Dyslipidemia and Associated Risk Factors among Nigerians with Hypertension

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Keywords

Dyslipidemia · Hypertension · Cardiovascular disease

Abstract

Background: Abnormalities in serum lipids and lipoprotein levels with essential hypertension are vital independent causal factors for atherosclerotic cardiovascular disease (ASCVD). The coexistence of these factors has a synergistic effect in heightening the risk of cardiovascular events. The aim of the study was to evaluate the pattern of dyslipidemia among hypertensives and to determine some of its correlations in patients attending a tertiary hospital in South South Nigeria. **Methods:** This was a cross-sectional study conducted on 544 eligible hypertensive patients attending the Cardiology Clinic, University of Uyo Teaching Hospital (UUTH), Uyo, Nigeria, over a period of 6 months. Fasting lipids, total cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C) were evaluated. **Results:** Overall, 60.0% of the hypertensive patients had dyslipidemia, with 43.4.0% having high TC, 30.3% high LDL-C, 20.8% elevated TG, and 12.9% low HDL-C, respectively. There was a significant relationship between gender and lipoproteins, with women having significantly higher lipoproteins (TC, HDL-C, LDL-C, and non-HDL-C) than men. Women also had more measures of obesity

with a higher body mass index and waist circumference. TC and non-HDL had a significant association with both systolic and diastolic blood pressure (BP). Altogether, 43.4% of the hypertensives had poorly controlled BP and significantly higher atherogenic lipoproteins (TC, LDL-C, and non-HDL-C). **Conclusion:** This study has demonstrated the relatively high prevalence of dyslipidemia among hypertensive patient in this population. High plasma TC is the most dominant pattern of dyslipidemia. Hypertensive patients with poorly controlled BP have worse atherogenic lipoprotein values and are more likely predisposed to ASCVD.

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Introduction

Dyslipidemia and hypertension are the 2 major independent risk factors for atherosclerotic cardiovascular disease (ASCVD). ASCVD accounts for >80% of all deaths and disability in low- and middle-income countries and results in a high economic loss and burden [1, 2]. The combined effects of the above 2 vital factors have been shown to be multiplicative, meaning the risk of coronary heart disease is greater than the sum of the risks of each component occurring alone [3, 4]. About 50–80% of hypertensives have been reported to have plasma lipid ab-

normalities. The prevalence of hypertension has been steadily on the increase in Nigeria, as in most African countries, due to rapid urbanization, unhealthy lifestyle changes, and a reduced burden of infectious diseases. The prevalence of hypertension in Nigeria progressively increased, from 10.1–13.3% in the late 1960s to 38.8–44.5% [5]. In 2010, there were 20 million cases in Nigeria, and this figure has been projected to rise to 39.1 million by 2030 [5].

Dyslipidemia plays a role in endothelial dysfunction which is central to the pathogenesis of atherosclerosis, thrombosis, insulin resistance, and hypertension. Triglyceride (TG)-rich lipoproteins and low-density lipoprotein cholesterol (LDL-C) have been shown to be toxic to endothelial cells, but high-density lipoprotein cholesterol (HDL-C) is protective [6]. High levels of serum cholesterol are known to increase the risk of developing macrovascular complications such as coronary heart disease and stroke [7]. A rising trend of serum cholesterol TG, LDL-C, and very-low-density lipoprotein (VLDL), along with a fall in HDL-C has been found to be associated with the severity of hypertension [7].

The associations between blood pressure (BP) and the risk of stroke and coronary heart disease are well established. Similarly, there are also strong associations between serum cholesterol and the risk of coronary heart disease. The Framingham Heart Study data on the hypertensive population reported that >80% had at least 1 additional CVD risk factor and that these risk factors were predominantly atherogenic in nature. Studies have consistently indicated that hypertension and hypercholesterolemia frequently coexist, causing what is known as dyslipidemic hypertension [8].

Current guidelines for the management of dyslipidemia suggest screening in early adulthood. Early detection of lipid disorders will help in applying the proper treatment modalities such as implementing therapeutic lifestyle changes in preventing adverse cardiovascular outcomes. Early screening also decreases the risk of any future cardiovascular event and reduces the risks of any associated cardiovascular risk factors. Guidelines, such as those from the Adult Treatment Panel (ATP III), the US Preventive Services Task Force, the American College of Cardiology/American Heart Association (ACC/AHA), and the American Association of Clinical Endocrinologists (AACE) 2017, suggest screening for abnormal lipid profiles in adults >20 years of age [9–11]. Even though there is no published national guideline in Nigeria for the management of dyslipidemia, there has been sufficient evidence of early screening in this environment [12].

The relationship between dyslipidemia and the traditional cardiovascular risk factors, such as obesity and hypertension, has been clearly demonstrated in several epidemiological studies [13, 14]. The indicators or measures of the risk factors body mass index (BMI) and waist circumference (WC) for obesity have been shown to be a strong predictor of abnormal lipids and lipoproteins [14].

The risk of stroke and myocardial infarction has been shown to be significantly reduced by lipid-lowering drugs, so identifying hypertensive patients and the pattern of dyslipidemia in this population is key to successful management. Dyslipidemia in hypertensives has been demonstrated to vary according to the ethnic, socioeconomic, and cultural characteristics of population groups [15].

The pattern of lipid abnormalities among hypertensives and its impact on CVD risk in Uyo, South South Nigeria, has not been well characterized. Moreover, to the best of our knowledge, no study has focused on abnormal lipid pattern and possible risk factors for dyslipidemia among hypertensives. The purpose of this study was to estimate the prevalence and pattern of dyslipidemia among hypertensives and establish the relationship of lipid markers and other cardiovascular risk factors.

Methods

Study Design and Site

This was a cross-sectional study done at the University of Uyo Teaching Hospital (UUTH) over a period of 6 months, between April and October 2019. UUTH is a tertiary medical facility located in Akwa Ibom State, South South Nigeria. The hospital is a major referral center for both the private, primary, and secondary health care facilities in this state and adjoining states in Nigeria. We recruited 544 hypertensive patients (345 females and 196 males) attending the Cardiology Clinic during the study period.

Eligibility Criteria

We included all diagnosed hypertensives attending cardiology clinic. We excluded diabetics and patients on antihypertensives and lipid-lowering agents.

Measurements

BP was measured in a sitting position using a standard mercury sphygmomanometer after 5 min of rest. Body weight and height were measured with a portable standardized weighing scale and a stadiometer, respectively. BMI was calculated. WC measurements were then taken with a tape measure at a point midway between the inferior margin of the lower-most rib and the iliac crest in a horizontal plane. Fasting serum lipid profile was determined using blood obtained following an overnight (10–12 h) fast. Total

Table 1. Baseline characteristics of study participants

	Total (<i>n</i> = 544)	Male (<i>n</i> = 199)	Female (<i>n</i> = 345)	<i>p</i> value
Age, years	56 (12)	59 (12)	54 (12)	<0.001
Systolic BP, mm Hg	131 (21)	132 (21)	131 (21)	0.536
Diastolic BP, mm Hg	81 (14)	82 (13)	81 (14)	0.519
BMI, kg/m ²	30.1 (6.3)	27.0 (5.2)	31.8 (6.2)	<0.001
WC, cm	99 (14)	96.7 (13.8)	99.8 (14.7)	0.014
TC, mmol/L	5.04 (1.25)	4.81 (1.23)	5.18 (1.23)	0.001
TG, mmol/L	1.29 (0.60)	1.32 (0.68)	1.27 (0.54)	0.382
HDL-C, mmol/L	1.53 (0.48)	1.44 (0.44)	1.58 (0.49)	0.001
LDL-C, mmol/L	2.88 (1.14)	2.73 (1.13)	2.97 (1.14)	0.020
Non-HDL-C, mmol/L	3.51 (1.17)	3.36 (1.16)	3.60 (1.16)	0.021
TC/HDL-C ratio	3.63 (2.28)	3.53 (1.12)	3.68 (2.73)	0.458

Values are expressed as mean (SD). * $p < 0.05$. LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol; BP, blood pressure; TG, triglycerides; BMI, body mass index; WC, waist circumference; TC, total cholesterol.

Table 2. Prevalence of dyslipidemia based on age and gender

	High TC (≥ 5.20)	High TG (≥ 1.70)	Low HDL-C (< 1.04)	High LDL-C (≥ 3.37)	High TC/HDL-C (≥ 5)
Total	236 (43.4)	113 (20.8)	70 (12.9)	165 (30.3)	58 (10.7)
Male	72 (13.2)	40 (35.4)	34 (6.3)	53 (9.6)	21 (3.9)
Female	164 (30.2)	73 (64.6)	36 (6.6)	112 (20.7)	37 (6.8)
<i>p</i> value	0.358	0.204	0.065	0.599	0.192
Age					
25–34 years	10 (4.2)	4 (3.5)	6 (8.6)	8 (4.8)	6 (10.3)
35–44 years	26 (11.0)	12 (10.6)	4 (5.7)	18 (10.9)	3 (5.2)
45–54 years	56 (23.7)	27 (23.9)	18 (25.7)	34 (20.6)	11 (19.0)
55–64 years	87 (36.9)	45 (39.8)	23 (32.9)	63 (38.2)	20 (34.5)
≥ 65 years	57 (24.2)	25 (22.1)	19 (27.1)	42 (25.5)	18 (31.0)
<i>p</i> value	0.448	0.806	0.375	0.231	0.090

Values are expressed as *n* (%). The lipoprotein cut-off values are all in mmol/L. LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol; TG, triglycerides; TC, total cholesterol.

cholesterol (TC), TG, and HDL-C were analyzed using an enzymatic method on an automated chemistry analyzer, Selectra Pro M (ELITech Group, The Netherlands). Non-HDL-C was calculated as TC minus HDL-C and LDL-C was determined using the Friedewald formula.

Definition of Terms

Dyslipidemia was defined according to the National Cholesterol Education Program (NCEP) ATP III [9] as a raised TG level of ≥ 1.7 mmol/L, reduced HDL-C of < 1.04 mmol/L, an LDL-C level of > 3.37 mmol/L, and/or a TC level of ≥ 5.2 mmol/L.

Hypertension was defined as systolic BP (SBP) 140 mm Hg and/or diastolic BP (DBP) 90 mm Hg, using criteria from the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of Hypertension [15].

Controlled BP is an SBP < 140 mm Hg and a DBP < 90 mm Hg which is controlled by antihypertensive drug(s) and/or nonpharmacological methods.

Uncontrolled or poorly controlled BP is an SBP ≥ 140 mm Hg and/or DBP ≥ 90 mm Hg.

Statistical Analysis

Data was analyzed using SPSS v20 software (SPSS Inc., Chicago, IL, USA). Simple descriptive statistics were used to present the demographic characteristics of the study participants. Continuous variables were presented as mean $\pm$ SD and were compared using the Student *t* test. Categorical variables were presented as proportions, and the χ^2 test was used to compare them. Other associations were evaluated with Pearson's correlation coefficient. A *p* value < 0.05 was considered statistically significant.

Results

A total of 544 hypertensive patients who attended the Cardiology Clinic, UUTH, between April and October 2019 were recruited to this study. The age range was 27–80 years; 63% were female ($n = 345$) with a mean age of 54 years and 37% were male with a mean age of 59 years. There was no significant difference in BP and plasma TG between the genders, but women had significantly higher lipoproteins (TC, HDL-C, LDL-C, and non-HDL-C). Women also had more measures of obesity, with a higher BMI and WC than men (Table 1).

Overall, 60% of hypertensive patient had dyslipidemia and at least 1 abnormal lipoprotein. Table 2 shows the dyslipidemia based on age and gender. The most prevalent abnormal lipid fraction was high TC, which occurred in 43.4% of the study population, more in females and the age group of 55–64 years. LDL-C was elevated in about one-third, within the same age group and with the same gender dominance as TC. There was high TG and low HDL-C in 20.8 and 12.9% of the study population, respectively.

There was a significant relationship between gender and lipoproteins. The women had significantly higher lipoprotein levels than the men (Table 3). TC and non-HDL-C had a significant association with both SBP and DBP. It was observed that more than half of the study population were obese (BMI ≥ 30) and 65.6% had a WC ≥ 102 cm, also significantly more women than men (Table 4A). Most of the subjects had good BP control; only 43.4% had poorly controlled BP. In the men, TC, LDL-C, and non-HDL-C were significantly higher in those with poorly controlled BP than those whose BP was well controlled (Table 4B).

Discussion

This study was designed to determine the pattern of dyslipidemia among hypertensive patients attending the Cardiology Clinic, UUTH, Uyo, and also investigate the association with cardiovascular risk factors (indicators/measures of obesity). Our results showed a high prevalence of dyslipidemia with higher TC, TG, and LDL-C values, i.e., more than the respective cut-off values, with about 60% of the patients fulfilling at least 1 criterion for dyslipidemia according to the NCEP ATP III guideline for the detection, evaluation, and management of dyslipidemia [9]. This is consistent with reported rates of dyslipidemia among hypertensives, which has ranged

Table 3. Association of plasma lipoproteins with other cardiovascular risk factor

	Pearson's correlation coefficient (r^2)	p value
TC		
Age	−0.10	0.813
Gender	0.146	0.001*
BMI	0.065	0.128
WC	0.032	0.450
SBP	0.657	<0.001*
DBP	0.111	0.009
TG		
Age	0.028	0.509
Gender	−0.038	0.382
BMI	0.043	0.544
WC	0.005	0.095
SBP	0.086	0.046
DBP	0.084	0.051
HDL-C		
Age	−0.039	0.360
Gender	0.139	0.001*
BMI	0.114	0.008*
WC	0.085	0.047*
SBP	0.059	0.170
DBP	0.018	0.668
LDL-C		
Age	0.014	0.748
Gender	0.100	0.020*
BMI	−0.019	0.662
WC	−0.028	0.509
SBP	0.078	0.069
DBP	0.082	0.057
Non-HDL-C		
Age	0.005	0.905
Gender	0.099	0.021*
BMI	0.023	0.593
WC	0.002	0.992
SBP	0.114	0.008*
DBP	0.111	0.009*

* $p < 0.05$. LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol; BP, blood pressure; TG, triglycerides; BMI, body mass index; WC, waist circumference; TC, total cholesterol.

between 49.5 and 78.9% in several studies worldwide [16–18].

The prevalence rate of 60% is comparable to the study by Akintunde et al. [19] who reported 58.9% in South West Nigeria, and by Adamu et al. [20] who reported 64.1% in North Central Nigeria. Dyslipidemia, as demonstrated by this study, increases with age and is prevalent in subjects between 55 and 64 years of age and in both genders. Ericsson et al. [21] hypothesized that hyperlipidemia

Table 4.**A** BMI, WC, and BP of hypertensive patients

	Total (<i>n</i> = 544), <i>n</i> (%)	Males (<i>n</i> = 199), <i>n</i> (%)	Females (<i>n</i> = 345), <i>n</i> (%)
BMI			
Normal (≤ 25)	123 (22.6)	76 (14.0)	47 (8.6)
Overweight (25–29.9)	133 (24.4)	61 (11.2)	72 (13.2)
Obese (≥ 30)	288 (52.9)	62 (11.4)	226 (41.5)
WC			
<102 cm (men)/88 cm (women)	187 (34.4)	135 (24.8)	52 (9.6)
≥ 102 cm (men)/88 cm (women)	357 (65.6)	64 (11.8)	293 (53.9)
BP			
Well-controlled	307 (56.4)	113 (20.8)	194 (35.7)
Poorly controlled	237 (43.6)	86 (15.8)	151 (27.8)

B Lipid profiles of male and female hypertensive patients with well-controlled or poorly controlled BP

	Males			Females		
	well-controlled (<i>n</i> = 113)	poorly controlled (<i>n</i> = 86)	<i>p</i> value	well-controlled (<i>n</i> = 194)	poorly controlled (<i>n</i> = 151)	<i>p</i> value
TC	4.59 (1.19)	5.09 (1.25)	0.005*	5.17 (1.21)	5.21 (1.27)	0.771
TG	1.26 (0.64)	1.40 (0.73)	0.164	1.24 (0.50)	1.31 (0.59)	0.226
HDL-C	1.44 (0.48)	1.45 (0.40)	0.899	1.59 (0.46)	1.56 (0.52)	0.550
LDL-C	2.59 (1.08)	2.93 (1.16)	0.035*	2.96 (1.13)	2.99 (1.15)	0.812
Non-HDL-C	3.15 (1.08)	3.64 (1.22)	0.003*	3.57 (1.17)	3.64 (1.15)	0.576

* $p < 0.05$. LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol; BP, blood pressure; TG, triglyceride; TC, total cholesterol; BMI, body mass index; WC, waist circumference.

with advancing age can be due to a reduced catabolism and clearance of plasma lipoproteins. We also observed that women had more abnormalities in serum lipids than men, especially in the age group of 55–65 years. This is consistent with large-scale studies such as the Framingham Heart Study and the National Health and Nutrition Examination Survey (NHANES) [4, 22]. Studies has shown that postmenopausal women have proatherogenic lipid profiles in comparison to age-matched men; this is due to the decline in the influence of sex steroids that mediates sex differences in plasma lipid homeostasis [22, 23].

The most common type of dyslipidemia observed in our study population was hypercholesterolemia. This was also reported by Osuji et al. [17] in South East Nigeria. However, some other studies in the South West have reported mostly low HDL-C as the predominant type [19, 24]. Social economic status, dietary pattern, and other environmental factors also differ widely according to ethnicity and are likely contributors to the observed disparities. We found a significant relationship between TC and

both SBP ($p < 0.001$) and DBP ($p = 0.009$). A similar finding was reported by Okpara and Adediran [25]. Elevated TC is known to increase the risk of macrovascular complications such as CVD and stroke. Despite comparable TC, TG, and LDL-C results in other studies in different parts of the country, HDL-C in our study population was higher. However, elevated HDL-C was also observed by Onwubuya et al. [26] in the South East. The cause for this is not known, although it has been suggested that alcohol increases HDL-C by facilitating the transport of apolipoprotein A1 [27].

This study showed that most of the hypertensive patients (56%) had poorly controlled BP and 44% had well-controlled BP. The hypertensives with poorly controlled BP have worse atherogenic lipoprotein values. Hypertension and lipid abnormalities are well known to frequently coexist and synergize to be risk factors for CVD. The coexistence of increased BP and lipid abnormalities has many clinical implications and should be properly monitored and evaluated in the management of hypertension.

In our study population, 77.4% were either overweight or obese, and >65% had abdominal obesity. Obesity and consequent insulin resistance are major underlying factors in the pathogenesis of both hypertension and dyslipidemia. There is a strong association among these metabolic derangements forming the core of the diagnosis of metabolic syndrome. Lipid abnormalities, a characteristic of metabolic syndrome, have been found to predict hypertension, and it has also been shown in cohort studies that dyslipidemia in apparently healthy individuals leads to hypertension [25].

The main limitation of our study was the fact that it was hospital-based, making it difficult to generalize our findings to reflect the whole country. Also, it was a cross-sectional study, and thus cannot be used to predict some of the causal relationships indicated. We therefore recommend conducting more prospective studies with larger sample sizes.

Conclusion

The prevalence of dyslipidemia in our study population was high and increased with age. The most common dyslipidemia was hypercholesterolemia, and this occurred significantly more in women. Obesity was also more prevalent among female hypertensives. Patients with poorly controlled BP had significantly higher atherogenic lipoproteins and were thus more predisposed to developing CVD. These findings highlight the need to promote screening of hypertensive patients. It is there-

fore recommended that, in patients with hypertension, determination of the lipid and lipoprotein levels should complement other investigations.

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Statement of Ethics

The authors had the approval from the University of Uyo Teaching Hospital Institution Health Research Ethical Committee.

Conflict of Interest Statement

The authors have no conflicts of interest to disclose.

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Author Contributions

O.G.A.: conception, analysis, manuscript drafting, data analysis, literature review and final write up of the article. I.U.: design, data collection, literature review and critical analysis. C.A.: design, data collection, manuscript drafting, ethical approval, critical analysis.

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