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Serum Lipid Profiles and Risk of Cardiovascular Disease in Three Different Male Populations in Northern Nigeria

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ABSTRACT

The Fulani of northern Nigeria are indigenous semi-nomadic pastoralists whose diet consists largely of dairy products. Despite their consumption of relatively large amounts of saturated fats, an earlier study showed that their total cholesterol, high-density lipoprotein (HDL), low-density lipoprotein (LDL) and serum triglyceride levels fall within the reference range of values for North Americans. Men in the cities of Jos and Abuja, two populations who also reside in northern Nigeria, differ from the Fulani with regard to diet and activity level. Males in both Jos and Abuja have diets consisting of high protein or carbohydrate and are more sedentary than the Fulani subjects. The main aims of the study were to measure the concentrations of various lipids in the blood serum of male urban dwellers in Jos and Abuja and to compare their blood lipid profiles with those of the rural Fulani (mean age 33.9 years). Blood serum samples from 118 men in Jos (mean age 37.9 years) and 77 men in Abuja (mean age 34.4 years) were analyzed for total cholesterol, triglycerides, LDL, HDL, homocysteine, folate, and vitamin B_{12}. In addition to height and weight, systolic and diastolic blood pressures were measured. The mean total cholesterol, triglyceride, HDL and LDL values for the three groups of subjects fell within or close to the accepted range of values for North Americans. However, the Fulani males had HDL values (mean, 33.9 mg/dL) below the range of values prescribed for North Americans (>40 mg/dL). Moreover, the Fulani men and the men in Abuja had a total cholesterol/HDL ratio of 4.2 and 4.0 respectively, which exceed the accepted value (≤3.5) prescribed by the Columbia University. In all three populations, the incidence of homocysteinaemia (serum homocysteine >12.4 μmol/L) was very high. Their mean homocysteine levels ranged from 14.7 to 16.7 μmol/L and could not be accounted for by folate or vitamin B_{12} status. The mean blood pressures of the Abuja ($^{127}/_{77}$ mm Hg) and the Fulani ($^{120}/_{74}$ mm Hg) men were within the normotensive range ($<^{130}/_{85}$ mm Hg). However, the mean blood pressures of the Jos males ($^{131}/_{85}$ mm Hg) indicated borderline hypertension. These data indicate that, with regard to serum lipids, urban and rural adult Nigerian males have generally favourable risk factors for cardiovascular disease when compared with healthy North Americans. All three sub-populations, however, have levels of homocysteine that are cause for concern vis-à-vis their overall health status.

Key words: Cardiovascular diseases; Cholesterol; Cholesterol, Dietary; Triglycerides; Lipoproteins, LDL; Lipoproteins, HDL; Lipids; Homocysteine; Risk factors; Hypertension; Nigeria

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INTRODUCTION

It is widely accepted that cardiovascular disease is associated with hypertension (1) and elevated blood levels of low-density lipoprotein (LDL), total cholesterol, and triglycerides (2). In contrast, a low level of high-density lipoprotein (HDL) is a risk factor for mortality

from cardiovascular disease (2). Furthermore, hyperhomocysteinaemia is associated with an increased risk of the disease that can lead to stroke or heart attack (3). According to the guidelines of the American Heart Association, the following values are prescribed for the above-mentioned risk factors for cardiovascular disease: blood pressure: <130/85 mm Hg; total cholesterol: <200 mg/dL; triglycerides: <200 mg/dL; HDL: >40 mg/dL; and LDL: <130 mg/dL (4). In addition, certain lipid ratios, for example, the total cholesterol/HDL ratio and the LDL/HDL ratio also correlate with cardiovascular disease. The recommended targets for the total cholesterol/HDL ratio and the LDL/HDL ratio are both less than or equal to 3.5 (5,6).

Hyperhomocysteinaemia is associated with an increased risk of cardiovascular disease that can lead to stroke or heart attack, both of which are causes of mortality in African populations, especially males. The recommended reference value for serum homocysteine, an independent risk factor for cardiovascular disease, is 12.4 μmol/L (7).

In addition to blood lipids and homocysteine, other factors, such as age, activity level, genetics, body composition, alcohol intake, tobacco use, and body-fat distribution contribute significantly to risk of cardiovascular disease (8).

Previous studies have shown that, as a population, blacks have one of the highest rates of coronary artery disease in the world (9). Hypertension is widely recognized as a major cause of cardiovascular morbidity and mortality in indigenous people of Africa (10). Furthermore, several studies have shown that male urban dwellers in Africa have a higher incidence of hypertension compared to males living in rural areas (1,11-14). van der Sande *et al*. reported that, over the past 55 years in West Africa, there has been a 20% decrease in communicable diseases, that has been offset by a proportionate increase in non-communicable diseases, particularly cardiovascular disease (15).

We recently reported the results of a study of the blood lipid profiles of adult males and females in a community of cattle Fulani on the Jos Plateau of northern Nigeria (7). Like another nomadic ethnic group in Africa, namely the Masai of East Africa (16), the Fulani men and women consume a diet that consists largely of dairy products which are rich in saturated fats (7). Despite their consumption of a diet high in saturated fats, the total cholesterol, HDL, LDL and triglyceride levels in the serum of the semi-nomadic cattle Fulani (7) and the Masai (16) in those studies fell within the reference range values for North Americans (7).

In the light of results of our study of the risk factors for cardiovascular disease in the Fulani of northern Nigeria (7), we compared the blood lipid profiles of adult Fulani males with those of two urban, non-Fulani males who also reside in northern Nigeria.

The semi-nomadic cattle Fulani who inhabit the Jos Plateau of northern Nigeria have a very active lifestyle. In addition, tobacco use is rare among the Fulani, and the herdsmen tend to remain physically active and lean throughout their lives (7). In contrast, non-Fulani adult males in the city of Jos, Nigeria, are engaged primarily in relatively sedentary occupations and consume a diet that is high in protein and carbohydrates. Urban males in Jos are similar to men living in Abuja, the federal capital of Nigeria, with regard to lifestyle and diet, except that the latter are economically better-off and consume larger quantities of meat than men in Jos as preliminary inquiries have indicated.

This study reports the results of our comparative analysis of the risk factors for cardiovascular disease in adult males drawn from three different populations residing in northern Nigeria: adult Fulani males living in the savannah surrounding Jos, non-Fulani male inhabitants of Jos, and men in Abuja. We specifically analyzed the sera of these men for total cholesterol, triglycerides, LDL, HDL, and homocysteine, and measured the blood pressure in these subjects. Because homocysteine metabolism is influenced by folate and vitamin B_{12} status, we also analyzed the blood sera to determine the levels of these two vitamins. We anticipated that the least desirable blood lipid profiles would be found among men in Abuja, because they are relatively sedentary and appear to be of a somewhat higher socioeconomic status than the urban males in Jos and the semi-nomadic cattle Fulani of the Jos Plateau.

MATERIALS AND METHODS

Study population

This study was conducted in the cities of Jos and Abuja of northern Nigeria. The subjects in Abuja were selected from among the relatives of patients attending the National Hospital, Abuja, which provides care mainly to patients from the upper socioeconomic stratum. The urban subjects in Jos were selected from among the relatives of patients

attending the Jos University Teaching Hospital that serves a population representing a broad range of socioeconomic classes. However, most patients cared for at Jos University Teaching Hospital are from the lower socioeconomic stratum. The data for the Fulani men were taken from a previous publication (7). All of the subjects were in good health. This study was approved by the Human Research Review Committee of University of New Mexico School of Medicine and the Human Ethics Committee of Jos University Teaching Hospital, and was in accordance with the Helsinki Declaration.

Anthropometric measurements

Height and weight of the subjects were determined using a portable stadiometer and battery-operated scale (accurate to 0.5 kg) respectively.

Biochemical analyses and measurement of blood pressure

Fasted blood samples were obtained early in the morning by venipuncture, and the samples were allowed to clot at room temperature for 45 minutes before centrifugation to separate the serum. The samples were then aliquoted into cryovials and stored at -40 ˚C until these were transported in a frozen state to Albuquerque, New Mexico, for analysis.

Total cholesterol was determined by the end-point colorimetric method of Allain *et al*. using a Vitros 950 analyzer (17). HDL-cholesterol was determined using Kodak Vitros Cholesterol slides and a Vitros 250 analyzer (18). Triglycerides were determined by the method of Spayd *et al*. using a Vitros Analyzer Clinical Chemistry Slide (TRIG) and a Vitros 950 analyzer (19). LDL-cholesterol was calculated using the following equation:

LDL-cholesterol=total cholesterol–(HDL-cholesterol+ VLDL-cholesterol).

Serum homocysteine levels were determined using the IMx Homocysteine assay kit (Abbott Diagnostics Division, Abbott Laboratories, Abbott Park, IL, USA). Serum folate and vitamin B_{12} were determined immunologically by competitive magnetic separation assays using the Bayer Immuno 1 System (Bayer Corporation, Tarrytown, NY, USA).

Blood pressure of each subject was measured twice on the same day using a nylon cuff and latex inflation system (Prestige Medical, Inc., Northridge, CA) and was repeatable.

Statistical analysis

Descriptive statistics, group comparisons and correlations were made using the Number Cruncher Statistical Software (NCSS, version 6, Kaysville, UT, USA). Results are expressed as mean±standard deviation. Multivariate ANOVA modelling was used for comparing the three different populations. A two-sample *t*-test was used for determining the statistical significance of a parameter between the different groups. A p value of 0.05 was considered statistically significant.

RESULTS

Comments on the study population

The subjects in the present study consisted of 118 men from Jos, 77 men from Abuja, and 41 rural Fulani men. As shown in Table 1, the mean ages of the men in Jos, Abuja, and Fulani were 37.9, 34.4, and 33.9 years respectively. The Abuja men were taller and heavier than the men in the other two populations ($p<0.001$) and had a mean body mass index (BMI) of 24.8 kg/m^2. The Jos and the Fulani men were comparable in height but different in weight ($p=0.003$), the Fulani being lighter of the two; the mean BMI values of these two groups were 22.3 kg/m^2 and 20.0 kg/m^2 respectively.

Table 1. Characteristics of three male populations in northern Nigeria

Parameter	Jos (n=18)	Abuja (n=77)	Fulani (n=41)
		Mean±SD	
Age (years)	37.9±10.2	34.4±9.51	33.9±12.5
Height (m)	1.68±0.06	1.72±0.06	1.69±0.07
Weight (kg)	63.1±10.5	72.7±12.1	57.5±8.75
Body mass index (kg/m^2)	22.3±3.32	24.8±3.96	20.0±2.24
Systolic BP[a] (mm Hg)	131±20.4	127±16.3	120±15.5
Diastolic BP (mm Hg)	85.1±12.8	77.0±12.9	73.9±10.4

[a] Blood pressure

Blood pressure

As shown in Table 1, both systolic and diastolic blood pressures of the Abuja men ($^{127}/_{77}$ mm Hg) and the Fulani subjects ($^{120}/_{74}$ mm Hg) were in the normotensive range as prescribed by the American Heart Association (3). The Jos subjects, on the other hand, had borderline high blood pressure ($^{131}/_{85}$ mm Hg). There was no statistically significant difference in the systolic pressure of the Abuja and the Jos subjects. However, there was a statistically significant difference in the systolic pressure of the Abuja and Fulani subjects (127 vs 120 mm Hg respectively, p=0.012) and in the systolic pressure of the Jos and the Fulani subjects (131 vs 120 mm Hg respectively, p<0.001). Although there was no significant difference in the diastolic pressure of the Abuja and the Fulani subjects, there was a significant difference in the diastolic pressure of the Fulani and the Jos subjects (74 vs 85 mm Hg respectively, p<0.001) and in the diastolic pressure of the Abuja and the Jos subjects (77 vs 85 mm Hg respectively p<0.001).

Serum lipid profiles

As shown in Table 2, the mean total cholesterol levels for all three study groups were well within the reference range that has been set for North Americans. Men in Abuja had the highest mean total cholesterol levels (mean, 184 mg/dL) compared to the other two groups (Jos men, 157 mg/dL; Fulani men, 136 mg/dL). In contrast, a different pattern was observed for the serum triglyceride fraction: the mean serum triglyceride concentration was the highest in the cattle Fulani (143 mg/dL), followed by the Jos (121 mg/dL) and the Abuja males (111 mg/dL) respectively. The level of cardioprotective HDL was the highest in the Jos (50.4 mg/dL) and the Abuja (51.6 mg/dL) males, whereas for the cattle Fulani, the HDL concentration (33.9 mg/dL) was below the lower limit of the reference range for North Americans. There was a statistically significant difference between the mean HDL values of the Jos and the Fulani subjects (p<0.001). No statistically significant difference was observed in the mean serum triglycerides and HDL values of the Jos and Abuja subjects. LDL, a prominent risk factor for cardiovascular disease, was present at similar concentrations in the Fulani (71.0 mg/dL) and Jos (82.1 mg/dL) subjects, whereas it was about 75% higher in the Abuja subjects (113 mg/dL). With regard to the ratios of particular lipids, for example total cholesterol/HDL and LDL/HDL, there were no statistically significant differences between the Abuja and the Fulani subjects. In contrast, a statistically significant difference was observed between the Abuja and the Jos subjects with regard to the total cholesterol/HDL (p=0.027) and LDL/HDL (p<0.001) ratios.

Serum homocysteine

As shown in Table 3, the mean serum homocysteine concentrations in the urban men in Abuja and Jos, and the rural Fulani men were 16.6, 16.7, and 14.7 μmol/L respectively. These values are substantially above the upper limit of the reference range (12.4 μmol/L).

Table 2. Comparison of serum concentrations of biochemical risk factors of cardiovascular disease in three male populations in northern Nigeria

Parameter	Jos (n=118)	Abuja (n=77)	Fulani (n=41)	Healthy Nigerians (15)	Reference range
			Mean±SD		
Total cholesterol (mg/dL)	157±36.4	184±49.1	136±31.3	165±18.3	<200 (4)
Triglycerides (mg/dL)	121±73.5	111±59.5	143±79.2	56.5±16.0	<200 (4)
HDL (mg/dL)	50.4±13.4	51.6±12.1	33.9±10.8	53.8±8.80	40-60 (4)
LDL (mg/dL)	82.1±33.1	113±44.5	71.0±26.5	97.4±16.0	<130 (4)
Total cholesterol/HDL ratio	3.22*	3.58*	4.14*	NA	<3.50 (5)
LDL/HDL ratio	1.78±0.90	2.23±0.79	2.15±0.59	NA	<3.50 (6)

* Median; reported due to non-normal distributions of the variables
NA=Not available
LDL=Low-density lipoprotein
HDL=High-density lipoprotein
Figures in parentheses indicate reference numbers in the Reference list

Correlations between homocysteine, folic acid, and vitamin B_{12}

The Figure shows a correlation plot of homocysteine vs folate levels and of homocysteine vs vitamin B_{12} in the

three Nigerian sub-groups. Group-specific correlations were observed in all three Nigerian sub-groups. The semi-nomadic cattle Fulani exhibited an inverse correlation between homocysteine and folate. In contrast, in the more sedentary non-Fulani urban dwellers in Jos, inverse correlations were observed between the concentrations of homocysteine and vitamin B_{12} and between the concentrations of homocysteine and folate. Among the relatively affluent non-Fulani men in Abuja, an inverse correlation existed between the concentration of homocysteine and vitamin B_{12}.

Table 3. Comparison of serum homocysteine levels in various black populations

Male population	No.	Age range (years)	Homocysteine (μmol/L) Mean±SD
Nigeria			
Abuja	67	19-62	16.6±9.4
Jos	112	21-75	16.7±5.8
Fulani	32	18-64	14.7±6.2
United States blacks (25)	25	NR	8.3±2.7
South Africa blacks (26)	12	19-24	8.4±2.4

NR=Not reported
Figures in parentheses indicate the reference numbers in the Reference list

Correlations between blood pressure and serum biochemical parameters

We analyzed our data to determine if any correlations existed between the systolic and diastolic blood pressure and any of the biochemical parameters (Table 4). For the Fulani subjects, the only correlation we observed was between age and the systolic and diastolic pressures (p=0.02 in both the cases). Both the Jos and the Abuja subgroups exhibited statistically significant correlations (p<0.001) between both systolic and diastolic pressures and age. Furthermore, both Jos and Abuja subjects showed a correlation between both systolic and diastolic pressures and BMI. In the Abuja subjects, there was also a correlation between systolic pressure and total cholesterol levels. For the Jos subjects, correlations were found between the total cholesterol and LDL levels, the total cholesterol/HDL ratio, and the LDL/HDL ratio vs the systolic and diastolic pressures. Diastolic pressure and serum triglycerides were also correlated in the males in Jos.

Table 4. Positive correlations between systolic blood pressure (mm Hg) and diastolic blood pressure (mm Hg), age, BMI, and various lipid concentrations in the Jos, Abuja and Fulani subjects

Variable	Jos				Abuja				Fulani			
	Systolic		Diastolic		Systolic		Diastolic		Systolic		Diastolic	
	r	p	r	p	r	p	r	p	r	p	r	p
Age (years)	0.33	<0.001	0.36	<0.001	0.42	<0.001	0.45	<0.001	0.35	0.02	0.36	0.02
BMI	0.22	0.027	0.20	0.044	0.48	<0.001	0.35	0.002	NS		NS	
Total cholesterol	0.33	<0.001	0.41	<0.001	0.32	0.007	NS		NS		NS	
Triglycerides	NS		0.20	0.30	NS		NS		NS		NS	
LDL	0.33	<0.005	0.33	<0.004	NS		NS		NS		NS	
HDL	NS		NS		NS		NS		NS		NS	
Total cholesterol/HDL	0.35	0.002	0.28	0.01	NS		NS		NS		NS	
LDL/HDL	0.30	0.01	0.22	0.045	NS		NS		NS		NS	

BMI=Body mass index; HDL=High-density lipoprotein; LDL=Low-density lipoprotein
NS=Not significant (p>0.05)

DISCUSSION

Due to the large and growing literature regarding hypertension and hyperlipidaemia as a risk factor for cardiovascular disease in African populations, and the increasing incidents of death due to cardiovascular disease in both urbanized and under-developed rural countries in Africa (15), we were compelled to compare our data with that for populations outside Africa. Our main conclusion is that all the three Nigerian sub-groups,

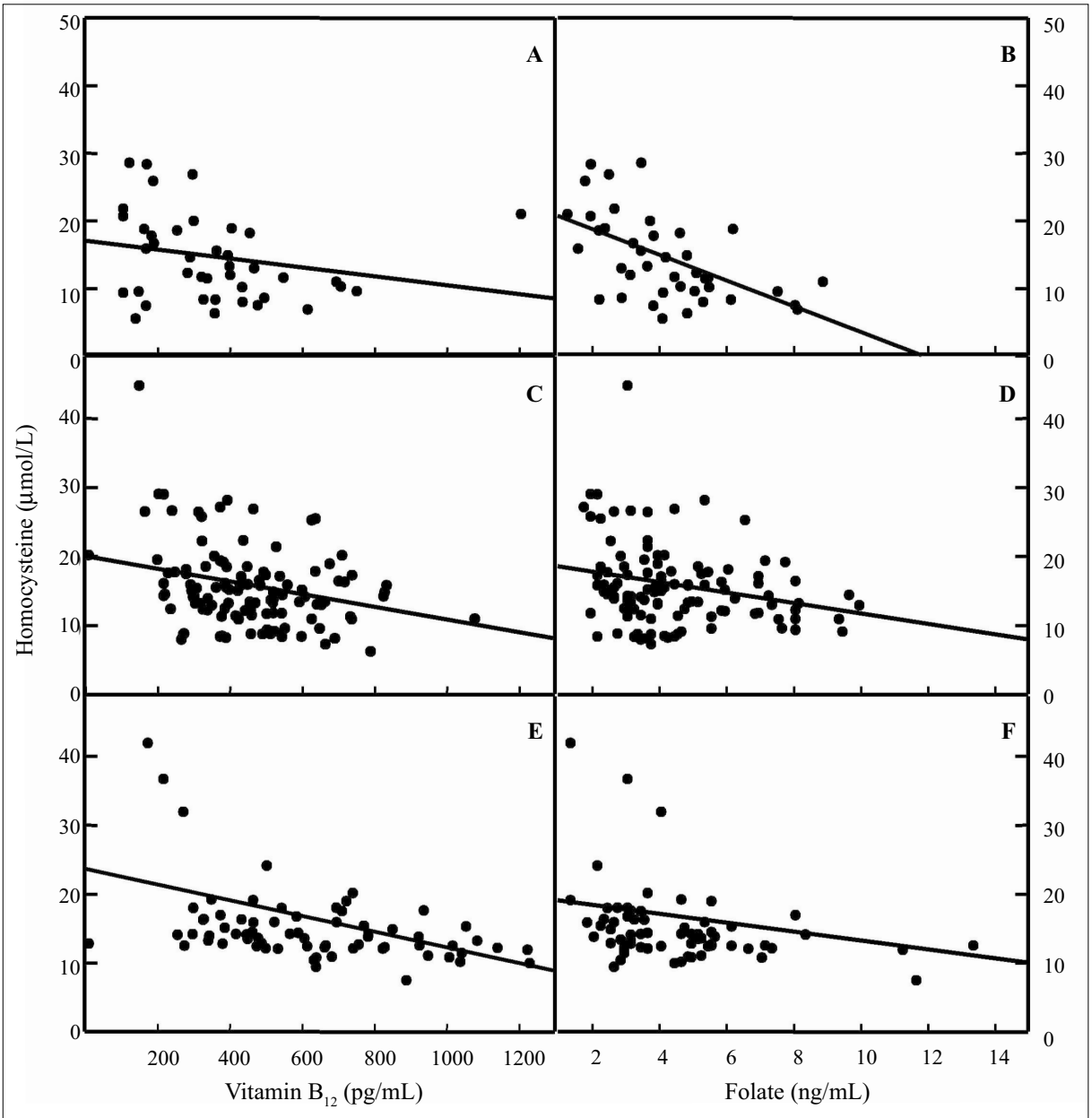

Fig. A. Relationship between serum homocysteine and vitamin B_{12} levels in Fulani males (n=40, p=0.74, r=0.04)
B. Relationship between serum homocysteine and folate levels in Fulani males (n=40, p<0.001, r=0.57)
C. Relationship between serum homocysteine and vitamin B_{12} levels in Jos males (n=114, p=0.001, r=0.30)
D. Relationship between serum homocysteine and folate levels in Jos males (n=114, p=0.007, r=0.25)
E. Relationship between serum homocysteine and vitamin B_{12} levels in Abuja males (n=73, p=0.005, r=0.33)
F. Relationship between serum homocysteine and folate levels in Abuja men (n=73, p=0.13, r=0.17)

who participated in our study, had generally favourable risk profiles for cardiovascular disease when compared with data for healthy North Americans: total cholesterol, triglyceride, and LDL concentrations of each group were favourable with regard to risk of cardiovascular disease. Furthermore, the LDL/HDL ratio of all the three Nigerian study groups fell well within the acceptable range of values for North Americans. In addition, HDL

concentrations were within the acceptable range of values for the males in Jos and Abuja but were below the lower limit of the acceptable range of values in the Fulani population. With regard to the total cholesterol/HDL ratio, both Abuja and Fulani men were at moderate risk of cardiovascular disease in that each population had ratios above the acceptable value for North Americans. The total cholesterol/HDL ratio for the Jos population was well within the acceptable range of values. The total cholesterol and triglyceride levels we report are in line with those reported for the nomadic Masai of East Africa by Biss and colleagues (16). The Tarahumara Indians of rural Mexico consume a diet that is low in total fat and saturated fatty acids and, like the nomadic Fulani and Masai who consume diets rich in fat, are hypolipidaemic and at a low risk of cardiovascular disease (20). One characteristic shared by all three populations—the Fulani, Masai, and Tarahumara Indians—is that their lifestyles demand intense and constant physical activity. Thus, it would seem that the level of physical activity of these people and, perhaps, their genetic make-up are more important than their diet in causing them to have desirable blood lipid profiles.

Although the lipid profiles of the three Nigerian subgroups were generally favourable (with the exception of the Fulani whose mean HDL level was relatively low), their homocysteine levels exceeded by a substantial margin of the upper limit of the reference range (12.4 μmol/L). These elevated homocysteine levels should be a matter of concern, since these are indicative of an increased risk for cardiovascular disease. For example, Nygard and colleagues have shown that, after four years, 6.5 times as many patients with homocysteine levels of 15 μmol/L or greater had died when compared to those whose homocysteine levels were below 9 μmol/L (3).

Our comparative study of three different Nigerian populations, namely the semi-nomadic cattle Fulani of the Jos Plateau, urban males residing in Jos, and another group of urban males in the capital city of Abuja, support two main conclusions. The first of these is that, based on blood lipid profiles, the cattle Fulani residing in rural areas are at a slightly greater risk of cardiovascular disease than the two urban populations. The cattle Fulani had the serum levels of HDL (mean, 33.9 mg/dL) substantially below the lower limit of the range of values recommended by the American Heart Association (>40 mg/dL). Furthermore, in addition to their having a remarkably low total cholesterol level (136 mg/dL), the Fulani exhibited a total cholesterol/HDL ratio of 4.2, which is well above the recommended value of ≤3.50 (5). Kinosian *et al.* have shown that the total cholesterol/HDL ratio is a superior measure of the risk for cardiovascular disease compared to either the total serum cholesterol concentration or the LDL level alone (21). Furthermore, they contend that the use of this ratio, instead of either LDL or HDL levels alone, is a more appropriate guideline for advising individuals about their risk of cardiovascular disease (21).

The Fulani population also had higher serum triglyceride levels compared to the other two sub-groups. This fact reinforces our assertion that the Fulani population has a less acceptable risk profile for cardiovascular disease compared to the other two Nigerian populations we studied, both of whom are urban dwellers. This finding runs counter to a previous study which concluded that urban Nigerians were at a greater risk of cardiovascular disease than rural Nigerians (1).

It is well-established that hypertension is a major cause of cardiovascular morbidity and mortality. Olatunbosun *et al.* have shown a relatively high prevalence of hypertension in urban Nigerians (1). Furthermore, it has been argued that this problem will likely grow worse with increasing urbanization in Africa (1). While the rural cattle Fulani had less favourable lipid profiles relative to their urban counterparts, their blood pressures were significantly lower than those of the urban Nigerians. None of the Fulani subjects had blood pressure above the acceptable range of values prescribed by the American Heart Association. In contrast, 4 (5.2%) of the 77 Abuja subjects had borderline hypertension ($>^{130}/_{85}$ mm Hg) and 8 (13%) of 77 had hypertension ($>^{140}/_{90}$ mm Hg). Thirteen (11%) of the 118 Jos males had hypertension ($>^{140}/_{90}$ mm Hg). Jarikre *et al.* have shown that plasma total cholesterol, LDL, and triglyceride concentrations are considerably higher in hypertensive subjects compared to normotensive individuals (22). Furthermore, Mtabaji *et al.*, Mafunda *et al*., and M'Buyamba-Kabangu *et al*. found from their studies of the relationship between hypertension and diet in urban and rural populations that hypertension was a greater problem amongst people living in the capital city vs those living in a rural community (11-13).

The present study supports this finding with the exception of triglyceride concentration which was the highest in the Fulani subjects who, of the three populations studied, had the lowest blood pressures. In comparing the two urban Nigerian populations, namely

those in Jos and Abuja, we found that the males in the Jos Plateau had a more favourable risk profile for cardiovascular disease with regard to serum lipid. Men in Abuja had higher mean values for four of the six lipid parameters we evaluated. As summarized in Table 2, the Abuja men had higher mean values for serum total cholesterol (184 vs 157 mg/dL, $p<0.001$) and LDL (113 vs 82.1 mg/dL, $p<0.001$) and higher total cholesterol/HDL (4.00 vs 3.34, $p=0.27$) and LDL/HDL ratios (2.23 vs 1.78, $p<0.001$). In addition, the total cholesterol/HDL ratio for the Abuja males (4.0) was above the accepted value (3.5) for North Americans. One must be cautious in applying cut-off points from one culturally-distinct population to another. In a study conducted in coastal and highland Papua New Guinea, Hodge *et al.* found total cholesterol and LDL levels to be higher in the urban coastal and periurban highland subjects compared to their rural counterparts (23). This finding supports those of the present study, both of which are contrary to the finding of a previous study which reported that high socioeconomic class was a protective factor for cardiovascular disease (24). Our study found that the more economically-privileged men in Abuja were at a slightly increased risk of cardiovascular disease relative to the less affluent men in Jos.

Several limitations may affect our findings and conclusions. Statistical power was compromised in the semi-nomadic cattle Fulani group due to a relatively small number of subjects we studied, i.e. 41 only. In addition, detailed nutritional information was not obtained for the Jos and Abuja populations, thereby preventing us from drawing conclusions with regard to the role of diet as a risk factor for cardiovascular disease. In addition, we lacked specific information on occupation, tobacco use, and alcohol consumption by the Jos and the Abuja subjects. Hence, socioeconomic status was inferred based on regionality and the restrictive hospital fees of the National Hospital, Abuja, where the male volunteers in Abuja were recruited.

Future studies that we are pursuing address these questions: (i) what are the factors responsible for the low HDL concentrations in the cattle Fulani?; (ii) is the total cholesterol/HDL ratio a reliable predictor of cardiovascular disease risk in Nigerian populations?; and (iii) how does the total cholesterol level correlate with serum triglyceride concentrations in Fulani males elsewhere in West Africa?

Most studies involving non-African populations have observed a direct proportionality between total cholesterol and serum triglycerides. However, in the present study, the Fulani males had the highest levels of serum triglycerides and the lowest levels of serum total cholesterol, whereas the Abuja males had the lowest levels of triglycerides and had the highest levels of total cholesterol. Our ongoing studies are designed to address the extent to which these observations are attributable to lifestyle and degree of physical activity, and whether the risk profile for cardiovascular disease is gender-specific.

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REFERENCES

1. Olatunbosun ST, Kaufman JS, Cooper RS, Bella AF. Hypertension in a black population: prevalence and biosocial determinants of high blood pressure in a group of urban Nigerians. *J Hum Hypertens* 2000;14:249-57.
2. Criqui MH, Heiss G, Cohn R, Cowan LD, Suchindran CM, Bangdiwala S *et al*. Plasma triglyceride level and mortality from coronary heart disease. *N Engl J Med* 1993;328:1220-5.
3. Nygard O, Nordrehaug JE, Refsum H, Ueland PM, Farstad M, Vollset SE. Plasma homocysteine levels and mortality in patients with coronary artery disease. *N Engl J Med* 1997;337:230-6.
4. American Heart Association. What do my cholestorol levels mean? (http://www.americanheart.org).
5. Columbia University's health question and answer internet service. (http://www.goaskalice.columbia.edu/1072.html).
6. Altruis biomedical network. (http://www.lipoproteins.net).
7. Glew RH, Williams M, Conn CA, Cadena SM, Crossey M, Okolo SN *et al*. Cardiovascular disease risk factors and diet of Fulani pastoralists of northern Nigeria. *Am J Clin Nutr* 2001;74:730-6.
8. Brochu M, Poehlman ET, Savage P, Ross S, Ades PA. Coronary risk profiles in men with coronary artery disease: effects of body composition, fat distribution, age and fitness. *Coron Artery Dis* 2000;11:137-44.
9. Kountz DS, Levine SL. Cardiovascular risk profiling in blacks: don't forget the lipids. *Am Fam Physician* 1998;58:1541-2.

10. Cruickshank JK, Mbanya JC, Wilks R, Balkau B, Forrester T, Anderson SG *et al*. Hypertension in four African-origin populations: current 'Rule of Halves', quality of blood pressure control and attributable risk of cardiovascular disease. *J Hypertens* 2001; 19:41-6.
11. Mtabaji J, Nara Y, Moriguchi Y, Yamori Y. Diet and hypertension in Tanzania. *J Cardiovasc Pharmacol* 1990;16(Suppl 8):S3-5.
12. Mufunda J, Scott LJ, Chifamba J, Matenga J, Sparks B, Cooper R *et al*. Correlates of blood pressure in an urban Zimbabwean population and comparison to other populations of African origin. *J Hum Hypertens* 2000;14:65-73.
13. M'Buyamba-Kabangu JR, Fagard R, Staessen J, Lijnen P, Amery A. Correlates of blood pressure in rural and urban Zaire. *J Hypertens* 1987;5:371-5.
14. M'Buyamba-Kabangu JR, Fagard R, Lijnen P, Staessen J, Ditu MS, Tshiani KA *et al*. Epidemiological study of blood pressure and hypertension in a sample of urban Bantu of Zaire. *J Hypertens* 1986;4:485-91.
15. van der Sande MAB, Inskip HM, Jaiteh KO, Maine NP, Walraven GEL, Hall AJ *et al*. Changing causes of death in the West African town of Banjul, 1942-97. *Bull World Health Organ* 2001;79:133-41.
16. Biss K, Ho KJ, Mikkelson B, Lewis L, Taylor CB. Some unique biologic characteristics of the Masai of East Africa. *N Engl J Med* 1971;284:694-9.
17. Allain CC, Poon LS, Chan CS, Richmond W, Fu PC. Enzymatic determination of total serum cholesterol. *Clin Chem* 1974;20:470-5.
18. Thomas L, editor. Labor and diagnose. 4th ed. Marburg: Die Medizinische Verfagsgsellschaft, 1992:208.
19. Spayd RW, Bruschi B, Burdick BA, Dappen GM, Eikenberry JN, Esders TW *et al*. Multilayer film elements for clinical analysis: applications to representative chemical determinations. *Clin Chem* 1978;24:1348-50.
20. Connor WE, Cerqueira MT, Connor RW, Wallace RB, Malinow MR, Casdorph HR. The plasma lipids, lipoproteins, and diet of the Tarahumara Indians of Mexico. *Am J Clin Nutr* 1978;31:1131-42.
21. Kinosian B, Glick H, Garland G. Cholesterol and coronary heart disease: predicting risks by levels and ratios. *Ann Intern Med* 1994;121:641-7.
22. Jarikre AE, Dim DC, Ajuluchukwu JNA. Plasma lipid levels in Nigerian hypertensives: the gender factor. *Nig Q J Hosp Med* 1996;6:293-8.
23. Hodge AM, Dowse GK, Erasmus RT, Spark RA, Nathaniel K, Zimmet PZ *et al*. Serum lipids and modernization in coastal and highland Papua New Guinea. *Am J Epidemiol* 1996;144:1129-42.
24. Adams-Campbell LL, Nwankwo MU, Omene JA, Ukoli FA, Young MP, Haile GT *et al*. Assessment of cardiovascular risk factors in Nigerian students. *Arteriosclerosis* 1988;8:793-6.
25. Estrada DA, Billett HH. Racial variation in fasting and random homocysteine levels. *Am J Hematol* 2001;66:252-6.
26. Ubbink JB, Vermaak WJ, Delport R, van der Merwe A, Becker PJ, Potieter H. Effective homocysteine metabolosm may protect South African blacks against coronary heart disease. *Am J Clin Nutr* 1995;62:802-8.