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Plasma lipid profile, atherogenic and coronary risk indices in some residents of Abeokuta in south-western Nigeria

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Abstract

The incidence of chronic degenerative diseases like stroke and myocardial infarction in African subpopulations is reported to be increasing. In view of the association between dyslipidemia and these chronic degenerative diseases, we investigated some well-established cardiovascular risk factors (plasma cholesterol and its fractions as high-density lipoprotein (HDL), low-density lipoprotein (LDL), triglyceride, adiposity and blood pressure) in 92 subjects (43 males and 49 females) in Abeokuta, Nigeria. LDL cholesterol was significantly higher in the women compared with men (128.58mg/dl vs 108.73mg/dl; $p = 0.028$). Total cholesterol, although slightly higher in women, was not significantly different from that of men (155.71mg/dl vs 147.26mg/dl). HDL cholesterol and triglyceride were not significantly different between the two sexes, although women tended to have lower HDL cholesterol when compared with men. LDL/HDL cholesterol and total cholesterol/HDL cholesterol were significantly higher in women compared with men (4.20 vs 2.97; $p = 0.004$; 5.03 vs 4.06; $p = 0.024$, respectively). Systolic blood pressure was higher in men compared with women (117.58 vs 104.84; $p = 0.002$). Results indicate that the association between cholesterol and chronic degenerative diseases is continuous with no single cholesterol level separating those who are at high risk from those who are not. Rather in defining cardiovascular risks in African populations, the ratios LDL/HDL cholesterol and total cholesterol/HDL cholesterol should be considered. It might be appropriate at this time in Nigeria to consider physical activity and pharmacological interventions in lowering blood lipids.

Keywords: Cholesterol, Triglycerides, Atherosclerosis, Abeokuta, Nigeria

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INTRODUCTION

Cardiovascular disease is a leading cause of disability and premature death. This chronic degenerative disorder has become a growing health problem worldwide. During the past years, several observational studies and clinical trials have revealed the adverse effects of abnormal blood lipid and lipoprotein levels in the pathogenesis and progression of atherosclerosis and cardiovascular diseases[1–5]. Numerous population studies have shown an inverse correlation between plasma high density lipoprotein (HDL) levels and risk of cardiovascular disease[6–8]. Epidemiological studies have also shown that elevated concentrations of total or low density lipoprotein (LDL) cholesterol in the blood are powerful risk factors for coronary disease[9].

In African populations, while mortality caused by infectious diseases is reported to be declining, dyslipidemia as a risk factor for cardiovascular disease and death due to cardiovascular disease in both urbanized and underdeveloped rural countries have been increasing steadily over the past decade[3,4,10–13]. Environmental factors[14], as well as dietary factors and migration of populations from rural areas to urban centers[15,16], have been shown to contribute to the increasing incidents. While the literature is replete with current data regarding lipid profiles of the general population in economically advanced countries, few published reports exist about lipid profiles of Nigerian population[3,4,13,17]. Because of the association between blood lipid profile and risk of cardiovascular disease, we undertook to investigate the distribution of blood lipids in some residents of Abeokuta in southern Nigeria.

Abeokuta is an urban township in southwestern Nigeria with about 650,000 inhabitants based on an annual growth rate of 3.5% from the 1991 census figures (Department of Statistics, Ministry of Finance, Abeokuta, Nigeria). Its topography is undulated i.e. not levelled but rocky. In it is situated the University of Agriculture, Abeokuta with a population of about 8,000 made up of academic and non-academic staff and students from all over the country, with a preponderance of the population from the western coast. They basically consume typical Nigerian low fat, high carbohydrate and protein diets. Apart from this, they live an active life-style in the community. This report describes the results of our studies and relationships between body composition and plasma lipids in this population.

SUBJECTS AND METHODS

Subjects
Participation in our study was open to all in the community. After explaining the objectives of the study and its requirements to them, 43 males and 49 females voluntarily consented to participate in the study. All the subjects were non-smokers and non-alcoholics and none was on any steroidal or antilipidemic drug.

Anthropometric measurements
The weight of each subject was measured with a battery-operated scale accurate to 0.1kg and height, with a portable stadiometer to the nearest centimetre. From these data, Body Mass Index (BMI), Body Surface Area (BSA), Lean Body Mass (LBM), Body Fat Mass (BFM), Fat Free Mass Index (FFMI), Body Fat Mass Index (BFMI), Total Body Water (TBW), Intracellular Fluid (IF) and Extracellular Fluid (EF) were calculated[14,18-20]. The ideal weight of each subject was also calculated without correction for age according to the equation: Body height in centimeter – 100 = Ideal weight in kg[21].

Deviations from the ideal were then calculated for all the subjects. Blood pressure and pulse were measured two times on the left arm in each subject in a supine position using Omron manual inflation blood pressure monitor (model HEM. 412C, Omron Healthcare Inc. Illinois, USA). Each measurement was spaced twenty minutes apart and was usually performed before collection of blood samples. The average of the two measurements was used for all analyses.

Biochemical analysis
Blood samples were obtained once from the subjects by venipuncture, after an overnight fast. The blood samples were centrifuged (4000rpm for 10 minutes) to separate plasma and red blood cells. Plasma concentrations of total cholesterol (TC), LDL-Cholesterol (LDL-

C) and triglycerides (TG) were determined with commercial kits (Quimica Clinical Aplicada S.A, Spain). HDL-cholesterol (HDL-C) was determined in the plasma using the same commercial kits for total cholesterol after very low density lipoprotein (VLDL) cholesterol (VLDL-C) and LDL-C were precipitated with heparin-manganese chloride solution[22]. Atherogenic Index (AI = LDL-C/HDL-C) and Coronary Risk Index (CRI = TC/HDL-C) were then calculated for each subject.

Statistical protocol

Results are expressed as mean ± Standard Deviation (S.D). The student's t-test was used to determine if there were statistically significant differences between the men and women in the parameters. P values < 0.05 were statistically considered significant.

The relationships between anthropometric parameters and lipid profiles were also analyzed using Pearson correlations[23].

RESULTS

Anthropometric characteristics

Anthropometric characteristics of the subjects are shown in Table 1. The study group consisted of 43 men aged 20-54 years (mean age 28.58 ± 8.29 years) and 49 women aged 18-55 years (mean age 28.41 ± 8.63 years). With the exception of BSA, analyses of the anthropometric parameters revealed statistically significant differences between the two sexes. In the real sense, men were significantly heavier and taller than the women ($p<0.05$).

However, the calculated ideal weights indicate that heights for weights, men were 10% lighter whereas women were slightly heavier for their height. BMI, BFMI and BFM were statistically significantly higher in women when compared with their male counterparts ($p<0.05$). LBM, TBW, FFMI, IF and EF were significantly higher in men when compared with women ($p < 0.05$).

Table 1: Anthropometric characteristics of the subjects

Characteristics	Men (n=43)	Women (n=49)	*p* value
Age (years)	28.58 ± 8.29	28.41 ± 8.63	NS
Weight (kg)	64.85 ± 10.42	60.69 ± 10.48	<0.001
Height (m)	1.72 ± 0.07	1.60 ± 0.05	0.011
Ideal weight (kg)	71.86 ± 6.71	60.32 ± 5.38	
Deviation of real weight from ideal (kg)	-7.01 ± 9.73	0.50 ± 9.70	
BMI (kg/m^2)	21.94 ± 3.04	23.70 ± 3.84	0.009
BSA (m^2)	1.76 ± 0.14	1.95 ± 2.23	NS
BFMI (kg/m^2)	4.29 ± 1.71	6.61 ± 2.69	<0.001
FFMI (kg/ m^2)	17.65 ± 1.90	16.86 ± 1.29	0.018
LBM (kg)	52.76 ± 5.81	42.73 ± 6.27	<0.001
BFM (kg)	12.68 ± 5.02	17.54 ± 6.88	<0.001
TBW (L)	38.72 ± 5.80	31.13 ± 3.06	<0.001
IF (L)	21.30 ± 1.97	17.13 ± 1.68	<0.001
EF (L)	17.42 ± 1.61	14.00 ± 1.36	<0.001
Systolic blood pressure (mmHg)	117.58 ± 15.58	104.84 ± 16.27	<0.001
Diastolic blood pressure (mmHg)	73.84 ± 15.21	69.57 ± 12.26	NS
Pulse (min^{-1})	76.42 ± 10.02	76.06 ± 8.41	NS

NS = Not significant. Values are expressed as mean ± SD.

Table 2: Plasma lipid profiles of the subjects

Parameter	Men (n = 43)	Women (n = 49)	P value
Total-C (mg/dl)	147.26 ± 49.14	155.71± 51.39	NS
HDL-C (mg/dl)	39.43 ± 11.68	37.67 ± 16.04	NS
LDL-C (mg/dl)	108.73 ± 52.95	128.58 ± 45.77	0.028
TG (mg/dl)	69.78 ± 31.20	64.04 ± 30.51	NS
AI	2.97 ± 1.68	4.20 ± 1.31	0.004
CRI	4.06 ± 1.74	5.03 ± 2.83	0.024

Values are mean ± SD

Table 3: Relationship between biochemical parameters and cardiovascular risk factors

Parameters	Correlation coefficient (r)	
	Men (n=43)	Women (n = 49)
Age and BMI	0.538**	0.730**
Age and Diastolic BP	0.365*	0.420**
BMI and Diastolic BP	0.433**	0.385**
TC and TG	-	0.308*
HDL-C and AI	-0.427**	-0.595**
LDL-C and AI	0.778**	0.663**
HDL-C and CRI	-0.595**	-0.772**
LDL-C and CRI	0.563	-

* p<0.05; ** p<0.01

BSA, though higher in the women, was not statistically different from that of men ($p > 0.05$).

Blood pressure
The mean blood pressures of the subjects are also depicted in Table 1. Although the mean systolic and diastolic blood pressures indicate that both sexes were in the normotensive range, the systolic blood pressure of the men was about 11% higher than that of the women ($p < 0.05$), whereas no statistically significant difference was observed between the sexes in diastolic blood pressure and pulse ($p > 0.05$).

Plasma lipid profile
The mean plasma lipid concentrations of the subjects are shown in Table 2. With the exception of HDL-C, the study population seems to be normolipemic as prescribed by the American Heart Association (4). LDL-C in the women was 15% higher than that of men ($p < 0.05$). TC was also slightly higher in the women when compared with men, although this increase was not statistically significant ($p > 0.05$). HDL-C and TG were also not statistically different between the two sexes ($p > 0.05$), although women tended to have slightly lower HDL-C when compared with men. Both sexes however fell short of the 40mg/dl recommended by the American Heart Association.

The atherogenic (AI) and coronary risk (CRI) indices are also shown in Table 2. The two indices were significantly higher in the women when compared with men ($p < 0.05$).
Relationship between investigated lipids and AI and CRI and the anthropometrics

The relationships among some anthropometric parameters on one hand and investigated lipids and AI and CRI on the other hand, are depicted in Table 3. The inverse relationship between HDL-C and AI and CRI and the positive relationship between LDL-C and AI and CRI were observed for both sexes. Age correlated positively with BMI and diastolic blood pressure in both men and women. BMI also correlated positively with diastolic blood pressure in both sexes. In the men, positive associations were observed between systolic blood pressure and HDL-C ($r = 0.334$; $p = 0.019$), age and LDL-C ($r = 0.290$; $p = 0.043$), and age and triglyceride ($r = 0.377$; $p = 0.008$). A negative association was however observed between diastolic blood pressure and LDL-C ($r = -0.298$; $p = 0.037$). None of these associations was observed in women.

DISCUSSION

Mortality caused by infectious disease is reported to be declining in developing countries whereas the toll of chronic degenerative diseases like stroke and myocardial infarction, has been on the increase[3,4,10–13]. Extensive evidence between plasma lipid and lipoprotein levels and these chronic degenerative diseases has been well documented[1–5]. While Glew and his colleagues[3,4,13,24] have carried out a few studies in some parts of northern Nigeria, data regarding the levels of blood lipids in southern Nigeria are sparse[17]. Given the lack of current data regarding blood lipid levels in southern Nigeria, we investigated the distribution of some blood lipids in some residents of Abeokuta in southern Nigeria. We then compared our data with the guidelines of risk factors for cardiovascular disease given by the American Heart Association[4].

The results of this present investigation confirm previous findings[3,4,13,17] that

cholesterol levels in Nigerian population are significantly lower than that of their American counterparts. Our findings further indicate that with the exception of the borderline HDL-C levels of the study population, the levels of the investigated lipids in both sexes appear to be favourable with respect to risk of cardiovascular disease as prescribed by American Heart Association. When the two sexes were however compared, the higher TC and LDL-C in the females compared to their male counterparts, together with the borderline lower levels of HDL-C observed in both sexes, raise a lot of concern about their risk of cardiovascular disease. Furthermore, when certain lipid ratios like TC/HDL-C (CRI) and LDL-C/HDL-C (AI) of our study population were compared with these guidelines, our subjects seem to have unfavourable risk profile for cardiovascular disease. These two lipid ratios are widely regarded as powerful indices of risk for cardiovascular disease[25]. While the recommended ratios for the two are ≤ 3.5, the AI observed in the females was 4.20 ± 1.31 whereas for the men it was 2.97 ± 1.68. CRI on the other hand was 5.03 ± 2.83 for the women while it was 4.06 ± 1.74 for the men. Similar observations were made by Glew *et al*[13] in their study of male and female subjects in northern Nigeria. These findings suggest that women may be more at risk of cardiovascular disease than men since the two indices were higher in them than their male counterparts.

In their study of some stroke patients in northern Nigeria, Glew and his colleagues[13] observed that both control and stroke patients were "normolipid" in terms of triglycerides, total cholesterol, HDL cholesterol and LDL cholesterol. However, the LDL/HDL ratio distinguished the stroke patients from the control. While this ratio was 1.8 ± 0.5 and 2.3 ± 0.6 in male and female controls, it was 2.5 ± 0.7 and 2.7 ± 0.7 male and female stroke patients respectively, values which otherwise would have been regarded as still falling within the range of what was prescribed by American Heart Association. In view of the increasing trend in mortality due to cardiovascular disease in developing countries in spite of the normocholesterol levels, it is obvious that the association between cholesterol levels and cardiovascular disease is continuous and that no single level of

cholesterol seems to separate those who are at high risk from those who are not. Thus in defining the risks of cardiovascular disease in African populations, it might be appropriate to focus more on the imbalance between LDL cholesterol and HDL cholesterol on one hand, and total cholesterol and HDL cholesterol on the other hand.

In addition to blood lipids, other factors such as age, exercise, genetics, body composition, alcohol intake, tobacco use, body fat distribution and diet have been shown to contribute significantly to risk of cardiovascular disease[4,25]. All the subjects who participated in this study were non-smokers and non-alcoholics. They all consume the typical Nigerian diet of low fat, high carbohydrate and protein diets and the two sexes were of approximately the same age.

Correlations between the anthropometric parameters and plasma lipid levels were only observed in men. Positive associations were observed between systolic blood pressure and HDL-C ($r=0.334$; $p=0.019$), age and LDL-C ($r=0.290$; $p=0.043$), and age and triglyceride ($r=0.377$; $p=0.008$). A negative correlation was observed between diastolic blood pressure and LDL-C ($r=0.298$; $p=0.037$). Associations between other parameters of body composition and body fat distribution like BMI, BFMI and BFM and the investigated plasma lipids in both sexes were tested for, but none was found (Data not shown). Since only some of these relationships were observed in the males and none in the females, it is tempting to speculate that these anthropometric parameters do not seem to play any significant role in modulating plasma lipids in the subjects.

In economically advanced countries, results of screening the general population for blood lipids have led to the introduction of both physical exercise and pharmacological interventions in lowering blood lipids[13]. It is our opinion that the Nigerian population should consider this approach at this early stage. While physical activity has been shown to increase HDL-C[14], economic realities in Nigeria might preclude the consideration of expensive lipid lowering drugs commonly consumed in economically advanced countries. However, preliminary studies in our laboratory and studies going on at present

indicate that a daily supplementation of 300mg ascorbic acid for two weeks lowered total cholesterol, LDL-C and triglyceride while increasing the level of HDL-C. Ascorbic acid is readily available and cheap and can be administered without the supervision of a physician.

In conclusion, our study indicates that Nigerian populations are normo-cholesterolemic when compared with their American counterparts. Furthermore, the association between cholesterol and chronic degenerative diseases forms a continuum with no single cholesterol distinguishing those who are at risk from those who are not. Rather, the ratios LDL-C/HDL-C and total cholesterol/HDL-C should be considered in Nigerian population when defining risks of cardiovascular disease. It might be appropriate at this early stage in Nigeria to consider both physical activity and pharmacological interventions in lowering blood lipids.

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