

Original Article

Lipid Profile Pattern among Women Screened for Hyperglycaemia in Pregnancy at the University of Jos Teaching Hospital, Nigeria

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Abstract

Background: Hyperglycaemia in pregnancy (HIP) represents one of the most common medical challenges in pregnancy and the leading cause of adverse pregnancy outcomes the world over. Normal pregnancy is characterized by physiological adaptations such as progressive gestation-dependent increases in maternal triglycerides and total cholesterol which could be affected by insulin resistance, a common denominator affecting glucose and lipid metabolism. The study aimed to compare the patterns among pregnant women with HIP and those without HIP and determine the correlates of dyslipidaemia in pregnant women with HIP.

Methodology: This was a descriptive cross-sectional study. A total of 204 participants were recruited, made up of 65 women with HIP (cases) and 139 normoglycaemic women (controls). The data collected included demographics, anthropometric measurements, and medical history. Lipid profile assays were done using Roche Cobass C111 automated analyser (sdLDL was isolated using the Hiranol method prior to analysis).

Results: The prevalence of HIP was found to be 31.7% among the study population. Dyslipidemia defined by LDL, TG, TC, HDL, and sdLDL was seen in 60%, 38.5%, 22.5%, 19%, and 30% respectively. Women with HIP had a slightly higher risk of dyslipidemia than normoglycaemic women. Overall, the difference in dyslipidemia between HIP and normoglycaemic women was not statistically significant.

Conclusion: Dyslipidemia in pregnancy is a relatively common finding in the Nigerian population. However, the pattern of dyslipidemia in normoglycaemic pregnant women is largely similar to the pattern seen in women with hyperglycaemia in pregnancy in the Nigerian population.

Keywords: Hyperglycaemia In Pregnancy; Dyslipidaemia; Lipids; Lipoproteins; Small Dense LDL Cholesterol.

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Introduction

Hyperglycaemia in pregnancy (HIP) represents one of the most common medical challenges in pregnancy. HIP, manifesting as gestational or pre-gestational (Overt) Diabetes Mellitus (DM) is a leading cause of adverse pregnancy outcomes the world over. Hyperglycaemia and other metabolic derangements due to Gestational Diabetes Mellitus (GDM) and Overt Diabetes Mellitus in pregnancy (ODM) are associated with an increased risk of maternal and foetal complications.[1,2]

Women with a history of GDM are at increased risk of developing major cardiovascular risk factors, such as Type 2 DM, metabolic syndrome, hypertensive heart disease, as well as atherosclerosis.[3] These risks have been demonstrated to persist, despite the normalization of these glucose values shortly after delivery[4]

There is growing interest in understanding the correlation between HIP and the long-term risk of cardiovascular sequelae. Dyslipidaemia is known to contribute to the pathophysiology of cardiovascular diseases. Normal pregnancy is characterized by physiological adaptations such as progressive gestation-dependent increases in maternal triglycerides and total cholesterol (hypertriglyceridaemia and hypercholesterolaemia). The expected rise in total cholesterol is termed maternal physiological hypercholesterolaemia (MPH).[5]

The metabolism of lipids appears to be one of several pathways that are deranged in women with HIP. Dyslipidaemia in DM shows a lipid pattern of elevated concentrations of Triglyceride-rich lipoproteins (TG), low concentrations of cholesterol-rich High-density Lipoprotein (HDL-C), and a preponderance of the small-dense Low-density lipoprotein particles- a pro-atherogenic pattern. Since insulin resistance is the common denominator between T2DM and HIP, a similar lipid pattern is expected in women with HIP. However, several studies suggest varying forms of dyslipidaemia in women with HIP which may be related to racial differences, genetic determinants, and a host of other comorbidities such as obesity and a family history of DM.

Whereas higher TG, and TG/HDL-C ratios, with no significant alteration in Total Cholesterol (TC) between the HIP and normoglycaemic control groups, has been reported,[6] others [7,8] have reported significantly elevated levels of TC with attendant complications among women with HIP. This elevated TC pattern has been referred to as maternal supra-physiological hypercholesterolaemia (MSPH). Although maternal supra-physiological hypercholesterolaemia may occur independently of GDM, the majority of cases are associated with GDM.[5,7]

The sdLDL lipid sub-fraction has been shown to have a positive association with coronary artery disease and is thought to be an atherogenic lipoprotein.[9,10] Patients with HIP had a tendency toward the predominance of sdLDL, which may contribute to an increased risk for atherosclerosis and cardiovascular disease (CVD) in the post-partum period.[10] Women with the predominant hypertriglyceridaemia pattern have been demonstrated to have a high risk of foetal macrosomia and interventions during delivery, while those with a pattern of predominant hypercholesterolaemia show micro- and macrovascular endothelial dysfunction in mother and foetus, with risk for atherosclerosis in mother and child later in life.[11] MSPH is thought to be associated with foetal endothelial dysfunction and atherosclerosis, leading to cardiovascular disease.

Despite the highlighted implications of dyslipidaemia in adverse pregnancy outcomes of women with HIP,[4,5,7,11,12] the pattern of lipid disturbances in Nigerian pregnant women has not been well evaluated. This study is therefore an attempt to evaluate the lipid pattern in pregnant women with various forms of HIP with a view to providing baseline data that may provide further understanding of cardio-metabolic disturbances in HIP necessary to prevent adverse outcomes in women with HIP.

The prevalence of HIP is rising in Nigeria in keeping with the global trend occasioned by the ongoing epidemiological transition. For instance, recent studies in Jos suggested a prevalence of 9.9% in 2012 [13] based on WHO 1999 guidelines and a rise to 20.5% (GDM 15.7%, DIP 4.8%) in 2017[14], based on the WHO 2013 guidelines. In addition, the high fertility rate in Nigeria is expected to increase the burden of HIP in Nigeria in the coming years. This has implications for the increased burden of CVDs given that HIP is a strong predictor for future DM and CVD. [13,14]

Also, given that dyslipidaemia is key in the pathogenesis of CVD, it is important to understand the pattern of dyslipidaemia in women with HIP especially in the Nigerian context. There is however limited data on this subject in women with HIP. Few studies conducted on women with GDM have been reported in Nigeria[15,16] These studies did not describe the sdLDL subfractions of the lipid profile, and these studies considered GDM patients rather than HIP entirely. More so, the recent reclassification of HIP has made it imperative to study the lipid derangements in the various forms of HIP as previous studies did not examine this[.12, 15,16]

Methodology

The study was conducted at the Jos University Teaching Hospital (JUTH). JUTH is a 600-bed tertiary health centre with an established Obstetrics and Gynaecology department, which runs Antenatal clinics. The Department of Chemical Pathology runs a Dynamic Function Test (DFT) and Metabolic clinic where screenings for HIP are conducted.

The hospital serves the multi-ethnic population of the Jos Metropolis, as well as the surrounding states of Nassarawa, Kaduna, Benue, Gombe, and Bauchi States, for which it serves as a referral centre

Study Design

This study is an observational cross-sectional study conducted among pregnant women who were referred to the Metabolic Clinic of JUTH for an Oral Glucose Tolerance Test.

Study Population

Pregnant women are referred to the Metabolic Clinic of JUTH for OGTT due to the presence of risk factors which include obesity/overweight, a previous diagnosis of gestational diabetes, impaired glucose tolerance, or impaired fasting glycaemia; family history of a first-degree relative with T2DM; maternal age greater than 25 years; ethnic background such as African-Americans, Afro-Caribbeans, Native Americans, Hispanics, Pacific Islanders, and people originating from South Asia; a previous pregnancy which resulted in a child with a high birth weight (> 90th centile, or > 4000g) and previous poor obstetric history.

However, some obstetric units in the hospital practice universal screening for HIP. Screening for HIP is usually done between 24-28weeks of gestation. All women who consented and met the inclusion criteria were included in the study.

Inclusion Criteria

Consenting confirmed pregnant women not known to be diabetic, who were referred before 28 weeks of gestation.

Exclusion Criteria

Non-consenting pregnant women: Pregnant women whose first Antenatal visit will be after 28weeks of pregnancy; Hb less than 10g/L; Uncertain date of last menstrual period and no ultrasonographic estimation between 6 and 24 weeks of gestational age; Multiple pregnancies; Assisted conception by means of gonadotropin ovulation induction or in vitro fertilization; A diagnosis of Diabetes Mellitus before the current pregnancy and requiring treatment with medication and Pregnant women who are on

drugs that affect glucose and lipid metabolism such as steroids, beta-adrenergic blockers, and thiazide diuretics.

Study Procedure

A 2-hour OGTT with a 75g glucose load was carried out on all the participants, according to WHO standards, and blood samples were obtained for blood glucose assay. The sample for lipid determination was collected with the 0-hour blood sample after an 8-hour overnight fast in a plain vacutainer tube, following the standard order of draw of blood samples. Blood pressure, weight, and height were determined during the same test visit.

Blood specimens were collected from participants after an overnight fast of 8 hours in a well-lit phlebotomy room of the department. Under the aseptic technique, the vacutainer system was used to collect five millilitres of blood each into a fluoride oxalate container – for Fasting plasma glucose (FPG). All assays were done using the Roche Cobass C111 autoanalyser, and the sdLDL was run using the same machine, after subjecting the sample to the precipitation method of Hirano et al for sdLDL assay [18].

Definition of Glycaemic Status

Based on the outcome of the test, using the revised WHO 2013 criteria and the proposed cut-off values, participants were grouped into two, namely, “hyperglycaemia in pregnancy” (HIP) and normo-glycaemia in pregnancy (NIP). GDM is defined as a milder form of hyperglycaemia defined by the glucose ranges in Table 1. Overt DM is regarded as a higher degree of hyperglycaemia within the diabetic range in a non-pregnant population. The HIP is defined as any degree of hyperglycaemia ranging from milder to more severe forms. The description for the definition of NIP, GDM, and HIP are summarized in Table 1. Abnormalities in any of the time points are sufficient to make the diagnosis of GDM or HIP.

Table 1: Showing description for the definition of NIP, GDM, and HIP

	Normoglycaemia	GDM	Overt DM	HIP
0-hour (fasting) (mmol/L)	<5.1	5.1-6.9	≥ 7.0	≥ 5.1
1-hour (mmol/L)	< 10.0	≥ 10.0		≥ 10.0
2-hour (mmol/L)	< 8.5	8.5-11.0	≥ 11.1	≥ 8.5

Statistical Analysis

All data generated were cleaned, collated, and entered to a Microsoft Excel[®] spreadsheet 2007 and subsequently exported and analyzed using the Statistical Package for Social Science (SPSS[®]) version 23 for Windows. Quantitative data were presented using mean and standard deviation. Statistical analysis to compare quantitative variables was done using the student t-test while the chi-square test was to compare used qualitative variables. A confidence interval of 95% was used and the level of statistical significance was taken as a p-value of <0.05.

Ethical Consideration and Informed Consent

Ethical approval was obtained from the Jos University Teaching Hospital ethical committee. The objectives of the study, procedure, and benefits were explained to participants before enrolment for the study. All data collected from participants for the study were confidential, participation was voluntary, and the study did not add to the financial burden of the participants as no fee was charged for all

investigations. Participation was entirely voluntary, and participants were free to withdraw at any time with no obligations. The consent forms were signed at the participation venue.

Results

Prevalence of Hyperglycaemia in Pregnancy

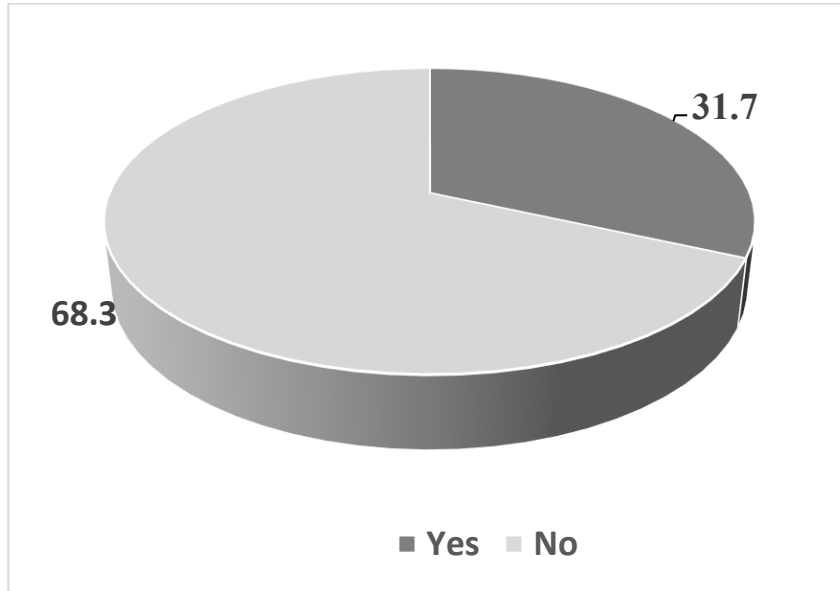


Figure 1: Proportion of women with hyperglycaemia in pregnancy

As shown in Figure 1, the proportion of women with hyperglycemia in pregnancy among pregnant women [at risk for hyperglycemia] within the 24-28week window was found to be 31.7%.

Socio-Demographic Characteristics of Participants

The socio-demographic characteristics of the participants is shown in Table 2, majority of the participants were in the 24–35-year age group, with HIP more prevalent in women with higher gravidity ($p=0.033$) and obesity 18(27.7) vs. 15(10.7), $p = 0.002$.

Table 2: Comparison of the Socio-Demographic Characteristics of the Study Participants

Variable	HIP group (n=65) f(%)	Control group (n=140) f(%)	Total (n=205) f(%)	X ²	p-value
Age group (years)					
<25	8(12.3)	25(17.9)	33(16.1)	3.251	0.197
25-34	30(46.2)	74(52.9)	104(50.7)		
≥35	27(41.5)	41(29.2)	68(33.2)		
Mean age (years)±SD	32.2±6.1	30.6±6.2	31.1±6.2	1.716 [#]	0.088
Education					
Primary	2(3.0)	4(2.9)	6(2.9)	0.539	0.722

Secondary	25(38.5)	46(32.9)	71(34.6)		
Tertiary	38(58.5)	90(64.2)	128(62.5)		
Gravidity					
1	7(10.8)	26(18.6)	33(16.1)	10.504	0.033*
2	6(9.2)	39(99.3)	37(18.0)		
3	15(23.1)	24(17.1)	39(19.0)		
4	12(18.5)	27(19.3)	39(19.0)		
5	25(38.5)	32(22.9)	57(27.8)		
Obesity					
Yes	18(27.7)	15(10.7)	33(16.1)	9.474	0.002*
No	47(72.3)	125(89.3)	172(83.9)		

T-test, * Statistically significant.

Clinical and Anthropometric Characteristics of the Study Participants

The clinical and anthropometric variables of the study participants is displayed in table 3.

Table 3: Comparison of the Clinical and Anthropometric Characteristics of the Study Participants

Variable	HIP Mean±SD	Control Mean±SD	Total Mean±SD	T-test	p-value
GA(weeks)	26.0±1.6	26.0±1.5	26.0±1.5	0.348	0.727
Height(m)	1.63±0.06	1.6±0.07	1.61±0.07	2.1883	0.030*
BMI(kg/m ²)	33.4±6.0	30.1±6.6	31.1±6.5	3.506	0.001*
Systolic (mmHg)	116.1±16.6	109.1±15.1	111.3±15.9	2.982	0.003*
Diastolic (mmHg)	69.6±13.3	67.0±12.5	69.6±13.3	1.359	0.176
Gravidity	4.4±2.4	3.4±2.2	3.7±2.3	2.946	0.004*
Parity	2.6±2.0	1.9±1.8	2.1±1.9	2.538	0.012*
No of miscarriages	1.7±1.0	1.6±0.8	1.6±0.9	0.662	0.511
Weight(kg)	88.6±17.1	77.5±16.8	81.0±17.6	4.379	<0.001*

* Statistically significant.

Biochemical characteristics in the study participants

Table 4 shows the biochemical variables in the study participants and compares those with HIP and without HIP.

Table 4: Comparison of biochemical parameters of the study participants

Variable	HIP Mean±SD	Control Mean±SD	Total Mean±SD	T-test	p-value
OGTT 0HR	5.5±1.0	4.4±0.4	4.9±0.9	11.675	<0.0001*
OGTT 1HR	8.7±2.3	6.3±1.2	7.1±2.0	10.023	<0.0001*
OGTT 2HR	8.2±2.3	5.8±1.1	6.6±1.9	10.165	<0.0001*
TG	1.6±0.6	1.6±0.6	1.6±0.6	0.352	0.726
TC	4.4±1.0	4.5±1.0	4.4±1.0	0.503	0.616
HDL	1.2±0.4	1.3±0.4	1.3±0.4	1.486	0.139
LDL	2.5±1.0	2.4±0.9	2.5±0.9	0.286	0.775
SDL	0.7±0.4	0.7±0.5	0.7±0.5	0.033	0.974
TC/HDL	4.2±1.7	4.1±3.5	4.2±3.1	0.059	0.953
TG/HDL	1.5±0.8	1.5±1.4	1.5±1.2	0.144	0.886
%sdLDL/LDL	31.8±21.1	31.0±20.6	31.2±20.7	0.249	0.804

*Statistically significant Note: All values in mmol/L except percentage sdLDL/LDL

The mean values of OGTT 0HR (mmol/L) 5.5±1.0 vs 4.4±0.4, OGTT 1HR (mmol/L) 8.7±2.3 vs. 6.3±1.2 and OGTT 2HR (mmol/L) 8.2±2.3 vs. 5.8±1.1, were significantly higher in subjects with HIP than those without HIP. No differences were observed in the lipid profile parameters of both groups.

Prevalence of Dyslipidaemia among study participants

There was no significant difference in the comparison of prevalence of elevated parameters of lipid profile between participants with HIP and without HIP as shown in Table 5.

Table 1: Comparison of Dyslipidaemia among the Study Participants

Variable	HIP group (n=65) f(%)	Control group (n=140) f(%)	Total n=205 f(%)	X ²	p-value
Elevated TC					
Yes	15(23.6)	31(22.1)	46(22.4)	0.022	0.881
No	50(76.4)	109(77.9)	159(77.6)		
Elevated TG					
Yes	23(35.4)	56(40.0)	79(38.5)	0.399	0.527
No	42(64.6)	84(60.0)	126(61.5)		
Elevated LDL					
Yes	29(44.6)	58(41.4)	87(42.4)	0.185	0.667
No	36(55.4)	82(58.6)	118(57.6)		
Decreased HDL					

Yes	16(24.6)	23(16.4)	39(19.0)	1.931	0.165
No	49(75.4)	117(83.6)	166(81.0)		
Elevated sdLDL					
Yes	19(29.2)	43(30.7)	62(30.2)	0.046	0.830
No	46(70.8)	97(69.3)	143(69.8)		
Elevated TC/HDL					
Yes	30(46.2)	55(39.3)	85(41.0)	0.863	0.353
No	35(53.8)	85(60.7)	80(100.0)		
Elevated TG/HDL					
Yes	42(64.6)	80(57.1)	122(59.5)	1.029	0.310
No	23(35.4)	60(42.9)	83(40.5)		
Elevated % sdLDL/LDL					
Yes	30(46.2)	67(47.9)	97(47.3)	0.052	0.820
No	35(53.8)	73(52.1)	108(52.7)		

At least one dyslipidaemia

The association cardiovascular risk factors and obstetric parameters and the prevalence of various elevated lipid profile parameters is displayed in table 6 and 7.

Table 6: Association cardiovascular risk factors and obstetric parameters with elevated lipid profile parameters

Variable	Elevated total cholesterol			Elevated triglyceride		
	Yes (n=15) f(%)	No (n=50) f(%)	p-value	Yes (n=23) f(%)	No (n=42) f(%)	p-value
Age group (years)						
<25	3(37.5)	5(62.5)	0.557	1(12.5)	7(16.7)	0.334
25-34	7(23.3)	23(76.7)		11(36.7)	19(63.3)	
≥35	5(18.5)	22(81.5)		11(40.7)	16(59.3)	
Diabetes						
Yes	1(33.3)	2(66.7)	>0.999	1(33.3)	2(66.7)	>0.999
No	14(22.6)	48(77.43)		22(35.5)	40(64.5)	
Hypertension						
Yes	2(15.4)	11(84.6)	0.713	3(23.1)	10(76.9)	0.476
No	13(25.0)	39(75.0)		20(38.5)	32(61.5)	
Family History of Diabetes						
Yes	5(23.8)	16(76.2)	0.923	8(38.1)	13(61.9)	0.752
No	10(22.7)	34(77.3)		15(34.1)	29(65.9)	
Family History of hypertension						
Yes	8(23.5)	26(76.5)	0.928	11(32.4)	23(67.6)	0.592
No	7(22.6)	24(77.4)		12(38.7)	19(61.3)	
Miscarriage						
Yes	6(23.1)	20(76.9)	1.000	8(30.8)	18(69.2)	0.525
No	9(23.1)	30(76.9)		15(38.5)	24(61.5)	

Stillbirth						
Yes	2(16.7)	10(83.3)	0.559	4(33.3)	8(66.7)	0.999
No	13(24.5)	40(75.5)		19(35.8)	34(64.2)	
PRV						
Yes	5(27.8)	13(72.2)	0.578	9(50.0)	9(50.0)	0.127
No	10(21.3)	37(78.7)		14(29.8)	33(70.2)	

Table 7: Association cardiovascular risk factors and obstetric parameters with elevated lipid profile parameters

Variable	Decreased HDL			Elevated LDL			Elevated sdLDL		
	Yes (n=29) f(%)	No (n=36) f(%)	p- value	Yes (n=16) f(%)	No (n=49) f(%)	p- value	Yes (n=19) f(%)	No (n=46) f(%)	p- value
Age group (years)									
<25	3(37.5)	5(62.5)	0.575	2(25.0)	6(75.0)	0.324	6(75.0)	2(25.0)	0.067
25-34	13(43.3)	17(56.7)		5(16.7)	25(83.3)		6(20.0)	24(80.0)	
≥35	13(48.1)	14(51.9)		9(33.3)	18(66.7)		7(25.9)	20(74.1)	
Diabetes									
Yes	2(66.7)	1(33.3)	0.848	2(66.7)	1(33.3)	0.296	1(33.3)	2(66.7)	0.999
No	27(43.5)	35(56.5)		14(22.6)	48(77.4)		18(29.0)	44(71.0)	
Hypertension									
Yes	5(38.5)	8(61.5)	0.618	4(30.8)	9(69.2)	0.829	4(30.8)	9(69.2)	0.999
No	24(46.2)	28(53.8)		12(23.1)	40(76.9)		15(28.8)	37(71.2)	
Family History of Diabetes									
Yes	12(57.1)	9(42.9)	0.160	7(33.3)	14(66.7)	0.260	4(19.0)	17(81.0)	0.339
No	17(38.6)	27(61.4)		9(20.5)	35(79.5)		15(34.1)	29(65.9)	
Family History of hypertension									
Yes	17(50.0)	17(50.0)	0.360	10(29.4)	24(70.6)	0.347	9(26.5)	25(73.5)	0.608
No	12(38.7)	19(61.3)		6(19.4)	25(80.6)		10(32.3)	21(67.7)	
Miscarriage									
Yes	12(46.2)	14(53.8)	0.839	6(23.1)	20(76.9)	0.814	7(26.9)	19(73.1)	0.738
No	17(43.6)	22(56.4)		10(25.6)	29(74.4)		12(30.8)	27(69.2)	
Stillbirth									
Yes	6(50.0)	6(50.0)	0.678	3(25.0)	9(75.0)	0.999	3(25.0)	9(75.0)	0.999
No	23(43.4)	30(56.6)		13(24.5)	40(75.5)		16(30.2)	37(69.8)	
PRV									
Yes	8(44.4)	10(55.6)	0.986	3(16.7)	15(83.3)	0.549	2(11.1)	16(88.9)	0.092
No	21(44.7)	26(55.3)		13(27.7)	34(72.3)		17(36.2)	30(63.8)	

Discussion

This study examined lipid patterns in the context of hyperglycaemia in pregnancy. The prevalence of HIP in the study was 31.7%, which was higher than previous reports in the same centre [15]. A 2017 study in the same centre, using the same criteria showed a prevalence of 20.5%, while a 2019 study in South East Nigeria [18] showed a similar prevalence (35.9%) with the results of this study. The increase in prevalence noticed is in line with the global increase in the incidence of glucose-related metabolic disturbances in both pregnant and non-pregnant populations.[19-23] This finding could be explained by changing dietary patterns, socioeconomic, as well as socio-behavioral dynamics in the last decade as well as genetic factors.

The majority of the subjects with HIP were classified based on their fasting plasma glucose levels alone (52%), while a lower proportion was classified based on their 1-hour and 2-hour values alone (15% and 1.5% respectively). This was based on the WHO 2013 criteria [17]. The use of other criteria suggesting a fasting plasma glucose cut-off of 5.3 mmol/L or 5.6mmol/L may significantly reduce the prevalence of HIP in this environment[15]. The implications of this reclassification in terms of outcomes would however need to be ascertained.

In this study, the overall prevalence of dyslipidemia in pregnant women as defined by at least one derangement in TC, TG, HDL, or LDL was 60%. Similar studies in Brazil[24] and Southern China[25] reported values of 83.3% and 31% using their respective national guidelines. The variation could be explained by varying guidelines in different environments, as no consensus on normal lipid values in pregnancy has been established. Dietary and genetic differences in metabolic patterns could also explain the wide variation. Comparing the HIP and normoglycemic subjects, a higher percentage of patients with HIP had at least one form of dyslipidemia than the normoglycemic group (67% and 55% respectively). A similar study in Tel Aviv showed a 1.8-fold risk among patients with GDM. Genetic and dietary differences, as well as socio-economic differences could explain this finding.

The commonest derangement noticed among the respondents was dyslipidemia based on their LDL-C levels in 48% of the women. This finding was not consistent with findings in largely Caucasian populations²⁶of about 60% incidence of LDL-C defined dyslipidemia. This could be attributable to the differences in dietary patterns between the African and Western populations and the incidence of obesity in the respective general populations.

Furthermore, 22.46% of pregnant women had dyslipidemia as defined by high levels of total cholesterol. This finding was expected and explainable, due to physiological increases in maternal cholesterol in pregnancy (MPH). This is consistent with pregnancy, as cholesterol increases to meet the demands of the growing foetus.²⁷ Though no consensus on normal values of TC in pregnancy has been established, values of >5.2mmol/L are considered high because they are associated with atherogenic changes (Adult Treatment Panel III)[18]. The difference between HIP subjects and normo-glycemic subjects was not found to be significant statistically. The relatively low cholesterol values observed when compared to Western populations could be due to genetic factors or due to the high-fibre diet in this part of the world, as well as a less sedentary lifestyle in the African population. The relatively lower prevalence of obesity in the Nigerian/African population could also explain this finding [15].

Hypertriglyceridemia was found in 38.5% of the study population. This was also an expected finding, as increases in serum triglycerides up to 4.6mmol/L are not uncommon findings in pregnancy, being an increased metabolic demand state[28]. The difference between HIP subjects and normoglycemic subjects was not statistically significant because physiological rises 2 to 4 times pre-pregnancy values are non-atherogenic and fall rapidly after delivery. About 65% of women with HIP had normal TG levels, which was consistent with findings in a European study that TG levels remained relatively unchanged in patients with T2DM [29].

Low levels of HDL-C define dyslipidemia. Due to the varying definitions of low HDL values (0.9-3.69mmol/L)[26] in pregnancy, the incidence of HDL-defined dyslipidemia was relatively low among the study population with an incidence of 19%. The mean HDL value was 1.3mmol/L which was similar to the findings in an Indian population[19]. This is possibly due to similar environmental, dietary, as well as socio-behavioral variables between African and Indian populations.

From the results of the study, findings were consistent with a similar Chinese study where no significant relationship was found in HDL-C, non-HDL-C, or TG between GDM and normoglycemic groups[30].

Small dense LDL (sdLDL) is not routinely assayed as a marker of dyslipidemia. In this study, thirty percent of the study population had elevated levels of sdLDL. Being a variant of LDL, this was not an unexpected finding due to high cholesterol requirements for the developing foetus. Fewer subjects had elevated sdLDL than those with elevated LDL (30% and 42.8% respectively), suggesting that elevations in serum LDL levels do not necessarily imply a concomitant increase in the more atherogenic sdLDL among women with HIP. Genetic factors may thus determine the predisposition to the formation of the more atherogenic sdLDL particle relative to the large buoyant variant. Using the cut-off value of 30% for the percentage sdLDL/LDL[20], a similar proportion of subjects in the HIP and control groups had elevated percentage sdLDL/LDL. Like other markers of dyslipidemia, the difference between the HIP and normoglycemic populations was not statistically significant. This was expected since sdLDL is a variant of LDL.

Due to the atherogenic risk of high plasma cholesterol, LDL, and sdLDL fractions, it is possible to have a proportional risk of cardiovascular disease, especially in grand multiparous women with elevated lipids due to repeated exposures to high cholesterol levels during the period of their pregnancies.

In conclusion, dyslipidemia in pregnancy is a relatively common finding in the Nigerian population, as is seen in Western and Asian populations. However, the pattern of dyslipidemia in normoglycaemic pregnant women is largely like the pattern seen in women with hyperglycaemia in pregnancy in the Nigerian population,

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