ORIGINAL RESEARCH MMJ

The relationship between measures of obesity and atherogenic lipids among Nigerians with hypertension

Olamoyegun A. Michael[1], Fawale M. Bimbola[2], Oluyombo Rotimi[3]

1. Department of Internal Medicine; Endocrinology, Diabetes & Metabolism Unit, LAUTECH Teaching Hospital, and College of Health Sciences, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria

2. Department of Medicine, Obafemi Awolowo University Teaching Hospital Complex, and Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria

3. Renal Unit, Department of Medicine, Federal Teaching Hospital, Ido Ekiti and College of Health Sciences, Afe Babalola University, Ado-Ekiti, Nigeria

Date Received: 31-Oct-2016
Revision Received: 11-Apr-2018
Date Accepted: 14-May-2018

Correspondence: Olamoyegun A. Michael
(dryemi@yahoo.com)

https://dx.doi.org/10.4314/mmj.v31i3.5

Abstract

Aim

This study aimed to determine the relationship between measures of obesity and serum lipid levels among hypertensive patients.

Methods

This was a cross-sectional study in which participants newly diagnosed with hypertension formed the study population. A range of demographic and anthropometric data was obtained, including weight, height, and waist and hip circumference. Fasting serum lipids were also measured, including total cholesterol, high density lipoprotein cholesterol (HDL-C) and triglycerides (TG). Low density lipoprotein cholesterol (LDL-C) was calculated using Friedewald formula. Statistical analysis was then carried out to determine the relationship between anthropometric indices and lipid profile levels.

Results

The study population consisted of 124 male and 290 female subjects with a mean age of 66±16.95 years (range, 30–100 years). The female subjects were older than the male subjects (p=0.020). Our analysis showed that 85%, 58.5% and 30.7% of the study population had abnormal waist circumference (WC), abnormal waist-hip ratio (WHR) and a body mass index (BMI) >25 kg/m2, respectively. Decreased HDL-C (70.1%) was the commonest lipid abnormality detected, followed by elevated LDL (6.0%). None of the anthropometric indices were independent predictors of abnormal lipid levels. However, advanced age and female sex were independent predictors for at least one serum lipid abnormality.

Conclusion

None of the measures of obesity could independently predict abnormal lipid levels in individuals newly diagnosed with hypertension. However, female sex, advanced age and systolic blood pressure were independently associated with abnormal serum lipids. Encouraging regular exercise, and the possible addition of statins, may be beneficial in addressing both obesity and dyslipidaemia.

Key Words: Anthropometric indices, obesity, lipid profile, hypertension

Introduction

The force exerted by the blood on the vasculature is known as blood pressure and when this pressure exceeds a normal range, a patient becomes hypertensive. By 2030, the prevalence of hypertension is projected to increase by 7.2% from 2013 estimates by 2030[1]. Hypertension is one of the most common cardiovascular diseases and is associated with a number of other conditions, including dyslipidaemia and obesity, measured by abnormal body mass index (BMI), waist circumference (WC), and waist-hip ratio (WHR)[2]. Although there are increasing efforts by the world's health governing bodies to stem the prevalence of hypertension and its associated risk factors in Africa, the prevalence of hypertension still ranges from 6% to more than 48% in different rural, semi-urban and urban settlements[3–5].

Most African settlements are emerging semi-urban settlements and these account for more than half of the region's population[6]. Nigeria is a strategically placed country in the West African sub-region, and suffers from a range of non-communicable diseases, including hypertension and its modifiable risk factors; indeed, these conditions are responsible for at least 20% of all deaths and constitute approximately 60% of hospital admissions in most tertiary health institutions in this country[7,8].

The mechanisms of hypertension in obese individuals were poorly understood until recently. Accumulating evidence now indicates a close interaction between visceral adipose tissue and dysfunctional neurohormonal mechanisms, including adiponectin, leptin, resistin, tumour necrotic factor (TNF), and interleukin (IL)-6 caused by increased adiposity (fat deposition)[9–11]. An increase in cardiac output without a corresponding reduction in systemic vascular resistance, which is characteristic of obesity, also probably contributes to the aetiology of the hypertension in obesity. On the other hand, the association between dyslipidaemia and hypertension has been referred to recently as 'lipitension', a condition that is primarily caused by endothelial damage and the loss of physiological vasomotor activity due to atherosclerosis which usually occurs concomitantly with dyslipidaemia[12]. Dyslipidaemia refers to abnormal levels in a patient's lipid profile while obesity is determined by abnormal BMI, WC or WHR. Several studies have reported that obesity and dyslipidaemia often occur simultaneously and it is not uncommon for these conditions to co-exist in an individual.

These studies are with contrasting results. However, very few studies have been carried out in Nigeria to predict which measure of obesity (if any) will predict different types of lipid abnormality.Therefore, the purpose of this study was to evaluate the association between measures of obesity (abnormal BMI, WC and WHR) and dyslipidaemia in individuals newly diagnosed with hypertension, living in a semi-urban community in Nigeria.

Materials and methods

This was a cross sectional study of dyslipidaemia and obesity in individuals newly diagnosed with hypertension, living in semi-urban communities located in Ekiti State, Nigeria. The subjects were aged ≥30 years and the study was carried out between January and May, 2013. The sample was a subset of a larger sample in a study for the determination of cardiovascular assessment in semi-urban communities[5]. The subjects were asked basic questions about their age and other sociodemographic data. The instrument used was the WHO STEPS (II) questionnaire[13]. Clinical evaluation, along with blood and urine sample collection, were carried out at designated places in the communities such as churches, mosques, town halls, health centres and other convenient places.

Anthropometric and blood pressure measurements

Height: This was measured using a portable stadiometer. The subjects were asked to stand barefoot, place their arms by their sides and lean back on a vertical board[14]. Their height was then recorded to the nearest 0.1 cm.

Weight: This was taken while in light clothing with the subject standing in the centre of the platform of a standard portable bathroom weighing scale; weight was recorded to the nearest 0.1 kg

Waist circumference: The subject was asked to stand comfortably with their feet 25–30 cm apart. 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[14]. The waist circumference was measured to the nearest 0.1 cm at the end of normal expiration.

Hip circumference: Measurements were taken using a tape measure and was measured with the greater trochanters of the femur as reference points. The measurement was to the nearest 0.1 cm.

Blood pressure: Blood pressure (BP) was measured according to the guidelines presented in the seventh report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure (JNC-7)[15]. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured in the left arm after the participant had been seated for at least 5 minutes. An electronic blood pressure monitor (Omron M X2 Basic, Omron Health Care Co. Limited, Kyoto, Japan), which had been validated by the British Hypertension Society, was then used with an appropriate-sized cuff. The length and width of the blood pressure cuff bladder were approximately 80% and at least 40% of the circumference of the upper arm, respectively. BP was taken twice and if the difference was more than 10 mmHg, a third reading was taken at an interval of about 5 minutes.

Laboratory tests

Three millilitres of blood samples were collected after 8–12 hours of overnight fasting from each patient into plain bottles for lipid profile analysis, including total cholesterol (TC), high density lipoprotein cholesterol (HDL-C), and triglycerides (TG). However, low density lipoprotein cholesterol (LDL-C) was calculated using Frieeward's equation[16]. The samples were stored in a freezer at −8°C to await batch analysis in the laboratory.

Definition of terms

Hypertension: Hypertension was defined as SBP>140 mmHg and/or DBP≥90 mmHg and/or the concomitant use of antihypertensive medications15.

Dyslipidaemia: Dyslipidaemia was defined according to the Adult Treatment Panel III17 as raised TG level ≥1.7mmol/L, reduced HDL-cholesterol <1.03 mmol/L in males and <1.30 mmol/L in females, LDL-C level >3.37 mmol/L and/or TC level ≥5.2 mmol/L.

Obesity: Abnormal WC, WHR and BMI were defined as ≥94 cm in men and ≥80 cm in women; >0.90 for men and >0.85 for women; and ≥25 kg/m2 across sexes, respectively17.

Ethical considerations

Prior notices and permissions were obtained from traditional rulers, opinion leaders, church and mosque leaders. Informed consent was obtained from all participants. Ethical clearance was obtained from the ethics and research committee of Federal Medical Centre, Ido-Ekiti.

Statistical analysis

All the data were recorded and analysed using the Statistical Package for Social Sciences software (SPSS Inc, Chicago, IL; version 17). Continuous variables, including age, SBP, DBP, lipid profile, BMI, WC, and WHR, are presented as mean ± standard deviation and compared between sexes while other categorical variables were expressed in frequencies and percentages. A p-value <0.05 was considered to indicate statistical significance. Pearson correlation was used to test for association between measures of obesity and lipid abnormalities. Logistic regression models were constructed using the presence of at least one lipid abnormality (abnormal TC, LDL-C, HDL-C and TG) as the dependent variables, and age, sex, blood pressure and indices of body adiposity as the independent variables.

Results

A total of 124 male and 290 female Nigerian hypertensive patients were included in this study with age ranging from 30 to 100 years (mean=66.00±16.95 years). The female subjects were older than the male subjects (67.18±14.40 years vs. 63.22±18.89 years; p=0.020). There were also significant sex differences in WC, LDL-C and TG (Table 1)

Table 1: Basic demographic and clinical data of the population (mean ± standard deviation)

Variable	Male	Female	*p*–Value
Age (years)	63.22 ± 18.89	67.18 ± 14.40	0.020
Weight (kg)	61.69 ± 14.10	57.09 ± 12.55	0.004
Height (m)	1.62 ± 0.14	1.55 ± 0.07	<0.001
BMI(kg/m²)	22.49 ± 3.40	23.44 ± 4.86	0.050
WC (cm)	84.82 ± 9.73	88.03 ± 12.42	0.011
WHR	0.94 ± 0.06	0.96 ± 0.58	0.712
SBP (mmHg)	159.56 ± 25.99	161.36 ± 23.83	0.492
DBP (mmHg)	89.31 ± 13.58	89.70 ± 12.74	0.783
TC (mmol/L)	3.05 ± 0.97	3.22 ± 1.17	0.137
HDL–C (mmol/L)	1.12 ± 0.53	1.02 ± 0.49	0.067
LDL–C (mmol/L)	1.61 ± 0.86	1.83 ± 0.99	0.030
TG (mmol/L)	0.74 ± 0.34	0.85 ± 0.56	0.036

BMI = Body Mass Index, WC = Waist circumference, WHR = Waist – Hip ratio, SBP = Systolic Blood Pressure, DBP = Diastolic Blood Pressure, TC = Total Cholesterol, HDL–C = High density lipoprotein–Cholesterol, LDL–C = Low density lipoprotein–Cholesterol, TG = Triglycerides

https://dx.doi.org/10.4314/mmj.v31i3.5

Among the subjects, a disproportionately higher number of females had abnormal measures for both obesity and dyslipidaemia. A total of 218 females (75.2%) had abnormal WC as compared to 24 (19.4%) of the males. More than 30% of the study population had a BMI >25 kg/m^2. In 85% of cases, WHR was abnormal. Lipid sub-fraction analysis showed that low HDL-C was the most common abnormality and was observed in 70.0% of the study population, followed by elevated LDL-C levels, observed in 6.0% of the study population (Table 2). Of the dyslipidaemias, 6.6%, 75.9%, 7.6% and 5.9% of the females had high TC, low HDL, high LDL and high TG, respectively. Of these, only low HDL and high LDL were significantly higher than that of males (p<0.001, p=0.030, respectively).

Table 2: Prevalence of obesity and dyslipidaemia in the study population according to sex

Variable	Total n=414	Male n=124(%)	Female n=290(%)	p-value
Abnormal WC	242 (58.5)	24 (19.4)	218 (75.2)	<0.001
Abnormal BMI	127 (30.7)	29 (23.4)	98 (33.8)	0.022
Abnormal WHR	352 (85.0)	93 (75.6)	259 (89.3)	<0.001
High TC	23 (5.6)	4 (3.2)	19 (6.6)	0.130
Low HDL	290 (70.0)	70 (56.5)	220 (75.9)	<0.001
High LDL	25 (6.0)	3 (2.4)	22 (7.6)	0.030
High TG	20 (4.8)	3 (2.4)	17 (5.9)	0.102

BMI = Body Mass Index, WC = Waist circumference, WHR = Waist – Hip ratio, TC = Total Cholesterol, HDL–C = High density lipoprotein–Cholesterol, LDL–C = Low density lipoprotein–Cholesterol, TG = Triglycerides

Figure 1 shows the prevalence of the various lipid abnormalities. Among the participants, 310 (74.9%) had at least one form of lipid abnormality. More than a tenth (12.9%) of those with dyslipidaemia had more than one lipid abnormality in various combinations. Elevated TG and low HDL-C (14, 4.5%) was the most frequent dyslipidaemia combination, followed by the combination of elevated TC and elevated LDL-C (11, 3.5%).

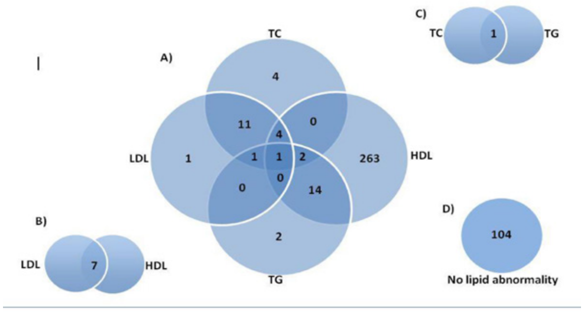

Figure 1: (A) Venn diagram showing the frequencies of, and overlap between, abnormal total cholesterol, HDL, LDL and triglycerides among subjects. (B) Representation of abnormal HDL and LDL profiles. (C) Representation of TC and TG. (D) Representation of subjects with no abnormalities in serum lipid profiles

The relationship between serum lipids, age, sex and blood pressure is shown in Table 3. SBP was significantly higher in subjects with abnormal TC when compared with subjects with normal TC (171.7±27.8 vs. 160.2±24.2; p=0.029). Furthermore, when compared between sexes, females had a significantly higher LDL-C and lower HDL-C when compared with males, 22 (7.6%) vs. 3 (2.4%); p=0.043 and 220 (75.9%) vs. 70 (56.5%); p<0.001.

Table 3: Relationships between serum lipids, age, sex and blood pressure

		Age (m±sd)	Sex n (%) Male	Female	SBP (m±sd)	DBP (m±sd)
TC	Normal	65.8±16.2	120 (96.8)	271 (93.4)	160.2±24.2	89.5±12.9
	Abnormal	69.6±11.2	4 (3.2)	19 (6.6)	171.7±27.8	91.5±14.8
	p	0.135	0.176		0.029	0.460
LDL-C	Normal	65.9±16.1	121 (97.6)	268 (92.4)	160.5±24.2	89.5±13.1
	Abnormal	68.1±13.8	3 (2.4)	22 (7.6)	165.8±29.0	91.4±11.9
	p	0.501	0.043		0.298	0.460
HDL-C	Normal	63.2±18.1	54 (43.5)	70 (24.1)	158.7±24.5	88.2±12.7
	Abnormal	67.2±14.8	70 (56.5)	220 (75.9)	161.7±24.5	90.2±13.1
	p	0.028	<0.001		0.255	0.124
TG	Normal	65.8±16.1	121 (97.6)	273 (94.1)	161.0±26.8	89.6±12.8
	Abnormal	69.6±12.4	3 (2.4)	17 (5.9)	160.8±26.8	89.6±16.0
	p	0.301	0.135		0.981	0.987
At least 1 lipid abnormality	Normal	61.9±18.7	49 (39.5)	55 (60.5)	157.2±23.7	87.8±12.0
	Abnormal	67.4±14.7	75 (19.0)	235 (81.0)	162.1±24.7	90.2±13.3
	p	0.008	0.000		0.078	0.105

p = p-value, (m ± sd) = mean ± standard deviation, SDP = systolic blood pressure, DBP = diastolic blood pressure, TC = total cholesterol, LDL = low density lipoprotein cholesterol, HDL = high density lipoprotein cholesterol, TG

There was no significant relationship between the measures of obesity (WC, WHR and BMI) and any of the lipid sub-fractions (Table 4). Pearson's correlation found that there were no associations between these measures (Table 5).

Table 4: Relationships between serum lipids and measures of obesity

		WC n (%) Normal	Abnormal	WHR n (%) Normal	Abnormal	BMI n (%) Normal	Abnormal
TC	Normal	165 (95.9)	226 (93.4)	60 (98.4)	330 (93.8)	270 (94.1)	121 (95.3)
	Abnormal	7 (4.1)	16 (6.6)	1 (1.6)	22 (6.2)	17 (5.9)	6 (4.7)
	p	0.266		0.147		0.623	
LDL-C	Normal	165 (95.9)	224 (92.6)	60 (98.4)	328 (93.2)	269 (93.7)	120 (94.5)
	Abnormal	7 (4.1)	18 (7.4)	1 (1.6)	24 (6.8)	18 (6.3)	7 (5.5)
	p	0.156		0.117		0.765	
HDL-C	Normal	60 (34.9)	64 (26.4)	22 (36.1)	102 (29.0)	84 (29.3)	40 (31.5)
	Abnormal	112 (65.1)	178 (73.6)	39 (63.9)	250 (71.0)	203 (70.7)	87 (68.5)
	p	0.065		0.265		0.648	
TG	Normal	166 (96.5)	228 (94.2)	60 (98.4)	333 (94.6)	275 (95.8)	119 (93.7)
	Abnormal	6 (3.5)	14 (5.8)	1 (1.6)	19 (5.4)	12 (4.2)	8 (6.3)
	p	0.283		0.207		0.354	
At least 1 lipid abnormality	Normal	52 (30.2)	52 (21.5)	21 (34.4)	83 (23.6)	70 (24.4)	34 (26.8)
	Abnormal	120 (69.8)	190 (78.5)	40 (65.6)	269 (76.4)	217 (75.6)	93 (73.2)
	p	0.043		0.072		0.606	

WC = Waist circumference, WHR = Waist – Hip ratio, BMI = Body Mass Index, TC = Total Cholesterol, HDL–C = High density lipoprotein–Cholesterol, LDL–C = Low density lipoprotein–Cholesterol, TG = Triglycerides, p = p-value

Table 5: Correlation matrix of measures obesity and serum lipids among the subjects

Variables		WC	WHR	BMI	Age	SBP	DBP
TC	*r*	-.005	-.024	.006	-.008	.017	.027
	p	.918	.622	.910	.875	.726	.579
HDL-C	*r*	-.067	-.043	-.016	-.131	-.015	-.040
	p	.174	.387	.753	.008	.756	.418
LDL-C	*r*	0.004	.000	-.002	.040	.020	.043
	p	.937	.997	.966	.413	.687	.379
TG	*r*	.069	-.350	.033	.061	.074	.036
	p	.163	.481	.499	.215	.130	.461

BMI = Body Mass Index, WC = Waist circumference, WHR = Waist – Hip ratio, TC = Total Cholesterol, HDL–C = High density lipoprotein–Cholesterol, LDL–C = Low density lipoprotein–Cholesterol, TG = Triglycerides.

Logistic regression analyses revealed that increasing age (odds ratio [OR]=1.017, 95% confidence interval [CI]=1.003–1.032, p=0.015) and female sex (OR=0.376, 95% CI=0.235–0.602, p<0.001) as the only independent predictors of at least one serum lipid abnormality (Table 6). When TC, HDL, LDL and TG were made the dependent variables, current SBP was the only predictor of high TC (OR=1.071, 95% CI=1.001–1.033, p=0.031); female sex was the only independent predictor of abnormal HDL (OR=0.407, 95% CI=0.260–0.635, p=0.000) and LDL (OR=0.305, 95% CI=0.089–1.037, p=0.057) while TG had no independent predicto

Table 6: Logistic regression model using any lipid abnormality as the dependent variable

Variable	*p*-value	Odds ratio	95% CI
Age	.015	1.017	1.003 - 1.032
Sex	.000	.376	.235 - .602
Systolic blood pressure	.446	1.004	.994 - 1.015
Diastolic blood pressure	.165	1.013	.995 - 1.031
Waist circumference	.902	1.044	.528 - 2.064
Waist-hip ratio	.588	.833	.430 - 1.612
Body mass index	.502	1.190	.715 - 1.981

Discussion

This study investigated the relationship between measures of obesity and lipid profiles among Nigerian adults with hypertension. Obesity and hypertension are two interrelated cardiovascular disease risk factors that usually co-exist. A reduction in body fat is one of the most effective preventive measures in decreasing not only blood pressure but also the overall cardiovascular risk. In this study, a relatively high proportion of subjects were obese, as indicated by different anthropometric indices: abnormal WC (58.5%), abnormal BMI (30.7%), and abnormal WHR (85%), and all obesity indices were significantly higher in females compared to males. The higher prevalence of obesity among the female subjects was partly attributed to physical inactivity, since they were generally engaged in occupations such as trading where they spend most of their time sitting down in their shops and engaging in predominantly sedentary activities. Also, this might be attributed to the weight gained by females during pregnancy which is not lost after delivery. This strong association between obesity and sedentary activities such as trading has also been documented by Afolabi et al.[18] in south-western Nigeria.

The prevalence rate of dyslipidaemia (75.1%) in this study was much higher than the 58.9% reported by Akintunde et al.[19] in south-western Nigeria among hypertensive patients and the 64% reported by Adamu et al.[20] in north-central Nigeria. Lipid abnormalities noted in the present study revealed that reduced HDL was the most common lipid abnormality, followed by increased LDL. This observation concurs with other Nigerian studies[19,21,22], which also found that the most prevalent lipid abnormality was low LDL-C in their participants. However, our findings differ from those of another study which recruited participants of a Caucasian descent where reduced HDL-C was said to be uncommon in Adult Treatment Panel III[17]. This disparity might be due to the environmental conditions, socioeconomic status, and genetic make-up of our study population. Isolated low HDL-C is said to be a relatively common baseline lipid abnormality among the general population in Nigeria, and the presence of hypertension only escalates this problem[23]. The role of HDL-C in the improvement of cardiovascular risks, though not fully elucidated, has been shown to relate to its potent anti-inflammatory and anti-oxidant effect that inhibits the atherogenic process[24,25].

Our study showed that none of the commonly used anthropometric indices were good enough to predict an abnormal lipid profile. However, we did identify a significant association with DBP, with WC having more association (p=0.001) than WHR (p=0.035), in a sample of semi-urban dwellers in south-western Nigeria. A similar finding was observed by Okpara and AAdediran[26] who found abnormal lipids to be strongly associated with both SBP and DBP. The significant association between WC and WHR with DBP is consistent with the established evidence that a direct association exists between obesity and blood pressure[27]. There was no significant alteration in lipid profiles with obesity among participants, which implies that obesity may be a less important factor in predicting abnormal lipid profiles in this population. This finding concurs with previous reports reporting a lack of association between lipid abnormalities and measures of obesity[26], but contradicts some studies which have shown a positive association between lipid levels and adiposity[23,28].

To our knowledge, this is the first study to compare three commonly used anthropometric indices to predict dyslipidaemia among patients with hypertension in a population of semi-urban dwellers of Nigeria. Our focus was to compare various indices of obesity among hypertensive patients in terms of their ability to predict dyslipidaemia.

The strength of the study was based on the fact that it was a community-based study with a moderate number of participants. However, the cross-sectional design of this study limits the freedom with which its results regarding causal relationships can be interpreted. Hence, prospective longitudinal studies should now be carried out, with larger sample sizes. Finally, we did not calculate novel lipid ratios like the Atherogenic Index of Plasma (AIP), Castelli Risk Index (CRI) I & II and Chol Index, which may also be abnormal, even in the presence of abnormal, but not statistically significant, lipid levels.

Conclusion

The findings of this study suggest that obesity is significantly more prevalent among female sub-urban dwellers with hypertension compared with their male counterparts and is not an important predictor of abnormal serum lipid levels. Advanced age, female sex and higher SBP were the most important and independent predictors of abnormal lipid levels in this population with hypertension. Also, there was positive correlation between WC and WHR and DBP.

References

1. Go AS, Mozaffarian D, Roger VL, Benjamin EJ, Berry JD, Borden WB, et al.; on behalf of the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics—2013 update: A report from the American Heart Association. Circulation. 2013;127(1):e6-e245. DOI: 10.1161/CIR.0b013e31828124ad

2. National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) final report. Circulation 2002;106:3143–421.

3. Mufunda J, Chatora R, Ndambakuwa Y, Nyarango P, Kosia A,

Chifamba J, et al. Emerging non-communicable disease epidemic in Africa: preventive measures from the WHO Regional Office for Africa. Ethn Dis 2006;16(2):521–6.

4. Dalal S, Beunza JJ, Volmink J, Adebamowo C, Bajunirwe F, Njelekela M, et al. Non-communicable diseases in sub-Saharan Africa: what we know now. Int J Epidemiol. 2011;40(4):885–901. DOI: 10.1093/ije/dyr050

5. Oluyombo R, Olamoyegun MA, Olaifa O, Iwuala S, Babatunde OA. Cardiovascular risk factors in semi urban communities in Southwest Nigeria: patterns and prevalence. J Epidemiol Glob Health. 2015;5:167–74. DOI: 10.1016/j.jegh.2014.07.002

6. United Nations Environmental Programme (UNEP). Global Environment Outlook 3; Past, present and future perspectives. Nairobi, Kenya: UNEP; 2002. p. 240–69.

7. WHO. Facing the facts: The impact of chronic disease in Nigeria. Geneva: WHO; 2005 [cited 2011 Mar 12]. Available from: http://www.who.int/chp/chronic_disease_report/ en.

8. Unachukwu CN, Agomuoh DI, Alasia DD. Pattern of non-communicable diseases among medical admissions in Port Harcourt, Nigeria. Niger J Clin Pract. 2008;11:14–7.

9. Dustan HP. Obesity and hypertension. Diabetes Care. 1991;14(6):488–504.

10. Landsberg L, Aronne LJ, Beilin LJ, Burke V, Igel LI, Lloyd-Jones D, et al. Obesity-related hypertension: pathogenesis, cardiovascular risk, and treatment; a position paper of The Obesity Society and the American Society of Hypertension. J Clin Hypertens (Greenwich). 2013;15:14–33. DOI: 10.1111/jch.12049

11. DeMarco VG, Aroor AR, Sowers JR. The pathophysiology of hypertension in patients with obesity. Nat Rev Endocrinol.. 2014; 10:364–76. DOI: 10.1038/nrendo.2014.44

12. Dalal JJ, Padmanabhan TNC, Jain P, Patil S, Vasnawala H, Gulati A. LIPITENSION: Interplay between dyslipidemia and hypertension. Indian J Endocrinol Metab. 2012;16(2):240–5. DOI:10.4103/2230-8210.93742

13. WHO. The WHO STEPwise approach to chronic disease risk factor surveillance (STEPS). WHO STEPS instrument (core and expanded). Assessed January 15,2017 http://www.who.int/chp/steps/ STEPS_Instrument_v2.1.pdf.

14. Bowring AL, Peters A, Freak-Poll R, Lim MSC, Gouillou M, Hellard M. Measuring the accuracy of self-reported height and weight in a community-based sample of young people. BMC Med Res Methodol 2012;12:175. DOI: 10.1186/1471-2288-12-175

15. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL Jr, et al. The seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure: the JNC 7 report. JAMA 2003;289(19):2560–71. DOI: 10.1001/jama.289.19.2560

16. Friedeward WT, Levy RI, Friedrickson DS. Estimation of the concentration of low–density lipoprotein in plasma, without use of preparative ultracentrifuge. Clin Chem. 1972;18:499–502.

17. Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. Executive summary of the third report of National Cholesterol Education Program (NCEP) expert panel on detection, evaluation and treatment of high blood cholesterol in adults (Adult Treatment Panel III). JAMA. 2001;285:2486–97. DOI: 10.1001/jama.285.19.2486

18. Afolabi AO, Addo AA, Sonibare MA. Activity pattern, energy intake and obesity among Nigerian urban market women. Int J Food Sci Nutr. 2004;55(2):85–90. DOI: 10.1080/09637480410001666450

19. Akintunde AA, Ayodele EO, Akinwusi OP, Opadijo GO. Dyslipidemia among newly diagnosed hypertensives: pattern and clinical correlates. J Natl Med Assoc. 2010;102(5):403–7.

20. Adamu UG, Okuku GA, Oladele CO, Abdullahi A, Odoh JI, Fasae AJ. Serum lipid profile and correlates in newly presenting Nigerians with arterial hypertension. Vasc Health Risk Manag. 2013;9:763–8.

21. Osuji CU, Omejua EG, Onwubuya EI, Ahaneku GI. Serum lipid profile of newly diagnosed hypertensive patients in Nnewi, South-East Nigeria. Int J Hypertens. 2012;2012:710486. DOI: 10.2147/VHRM.S50690

22. Adediran SO, Akintunde AA, Opadijo OG, Araoye MA. Dyslipidaemia, atherogenic index and urbanization in central Nigeria: associations, impact, and a call for concerted action. Int J Cardiovasc Res. 2013;2:4 DOI: org/10.4172/2324–8602.1000134

23. Odenigbo CU, Oguejiofor OC, Odenigbo UM, Ibeh CC, Ajaero CM, Odike MA. Prevalence of dyslipidaemia in apparently healthy professionals in Asaba, South-South Nigeria. Niger J Clin Pract. 2008;11:330–5.

24. Barter PJ, Nicholls S, Rye KA, Anantharamaiah GM, Navab M, Fogelman AM. Anti-inflammatory properties of HDL. Circ Res. 2004;95(8):764–72. DOI: 10.1161/01.RES.0000146094.59640.13

25. Mackness MI, Durrington PN, Mackness B. How high-density lipoprotein protects against the effects of lipid peroxidation. Curr Opin Lipidol. 2000;11(4):383–8.

26. Okpara IC, Adediran OS. Dyslipidemia and its relationship with different anthropometric measures in Nigerian adults. IOSR J Dent Med Sci. 2013;9(3):7–12.

27. Kadiri S, Walker O, Salako BL, Akinkugbe O. Blood pressure, hypertension and its correlates in urbanized workers in Ibadan, Nigeria: a revisit. J Hums Hypertens. 1999;13:23–27.

28. Crowther NJ, Ferros WF, Ojwang PJ, Rheeder P. The effect of abdominal obesity on insulin sensitivity and serum lipid and cytokine concentrations African women. Clin Endocrinol (Oxf). 2006;64(5):535–41. DOI: 10.1111/j.1365-2265.2006.02505.x

.