical Practice* 2014;103:137–149
6. Nabi T, Rafiq N, Trigotra S, Mishra S. Clinical Characteristics, Outcomes, and Progression to Type 2 Diabetes in Women with Hyperglycemia in Pregnancy. *Indian Journal Endocrinology Metab*. 2021 Nov-Dec;25(6):538-544
7. Lowe Jr WL, Scholtens DM, Kuang A, Linder B, Lawrence JM, Lebenthal Y, et al. Hyperglycemia and adverse pregnancy outcome follow-up study (HAPO FUS): Maternal gestational diabetes mellitus and childhood glucose metabolism. *Diabetes Care.* 2019;42:372–380
8. Kampmann U, Madsen LR, Skajaa GO, Iversen DS, Moeller N, Ovesen P. Gestational diabetes: A clinical update. *World Journal Diabetes.* 2015;6:1065–1072
9. Bellamy L, Casas J, Hingorani A, Williams D. Type 2 diabetes mellitus after gestational diabetes: a systematic review and meta-analysis. *Lancet.* 2009;373:1773–1779.
10. World Health Organization. Definition and Diagnosis of Diabetes Mellitus and Intermediate Hyperglycaemia: Report of a WHO/IDF Consultation. World Health Organization and International Diabetes Federation; WHO Press; Geneva, Switzerland: 2006
11. Shaw, J. E., Sicree, R. A., & Zimmet, P. Z. Global estimates of the prevalence of diabetes for 2010 and 2030. *Diabetes Research Clinical Practice.* 2010; 87(1):4–14.

12. Uloko, A. E., Musa, B. M., Ramalan, M. A., Gezawa, I. D., Puepet, F. H., Uloko, A. T., Borodo, M. M., & Sada, K. B. Prevalence and Risk Factors for Diabetes Mellitus in Nigeria: A Systematic Review and Meta-Analysis. *Diabetes therapy : research, treatment and education of diabetes and related disorders.* 2018; *9*(3), 1307–1316. https://doi.org/10.1007/s13300-018-0441-1

13. Albareda, M., Caballero, A., Badell, G., Piquer, S., Ortiz, A., de Leiva, A., & Corcoy, R. Diabetes and abnormal glucose tolerance in women with previous gestational diabetes. *Diabetes care*. 2003; *26*(4), 1199–1205.

14. Zhirong Miao, Honghua Wu, Liu Ren, Nan Bu, Lili Jiang, Huixia Yang, Junqing Zhang, Xiaohui Guo, "Long-Term Postpartum Outcomes of Insulin Resistance and β-cell Function in Women with Previous Gestational Diabetes Mellitus", *International Journal of Endocrinology*, vol. 2020, Article ID 7417356, 7 pages

15. Mi, C., Liu, H., Peng, H., Cheng, C., Wang, M., Liu, H., Feng, G., Wu, J., Nie, H., & Liu, M. Relationships Among Pre-Pregnancy BMI, Gestational, and Postpartum Oral Glucose Tolerance Results in Women With Gestational Diabetes Mellitus. *Frontiers in nutrition*, 2021;*8*, 714690

16. Morimitsu, L. K., Fusaro, A. S., Sanchez, V. H., Hagemann, C. C., Bertini, A. M., & Dib, S. A. Fibrinolytic dysfunction after gestation is associated to components of insulin resistance and early type 2 diabetes in latino women with previous gestational diabetes. *Diabetes research and clinical practice*, 2007; *78*(3), 340–348.

17. Andrade C. Sample Size and its Importance in Research. *Indian journal of psychological medicine*, 2020; *42*(1), 102–103. https://doi.org/10.4103/IJPSYM.IJPSYM_504_19

18. Kim C, Newton KM, Knopp RH. Gestational diabetes and the incidence of type 2 diabetes: a systematic review. *Diabetes Care* 2002;25:1862–1868

19. Wang, Y., Chen, L., Horswell, R., Xiao, K., Besse, J., Johnson, J., Ryan, D. H., & Hu, G. Racial differences in the association between gestational diabetes mellitus and risk of type 2 diabetes. *Journal of women's health (2002)*, 2012; *21*(6), 628–633.

20. Hod M., Kapur A., Sacks D.A. The International Federation of Gynecology and Obstetrics (FIGO) Initiative on gestational diabetes mellitus: A pragmatic guide for diagnosis, management, and care. *Int. J. Gynecol. Obstet.* 2015;131:S173–S211.

21. Mahalakshmi MM, Bhavadharini B, Kumar M, Anjana RM, Shah SS, Bridgette A, et al. Clinical profile, outcomes, and progression to type 2 diabetes among Indian women with gestational diabetes mellitus seen at a diabetes center in south India. *Indian Journal Endocrinology Metab.* 2014;18(3):400–6

22. Linne Y, Barkeling B, Rossner S. Natural course of gestational diabetes mellitus: long term follow up of women in the SPAWN study. *BJOG An International Journal Obstetrics Gynaecology*. 2002;109(11):1227–31.

23. Krishnaveni G V, Hill JC, Veena SR, Geetha S, Jayakumar MN, Karat CLS, et al. Gestational diabetes and the incidence of diabetes in the 5 years following the index pregnancy in South Indian women. *Diabetes Research Clinical Practice*. 2007; 78(3):398–404.

24. American Diabetes Association Standards of medical care in diabetes – 2014. *Diabetes Care*. 2014;37(suppl 1):S14–S80.