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Correlates of serum lipids in a lean black population

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Abstract

Exposure to an urban, sedentary work environment and higher socioeconomic status (SES) may stimulate adoption of Westernized lifestyles by populations in developing countries reversing the historically low risk for coronary heart disease. In a study of serum lipids in 1407 Nigerian civil servants, aged 25-54 years, we found a more atherogenic lipid profile among higher SES males and females compared with lower SES (LDL-cholesterol, 113 vs. 97 mg/dl, males, 125 vs. 114 mg/dl, females). Mean body mass index (BMI, kg/m^2) in higher and lower SES was 22.6 and 21.3, respectively, males, and 24.7 and 24.4, respectively, females. A strong relationship was observed between BMI and lipids although this relationship was absent among the leanest half of the population (BMI < 21.8). In multiple regression, SES and BMI were both strong and independent predictors of cholesterol. Both high and low SES consumed a typical Nigerian low fat, high carbohydrate diet, but somewhat higher meat, milk and egg intake suggested that some Westernization of the diet had occurred among the higher SES. Physical activity was lower among the higher SES. We conclude that SES related changes in lifestyle contribute to substantially higher total and LDL-cholesterol even in a generally lean population consuming a low fat diet.

Keywords: Lipids; Blacks; West African; Body mass index; Socio-economic status; Physical activity

1. Introduction

While coronary heart disease is the leading cause of death among blacks in Westernized countries, West African blacks have enjoyed a near absence of recognized coronary heart disease [1-3]. There has been little study of lifestyle factors related to coronary heart disease in West Africans, but, in general, these populations are lean, consume a low cholesterol diet, and have high levels of physical activity. Competing causes of death, e.g. high rates of accidents and infection, have also affected rates of coronary heart disease mortality.

One important risk factor for coronary heart disease which has been well documented in the West African populations is serum cholesterol.

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Low levels of serum cholesterol have generally been observed [4–10] although higher levels have been observed in some segments of the population in several studies [4,8,11–13]. Other serum lipids have received less study. Both high [9,12,13] and low [6,7,10] levels of HDL-cholesterol have been reported. Low triglyceride levels have been reported [4,9] with one exception [13].

As segments of these populations adopt more Westernized lifestyles, we hypothesize that prevalence of the chronic diseases of Westernized culture will increase. The prevalence of hypertension in upper SES Nigerians [14] already approaches that in US blacks. We studied three populations of civil servants in Nigeria. In contrast with the general population which continues in a rural subsistence culture, these urban populations work in a more Westernized setting and enjoy a more regular income. Among the civil servants, the senior staff, or the professionals and administrators, are part of a small emerging middle class which enjoys a moderately comfortable standard of living but are far less affluent than the upper class. The junior staff, or support staff of clerks, drivers and maintenance personnel, are considerably better off than the general population but enjoy only a fraction of the resources of the senior staff. We hypothesized that the professionals and administrators had adopted a more Westernized lifestyle leading to higher serum lipids than the non-professional support staff.

2. Materials and methods

Three populations of Nigerian civil servants were studied: 1) in 1988, 376 civil servants were recruited from four ministries of Bendel State, Benin City, south-central Nigeria; 2) in 1990, 539 civil servants from six ministries of Sokoto State, Sokoto, Northern Nigeria; 3) in 1992, 804 civil servants from three ministries of Edo State, Benin City. Edo State is one of two states formed when the former Bendel State was split between 1988 and 1992. Recruitment methods were similar across studies. Each day of the study, a messenger was sent to a specific work area to describe the study and attempt to recruit all workers present. The study was described as a health survey. Participation rates in 1988 and 1990 appeared to be very high but could not be determined because census data for these ministries could not be obtained. Participation rates could be determined in 1992 based on a study-conducted census completed in each ministry prior to recruitment. Ninety-two percent of all civil servants present at work at the time of recruitment participated (84% of all censused, which included those on vacation, training leave, field assignment, sick leave and absent).

At the first visit in each study, height was measured using a measuring tape fixed to the wall. Weight was measured using a digital bathroom scale. Waist was measured at the narrowest point or at the umbilicus in the absence of a narrowest point. Hips were measured at the widest part of the buttocks. All measurements were made in light clothing without shoes. Questionnaires were used to collect data on demographic factors. Civil service staff status, junior staff (non-professional staff, salary grades 1–6) and senior staff (professional and administrative staff, salary grades 7–16) was used as a marker of socioeconomic status.

At the end of the first visit, subjects were scheduled to return for a second visit, usually within 1–2 days. Subjects were instructed to fast after 22:00 h of the evening prior to the second visit. Fasting bloods were drawn using a 10 or 15 ml plain red-top vacuum tube. In 1988 and 1990, tubes of blood were held at ambient temperature for 3–6 h until serum was separated by centrifugation for 15 min at ambient temperature, then poured into 5 ml plastic tubes with push stoppers and placed in storage at −20°C. In 1992, serum was separated as above after 1–2 h at ambient temperatures, then aliquotted into 1.25 ml cryotubes with O-ring screw-tops and placed on ice for 3–5 h until transported to storage at −20°C. Within 2 (1988, 1990) or 3 (1992) months of the blood draw, samples were hand carried on ice packs (1988, 1990) or dry ice (1992) to the University of Pittsburgh where they were stored at −70°C. Lipid measurements were generally completed within 6–12 months of the blood draw. Total cholesterol [15], HDL-cholesterol [16], and triglycerides [17] were assayed in the Heinz Nutrition Laboratory in the Graduate School of Public Health, University of Pittsburgh, which participates in the Centers for Disease Control standardization program. LDL-cholesterol was calculated using the Friedewald equation [18].

In the 1992 Benin study, additional data were collected regarding physical activity and dietary intake. Leisure and occupational physical activity averaged over the past year were assessed using a detailed questionnaire [19] modified for use in this population. Activities were weighted by an estimate of the relative intensity of the activity termed the metabolic equivalent or MET (ratio of the metabolic rate during the activity to the resting metabolic rate). Time spent on each activity was weighted by its MET value, summed across activities, and reported as MET h/week averaged over the past year [19]. Included in the occupational section of the physical activity questionnaire was an estimate of the minutes spent walking or biking to work each day. Twenty-four hour dietary recalls were collected for a weekday and for a Sunday. Standard local measures and crude food models were used to assist with quantification of intake. Data were entered and analyzed using the Nutritionist IV computer program (N-Squared Computing, Version 3.0, 1993, Salem, OR). Macronutrient values for local foods were derived from published sources [20–23] and added to the database. Average intake from the two recalls was used in data analysis. Average weekday and average weekend-day intake of beer, palm wine, wine, hard liquor and ogogoro (locally brewed hard liquor) were assessed using detailed questions. Alcohol data were converted to grams of absolute ethanol per week.

Analyses were limited to the ages 25–54 to include age groups represented in all staff status groups with the exception of the absence of females aged 45–54 in the Sokoto population. Means adjusted for age and other factors were calculated and tested by analysis of variance. The possibility of a threshold relationship between body measurements and lipids was explored by examining lipid means across several ntile distributions based on males and females combined across the total population. Sextiles yielded relatively smooth curves and were used in the analyses. Trends across age groups and ordinal categories (sextiles) were assessed by analysis of variance and tested for linearity and deviation from linearity. Forward stepwise multiple regression was used to examine the relationship of lipids to staff status and physical measurements adjusting for population and age. Physical measurements were used as continuous variables or as ordinal variables (sextiles).

3. Results

A very high proportion of subjects in each population returned for the blood draw, 336 of 376 in 1988 (89%), 451 of 539 in 1990 (84%), and 777 of 804 in 1992 (97%). The age ranged from 25–54 years in Benin 1988 males and females, 20–54 in Sokoto males, 20–44 in Sokoto females, 20–64 in Benin 1992 males and females. These analyses were limited to 1036 males and 391 females aged 25–54. Thirty-nine percent of the civil servants were senior staff. Physical measurements and serum lipids for the three populations are shown by staff status in Table 1. These were lean populations with lipid profiles generally in the range associated with low atherogenic risk. BMI was highest in the 1988 population. The differences in cholesterol and triglycerides across populations were small but significant with higher values observed in the Benin 1988 population in both males and females. LDL-cholesterol did not differ significantly across populations. HDL-cholesterol was markedly higher in junior and senior staff males combined in the 1988 population, 53.4 compared with 42.3 and 46.2 mg/dl in the 1990 and 1992 populations, respectively. This range of difference was not observed in females among whom HDL-cholesterol was 55.7, 53.4 and 51.2 mg/dl, respectively.

BMI, and waist circumference were higher among the male senior staff than the junior staff, as were total cholesterol and LDL-cholesterol. Triglycerides were marginally higher among senior staff, while HDL-cholesterol did not differ. Among females, total cholesterol and LDL-cholesterol were considerably higher in senior staff than junior staff, even though the groups were similar in BMI, waist circumference and waist-hip ratio.

Table 1
Lipids and physical measurements by staff status, Nigerian civil servants, 1988–1992

	Benin 1988[a]		Sokoto 1990[a]		Benin 1992[a]		Combined populations[b]		ANOVA P-values		
	Sr	Jr	Sr	Jr	Sr	Jr	Sr	Jr	Staff	Age	Pop
Males (aged 25–54)	n = 89	n = 170	n = 130	n = 210	n = 182	n = 255	n = 401	n = 635			
Age (years)	43.0	34.0	36.8	32.8	42.3	41.0	40.5	36.5	0.000	—	0.000
Height (cm)	171.9	169.8*	172.5	172.6	171.6	170.3	172.0	170.9	0.024	0.000	0.360
Weight (kg)	74.3	64.2***	63.4	61.0*	66.7	62.4***	67.1	62.5	0.000	0.000	0.000
BMI (kg/m^2)	25.0	22.1***	21.3	20.4*	22.6	21.5***	22.6	21.3	0.000	0.000	0.000
Waist girth (cm)	87.2	80.0***	80.6	77.2***	85.8	82.2***	84.1	80.2	0.000	0.000	0.460
Waist:hip ratio	0.90	0.90	0.89	0.88	0.90	0.90	0.89	0.89	0.029	0.000	0.019
Cholesterol (mg/dl)	181.5	161.1***	176.0	157.6***	173.5	160.6***	176.4	159.6	0.000	0.000	0.016
HDL cholesterol (mg/dl)	55.5	52.4	42.6	42.0	45.4	46.7	46.4	46.9	0.620	0.000	0.000
Triglyceride (mg/dl)	89.6	85.6	86.0	80.1	84.9	76.3*	86.1	80.1	0.038	0.000	0.003
LDL cholesterol (mg/dl)	108.1	91.6**	116.3	99.6***	111.1	98.6***	112.8	96.7	0.000	0.000	0.43
Females (aged 25–54)	n = 30	n = 47	n = 14	n = 24	n = 113	n = 163	n = 157	n = 234			
Age (years)	40.2	32.8	35.7	29.6	40.5	38.2	39.9	36.3	0.000	—	0.000
Height (cm)	162.3	158.8	165.1	159.1	162.4	162.0	162.6	161.1	0.027	0.74	0.018
Weight (kg)	66.7	64.1	64.4	61.5	65.3	63.6	65.6	63.4	0.12	0.000	0.19
BMI (kg/m^2)	25.2	25.4	23.5	24.1	24.7	24.2	24.7	24.4	0.48	0.000	0.020
Waist girth (cm)	79.8	82.6	86.4	84.4	88.7	87.3	87.0	86.0	0.41	0.000	0.002
Waist:hip ratio	0.82	0.87**	0.85	0.87	0.86	0.86	0.86	0.86	0.31	0.052	0.98
Cholesterol (mg/dl)	182.4	194.6	191.7	174.4	191.1	175.7***	190.3	178.8	0.005	0.000	0.008
HDL cholesterol (mg/dl)	57.0	54.8	52.0	51.4	51.7	51.0	52.6	51.8	0.56	0.115	0.004
Triglyceride (mg/dl)	64.5	73.7	59.6	74.7	65.0	63.9	64.7	66.6	0.59	0.001	0.017
LDL cholesterol (mg/dl)	112.5	125.1	127.9	108.0	126.4	111.9***	124.7	113.7	0.002	0.000	0.15

[a]Means adjusted for age within population, within gender; *$P < 0.05$, **$P < 0.01$, ***$P < 0.001$, Sr vs Jr staff.
[b]Means adjusted for age and population within gender

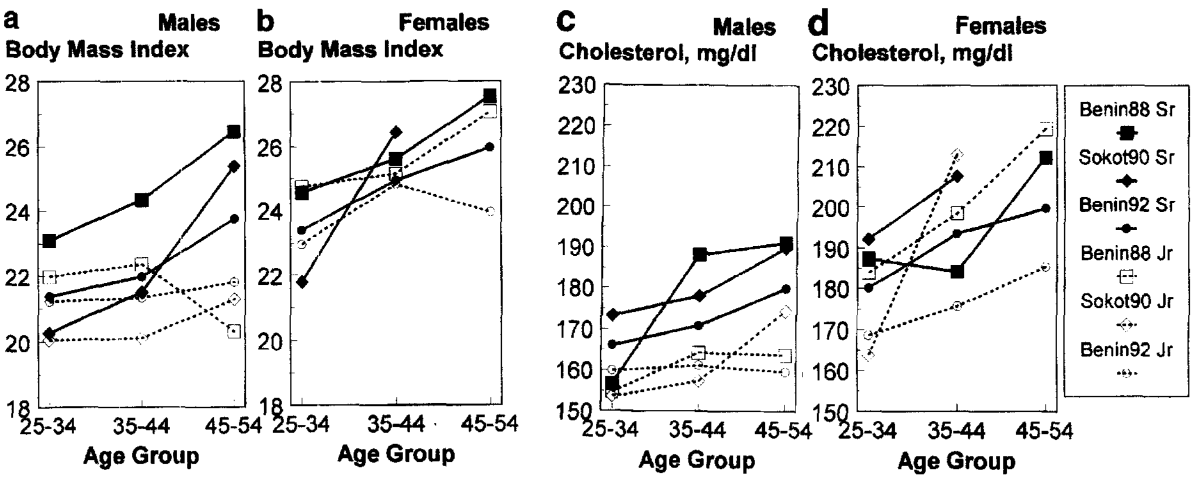

Fig. 1. BMI (a, males, b, females) and total cholesterol (c, males, d, females) by age group in senior and junior staff in three Nigerian civil servant populations.

Fig. 1 shows the relationship between BMI and age, and total cholesterol and age in junior and senior staff in the three populations. BMI was very low and did not increase significantly across age groups among male junior staff in any of the populations. Similarly, cholesterol levels were low and did not increase significantly with age among junior staff males. BMI increased across age groups among the male senior staff. Cholesterol levels were higher in the male senior staff and increased with age. Although BMI was consistently higher in the Benin 1988 group than in the other two groups, cholesterol levels were not higher. Among the females, BMI increased across age groups among both senior and junior staff in all populations. Cholesterol also increased across age groups among senior and junior staff in all populations. Despite only small differences in BMI across groups, cholesterol was considerably lower among Sokoto 1990 and Benin 1992 female junior staff, while levels in Benin 1988 junior staff were similar to senior staff levels.

As shown in Fig. 2, strong positive relationships were observed between BMI and total cholesterol, LDL-cholesterol and triglycerides in both males (P for linearity < 0.0001 for each measure) and females (P for linearity < 0.0001 for cholesterol, LDL, and < 0.0057 for triglycerides). However, there appeared to be a threshold such that among the leanest half of the population, BMI < 21.8, there was no relationship between BMI and these lipid measures. Among males the deviation from linearity was significant for cholesterol ($P = 0.02$) and triglycerides ($P = 0.003$), and of borderline significance for LDL ($P = 0.08$). Among females, a similar pattern was present, but weaker, and there were no significant deviations from linearity. Adjustment for age, population, and staff status had very little effect on these patterns (data not shown). HDL-cholesterol was weakly negatively related (n.s.) to BMI in males, and no relationship between HDL-cholesterol and BMI was observed among females.

Strong relationships were also observed between waist girth and lipids, Fig. 3. These relationships were generally more linear than the relationships observed between BMI and lipids. Weaker but significant relationships between waist-hip ratio and lipids were observed in men, but among women, only HDL-cholesterol decreased across quartiles of waist-hip ratio ($P = 0.04$) while total cholesterol, LDL-cholesterol and triglycerides did not change.

In simple age-adjusted and population adjusted regression models examining the relationship be-

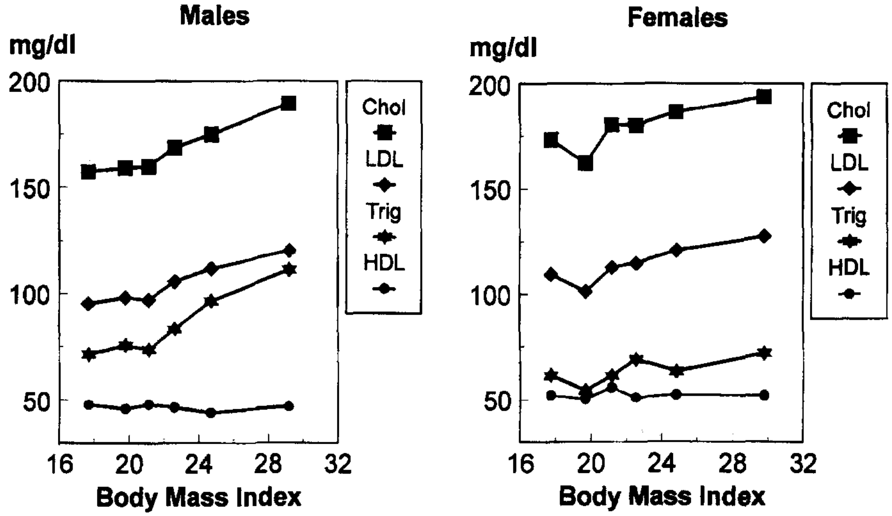

Fig. 2. Cholesterol (Chol), LDL-cholesterol (LDLc), triglycerides and HDL-cholesterol (HDLc) plotted across sextiles of BMI: a, males, b, females. BMI sextiles were based on entire distribution of BMI across the three populations, males and females combined, aged 25–54. Sample sizes for sextiles 1–6 were 197, 199, 200, 178, 149, 109, respectively, males, and 40, 38, 37, 59, 88, 128, respectively, females. Plotted at mean BMI within each sextile.

tween staff status and lipids, total cholesterol and LDL-cholesterol were 16.8 and 15.9 mg/dl, respectively, higher in senior staff than in junior staff males ($P < 0.001$), and 12.0 and 11.2 mg/dl higher in females ($P < 0.003$). Forward stepwise regression age and population adjusted models for lipid levels with staff status and with BMI, waist girth and waist-hip ratio available to the model are shown in Table 2. BMI was a strong predictor of total cholesterol in males and females, and LDL-cholesterol in females. Waist and waist-hip ratio predicted LDL-cholesterol in males. Adjustment for fat-related variables reduced the elevation of total cholesterol and LDL-cholesterol in senior staff to 14.5 and 13.4 mg/dl in males, and to 11.0 and 10.6 mg/dl in females. However, staff status remained a strong independent predictor of total cholesterol and LDL-cholesterol. Central weight, as assessed by waist girth and waist-hip ratio, predicted HDL-cholesterol in males but not in females. Triglycerides were related to waist girth in both males and females. Because of the apparent threshold in the relationship between BMI and lipids, models were also examined across sextiles of physical measurements, and in the case of BMI, the first three sextiles of BMI were combined in regression analyses. Very similar models resulted explaining the same proportion of variance as the continuous models (data not shown). The only difference between models was that BMI was a strong predictor of LDL-cholesterol in males, replacing both waist and waist-hip ratio in the equation.

In the Benin, 1992 population, additional information including fasting insulin, alcohol intake, minutes spent walking or biking to work, total physical activity, and dietary intake were considered in the analyses. Physical activity was higher in the junior staff (Table 3). The diet was high in carbohydrate and low in fat intake. Dietary differences between junior and senior staff were small. However, senior staff reported higher meat intake than junior staff. Senior staff were more likely to report milk and egg intake. Among males, senior staff reported slightly but significantly higher intake of protein and fat than junior staff (Table 3). Alcohol intake was relatively high in males but did not differ by staff status.

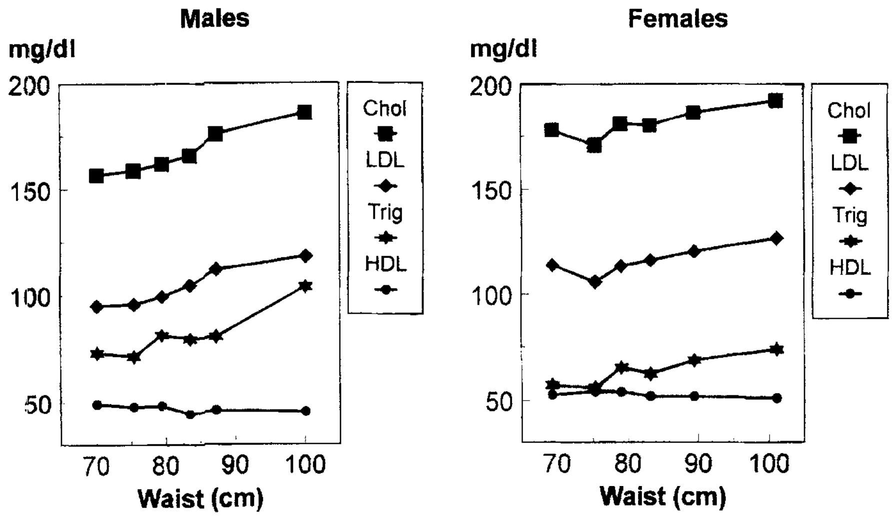

Fig. 3. Cholesterol (Chol), LDL-cholesterol (LDLc), triglycerides and HDL-cholesterol (HDLc) plotted across sextiles of waist girth (cm): a, males, b, females. Waist girth sextiles were based on entire distribution of waist across the three populations, males and females combined, aged 25–54. Plotted at mean waist within each sextile.

4. Discussion

Total cholesterol and LDL-cholesterol were considerably higher in the higher socioeconomic status segments of these civil servant populations. These results were consistent across populations which differed in religious practice, diet and ethnicity and genetic background. The Sokoto population from northern Nigeria was predominantly Muslim and of the Hausa and Fulani tribes, and consumed a diet high in grains, low in palm oil, with meat the predominant source of protein. The southern populations from Benin City were predominantly Christians of the Bini group of tribes. Root tubers were their major dietary carbohydrate. Fish intake was high and palm oil was the major cooking fat. Higher levels of BMI and central weight were observed among the higher SES groups across all three populations. Part of the higher total cholesterol and LDL-cholesterol could be attributed to higher weight among those of high SES, although even those of higher SES were generally quite lean compared with Western populations [24]. Unmeasured factors related to higher SES strongly influenced lipid levels independent of fat-related measures.

The male junior staff was similar to subsistence African populations [25,26] in that BMI was low and did not increase across age groups. In this segment of the population, cholesterol did not increase with age. In contrast, among the male senior staff, and among female senior and junior staff, both BMI and total cholesterol increased across age groups as seen in Westernized populations [27].

Total cholesterol levels were very low, means ranging from 120–156 mg/dl in males, in rural and low socioeconomic status populations in earlier studies in Nigeria [4–6] and West Africa [6,7]. Historically, these populations have experienced a low incidence of ischemic heart disease [1–3]. In the current study, the cholesterol levels in the urban junior civil servants were still relatively low, 160 mg/dl, despite a higher socioeconomic status than in the earlier subsistence populations studied above. Findings were very similar in a study of office workers and agricultural workers living in and near Benin City [10]. Cholesterol levels among those of higher socioeconomic status, the senior civil servants, were higher as in earlier studies of urban or higher SES Nigerian subjects [4,5,8,12,13], but were still lower than levels observed among Westernized blacks [27].

Table 2
Multiple linear regression across three populations of Nigerian civil servants, 1988–92

	Cholesterol		HDL-Cholesterol		Triglycerides		LDL-Cholesterol	
	Beta	*P*-value	Beta	*P*-value	Beta	*P*-value	Beta	*P*-value
Males (n = 1032)								
Age (years)	0.44	0.004	0.30	0.0000	0.07	0.71	0.13	0.38
Population[a]	−1.92	0.18	−3.67	0.0000	−5.02	0.004	1.75	0.36
Staff status[b]	14.50	0.0000					13.43	0.0000
BMI	1.82	0.0000						
Waist			−0.12	0.031	1.35	0.0000	0.81	0.0000
WHR			−21.63	0.018			−57.14	0.014
Adj. R^2	0.11		0.07		0.09		0.10	
Females (*n* = 390)								
Age (years)	0.95	0.002	0.15	0.12	0.63	0.010	0.64	0.016
Population[a]	−5.23	0.034	−2.42	0.004	−5.80	0.005	−1.86	0.39
Staff status[b]	11.04	0.006					10.61	0.003
BMI	1.40	0.001					1.39	0.0002
Waist					0.44	0.002		
WHR								
Adj. R^2	0.10		0.02		0.05		0.09	

[a]Population coding: 1, Benin 1977; 2, Sokoto, 1990; 3, Benin, 1992.
[b]Staff status coding: 1, junior staff; 2, senior staff.

Many illnesses may lower serum lipid levels [28]. This phenomenon may contribute to the lower lipid levels observed in developing populations. However, the working populations studied here are likely to be more healthy than the general Nigerian population. The senior staff may have better access to health care than the junior staff but health care resources are quite limited in general. Thus, a higher burden of illness may make some contribution, though probably small, to the lower lipid levels observed among the junior class.

Lipids were strongly related to BMI even in this very lean population. However, there appeared to be a threshold in the relationship between BMI and lipids among men and a similar but weaker pattern among women. Approximately half of the population was below this threshold around a BMI level of 21–22. Among subjects above the threshold, a strong relationship was observed between lipids and BMI, even though this group was still lean by Western standards. A similar threshold was also observed between BMI and blood pressure in this population [29].

Cholesterol levels and weight-related measures were lower in Benin in 1992 than in a very similar population measured in 1988. This probably reflects the abrupt deterioration in the economy which occurred after 1988 and strongly affected the poor and the middle class. Meat, milk and eggs became luxury items.

HDL-cholesterol levels were similar to levels in Westernized countries in women in all three populations, and in men in Benin, 1988. HDL-cholesterol was lower among males in 1990 and 1992 than in 1988 [27]. These differences seemed unlikely to be due to some problem with storage, shipment or assay, since only small differences were observed among females across populations. This again probably reflects the economic conditions which were likely to have resulted in a reduction in meat consumption after 1988 leading to lower cholesterol levels. Nigerian men generally consume more meat and other special foods, if available, than the women and children in the family. Under growing economic hardship, meat intake may have decreased more among men than among women. Low HDL-cholesterol levels have

Table 3
Physical activity, dietary intake and serum fasting insulin by staff status, Nigerian civil servants, Benin City, 1992

Physical activity/dietary intake	Males		Females	
	Sr	Jr	Sr	Jr
Physical activity				
Walking (min/day)	20.2	29.3***	16.2	25.6***
Total physical activity (METS/week)	86.0	111.5***	59.6	68.5
Dietary intake				
Meat (g/day)	50.2	40.2	50.4	33.3*
Fish (g/day)	77.7	78.7	54.5	69.8*
Milk (%)[a]	9.5	6.5	34.4	16.7*
Eggs (%)[a]	16.8	7.4*	21.3	15.4
Kcal/day	2657.9	2636.5	1886.0	1964.5
Protein (g/day)	65.1	61.1	50.6	50.9
% of calories	10.0	9.3*	10.9	10.6
Carbohydrates (g/day)	440.1	455.4	318.3	328.1
% of calories	66.2	69.1***	67.2	66.6
Fat (g/day)	68.2	59.9	46.9	50.8
% of calories	23.0	20.5***	22.5	23.1
Ethanol intake (g/week)	145.6	161.4	29.5	26.6

$^{*}P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$; ANOVA for staff status adjusted for age, gender specific, age 25–54.
[a]Percent reporting any intake on 24 h dietary recalls; $*P$, 0.05, χ^2.

been observed in other non-western populations with low total cholesterol levels [30–32]. Also, low HDL-cholesterol levels have been found in vegetarians in Western populations [33,34].

Triglyceride levels were low as in previous studies in Nigeria [4,9]. Triglycerides varied little by socioeconomic status.

Participation rates could not be determined but appeared to be high in the 1988 and 1990 populations. High participation rates based on census data were observed in 1992. While there could have been some self-selection by general health status, staff status, age or sex in these populations, it is unlikely that there was any self-selection directly related to lipid levels as these measures were rarely available and the level of awareness of lipid levels was very low.

Energy intake and expenditure were examined in the Benin 1992 population as possible mediators of the differences observed by socioeconomic status. This population consumed a high carbohydrate, low fat diet. Only small differences in macronutrient intake were observed between the high and low SES groups. Examination of foods eaten revealed that both high and low socioeconomic status civil servants generally consumed typical Nigerian foods (unpublished data). However, intake of meat, milk and eggs, all of which were very expensive, was higher among those of higher socioeconomic status. Measurement of serum fatty acids found significantly higher levels of total fatty acids, and arachidonic acid among those of higher socioeconomic status providing evidence of higher fat and meat intake [35]. Thus, while large differences in fat and other dietary intake were not demonstrated, the data suggest that there was some transition toward a more Westernized diet among those of higher socioeconomic status in this population. Reported energy expenditure, particularly walking or biking for transportation, was lower in the high SES group than in the low SES group. The senior staff were more likely to own a car or to be provided with a car and driver by the ministries.

We conclude that low adult weight and avoidance of adult weight gain have contributed to a low atherogenic risk lipid profile in these populations. It seems likely that these have been major factors determining the historically very low rate of cardiovascular disease. Transition toward higher SES and Westernization is associated with unfavorable changes in these cardiovascular risk factors. Dietary change and decrease in physical activity are likely to be major components contributing to these unfavorable changes. Avoidance of these behavioral changes may help these African populations avoid the high cardiovascular risks observed in related Western populations. Similarly, low adult weight and related behaviors in Westernized populations may substantially reduce incidence of cardiovascular disease.

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