STUDIES ON PLASMA LIPIDS IN INDUSTRIAL WORKERS IN CENTRAL TRINIDAD AND TOBAGO

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We assessed the plasma lipid profiles and other cardiovascular disease (CVD) risk factors in 187 (147 men, 47 women) apparently healthy employees of the Caribbean ISPAT industry in Trinidad and Tobago. Anthropometric indices and fasting plasma levels of total cholesterol (T-chol), triglyceride (TG), high-density lipoprotein (HDL), and low-density lipoprotein (LDL) were measured. The results indicate that: there was increased body mass and relative hyperlipidemia in the population studied, these CVD risk factors (increased body mass, increased blood T-chol, TG, and LDL) were more prevalent in men than women ($p < 0.05$), and these parameters did not differ significantly ($p > 0.05$) when compared among the three ethnic groups (African and Indian descendants and mixed descents). These features suggest a greater risk of CVD in men than in women. It is likely that this observation in the industrial workers might reflect the situation in the general population especially in men. Although further confirmatory studies are necessary across societal socioeconomic strata within Trinidad, we suggest that efforts should be directed at reducing excess body weight among the workers, and providing advice on increased complex carbohydrate diet in place of saturated fat. (*J Natl Med Assoc.* 2000;92:375–381.)

Key words: cardiovascular disease ♦ socioeconic status ♦ tropical medicine

Cardiovascular disease (CVD) was hitherto considered a disease of the industrialized nations,[1,2] but recent evidence has shown that CVD accounted for about 25% of all deaths in developing countries.[3] Indeed, in Nigeria, West Africa, autopsy reports have shown CVD to be the second most common cause of death in individuals older than 65 years.[4] However, there are variations in the types of cardiovascular disease encountered across the developing countries.[5] For instance, it has been shown that China alone has about 1 million deaths from cerebrovascular accidents (stroke) each year,[6] whereas hypertension, rheumatic heart disease, and cardiomyopathy are prevalent in different parts of the developing countries.[7] This increased prevalence of CVD risk in developing countries appears to be more common in countries undergoing rapid socioeconomic transformation and urbanization.[8,9]

Experts on demographic transition[10,11] have shown that changes in dietary pattern in the form of increased saturated fat consumption with less intake of complex carbohydrate and physical inactivity are antecedent CVD risk factors in populations undergoing transition. This has been shown in China,[12] where the proportion of people consuming >30%

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of their daily energy intake from fat has sharply increased. Another feature in the prevalence of CVD risk factors in the developing countries is the urban-rural differences. Higher prevalence rates of CVD risk factors have been shown in urban cities of countries such as China,[12] Nigeria,[13] and Costa Rica.[14]

Thus, with the recent industrialization and stable economy in Trinidad and Tobago over the years, it is likely that the experience of other developing countries will not be uncommon in the population. We therefore assessed plasma lipid profiles and CVD risk factors third World change into Western type diet and their effects in middle income Caribbean (Central Trinidad) industrial workers who, by virtue of their employment, were considered a high-income group. It is believed that any attempt at evaluating the effect of improved socioeconomic status on CVD risk should first start with a high-income group.

METHODS

Subjects, Study Area, and Recruitment

The subjects were ambulant and otherwise apparently healthy employees of the Caribbean ISPAT ("ISPAT" is the Hindu name for steel) industry. All subjects were nationals of Trinidad and Tobago, essentially descendants of African, Indian, and mixed ethnic groups. Trinidad is the larger of the Twin Island Republic, Trinidad and Tobago, located about 11 km off the northern coast of Venezuela in South America. The population of the republic is about 1.25 million,[15] with a per capita gross national product of about US$3670 in 1991.[16] Thus, Trinidad and Tobago is a middle-income country that could be described as fast developing with the concomitant demographic transition. Caribbean ISPAT is one of the steel mill conglomerates owned by ISPAT International. It is located in a village, Point Lisa, in central Trinidad. Caribbean ISPAT industry is one of the most viable industries in the Caribbean, recognized for good conditions of service and better incentives for its employees compared with the government. Employees of Caribbean ISPAT are considered high-income groups compared with other workers of similar education and qualification in government employ (the ratio is about 2:1). Thus, the employees of this industry serve as better candidates to assess the influence of improved socioeconomic status in a population undergoing economic transition. The industry workers were, therefore, recruited for the cholesterol-screening project through poster advertisements and announcements at the company. All subjects were informed that those with hypercholesterolemia (T-chol >5.2 mM; 200 mg/dL)[17] will receive results of full plasma lipid investigation and treated accordingly. All the subjects who participated in the study gave informed voluntary verbal consent.

Study Protocol

The subjects came to the health care facility center within the Caribbean ISPAT industry compound in the morning (7:00 a.m. to 8:00 a.m.) after a 12- to 24-hour overnight fast. All had hitherto been instructed to be on their usual diet and lifestyle 7 days before the study. An overnight fasting state was ascertained by direct questioning and further verified by checking the plasma samples for lipemic clouding. Details of ethnic origin; age; gender; alcohol and tobacco use; past illnesses; medications; hospital admission; and family history of diabetes, hypertension, heart disease, and sudden death were noted. The weights (kg) and height (m) of the subjects were taken while the subjects were wearing light clothing, without shoes. A 10-mL venous blood sample was taken from each subject and put into heparinized tubes for lipids estimation. Blood samples were separated within 2 hours of collection, and the plasma was stored frozen at −20°C.

Assessment of Lipidemia

Dyslipidemia was considered present when the following data were found: fasting total cholesterol (T-chol) levels >5.2 mM (200 mg/dL), triglycerides (TG) >2.26 mM (200 mg/dL), low-density lipoprotein (LDL) >3.37 mM (130 mg/dL), high-density lipoprotein (HDL) <0.91 mM (35 mg/dL), and T-chol/HDL >6.0.[17]

Biochemical Analysis

Plasma T-chol, TG, and high-density lipoprotein-cholesterol (HDL-chol) were determined by automated methods (Cholestech LDX Analyzer) based on enzymatic method.[18] Plasma LDL levels were calculated using the Friedwald formula.[19]

Statistical Analyses

The results are expressed as means ± SD. Plasma T-chol, TG, and lipoprotein parameters were log-

Table 1. Gender-related Differences in the Prevalence Rates (%) of CHD Risk Factors and Plasma Lipid Levels of All the Subjects Studied

Parameters	All subjects	All men	All women
Number (*n*)	187 (131–134)†	140 (99–102)*	47 (32)*
Mean age (year)	42.7 7.0	43.0 7.1	40.0 6.8
Cigarette smoking (%)	25 (19.1)	22 (22.2)	3 (9.4)
Alcohol use (%)	78 (59.5)	62 (62.6)	16 (50.0)
FHHT (%)	50 (37.3)	29 (28.4)	21 (65.6)†
FHDM (%)	41 (30.6)	28 (27.4)	13 (40.6)
FHHD (%)	34 (25.4)	23 (22.6)	11 (34.4)
	Hypercholesterolemic subjects with T-chol >5.2 mM (200 mg/dL)		
	N = 56	**N = 36**	**N = 20**
Weight (kg)	70.2 ± 15.3	72.8 ± 15.9	69.3 ± 15.1
Height (m)	1.58 ± 0.11	1.64 ± 0.13	1.50 ± 0.09‡
BMI (kg/m^2)	28.2 ± 5.7	27.3 ± 4.7	28.5 ± 5.9
T-chol (mM)	6.04 ± 0.86	6.2 ± 0.81	5.8 ± 0.89
TG (mM)	1.7 ± 0.98	2.0 ± 1.1	1.2 ± 0.48‡
HDL (mM)	1.3 ± 0.46	1.1 ± 0.35	1.5 ± 0.49†
LDL (mM)	4.0 ± 0.97	4.2 ± 0.95	3.7 ± 0.92‡
T-chol/HDL	5.4 ± 1.83	6.1 ± 1.7	4.1 ± 1.3‡

*Range of actual participants; there are missing values of 1.0%–1.5%.
†$p < 0.001$, ‡$p < 0.05$ comparison between men and women.
FHH = family history of hypertension, FHDM = family history of diabetes mellitus, FHHD = family history of heart disease.

transformed before statistical analyses to improve skewness and normalize data distribution. Student's *t*-tests, chi-square, and ANOVA were performed as appropriate by using the Statistical Package for the Social Sciences (SPSS).[20] A p value of <0.05 was considered statistically significant.

RESULTS

One hundred and eighty-seven subjects (140 men, 47 women, mean age 42.8 ± 7.0 years) participated in the cholesterol screening tests. Of this number, only 56 individuals (36 men or 25.7%; 20 women or 42.6%) had a T-chol >5.2 mM (200 mg/dL) and thus had full plasma lipid investigation.

Gender-Related Differences

Cigarette Smoking, Alcohol Use, and Family History of Hypertension. Most of the subjects were middle-aged as shown by the mean ages in Table 1. There was no significant difference in the prevalence rates of cigarette smoking, alcohol consumption, family history of diabetes, and heart disease among men and women ($p > 0.05$). However, a family history of hypertension was more prevalent among the men than in the women ($p < 0.001$). This observation was similar to those in Indian and mixed ethnic groups but not the African group. Again, more men than women had total plasma cholesterol levels >5.2 mM (Table 2).

Plasma Lipids. Table 1 also shows the plasma lipid profile of all the subjects. Plasma lipids were high. Men demonstrated significantly higher plasma levels of T-chol, LDL-chol, TG, and T-chol/HDL ratio than did the women ($p < 0.05$). These features may predispose the men to increased coronary heart disease (CHD) risk than it would the women. This observation was strengthened by the significantly higher plasma HDL-chol levels in women than men ($p < 0.05$). These gender-related differences in CHD risk were further observed in African descendants (Table 3) where plasma HDL levels were significantly higher in women than men ($p < 0.05$) and plasma TG and T-chol/HDL ratio tended to be higher in men than women ($p = 0.056$).

Differences Due to Ethnic Origin

Women. A total of 47 women initially participated in the cholesterol screening tests. Of this number, only 20 had T-chol levels >5.2 mM to warrant fur-

Table 2. Gender-related Differences in the Prevalence Rates (%) of Cigarette Smoking, Alcohol Use, and Family History of Hypertension, Diabetes, and Heart Disease in the Men and Women of the Three Ethnic Groups Studied

	Subjects*					
	African origin (all = 72)		Indian origin (all = 33)		Mixed (all = 27)	
Parameters	Men (56)	Women (16)	Men (28)	Women (5)	Men (17)	Women (10)
Mean age (years)	44.3 ± 7.2	43.3 ± 6.9	41.0 ± 7.2	40.8 ± 10.0	43.2 ± 6.1	40.6 ± 4.9
Cigarette smoking (%)	9 (16.7)	1 (6.3)	8 (28.6)	1 (20.0)	5 (31.3)	1 (10.0)
Alcohol use (%)	34 (63.0)	8 (50.0)	16 (57.1)	3 (60.0)	11 (68.8)	5 (50.0)
Positive FHH (%)	19 (33.9)	9 (56.2)	7 (25.0)	4 (80.0)†	3 (17.6)	8 (80.0)†
Positive FHDM (%)	13 (76.8)	5 (68.8)	10 (35.5)	3 (60.0)	4 (23.5)	5 (50.0)
Positive FHHD (%)	9 (83.9)	4 (75.0)	11 (39.3)	4 (80.0)†	3 (17.6)	3 (30.0)

*There are missing values of 1.0%–1.5%.
†$p < 0.05$, comparison between men v women for each ethnic group.
FHH = family history of hypertension, FHDM = family history of diabetes mellitus, FHHD = family history of heart disease.

ther lipid analysis. This small sample side affected the statistical power of most of the analyses. Prevalence rates of cigarette smoking, alcohol consumption, and family history of hypertension, heart disease, and diabetes were similar among the three ethnic groups of Africa and India descents and mixed race (Table 4). Similarly, there were no statistically significant differences in the overall lipid profiles of the women in the three ethnic groups. There was, however, a trend toward higher HDL levels among the women of African descent than among women from either Indian or mixed ethnic groups. The mean LDL-chol level was highest in the Indian women than women of Africa descents and mixed, but this was not statistically significant. On the other hand, women of the mixed ethnic group had the lowest mean T-chol level compared with women of African and Indian descents ($p > 0.05$) (Table 5).

Men. More men than women (140 vs. 47) volunteered to participate in the initial cholesterol screening tests. Only 36 men had T-chol levels >5.2 mM required for further lipid profile investigation. Although alcohol consumption had the highest prevalence rate (63%) among the men, there was no statistical significance in alcohol consumption among males of the three ethnic groups ($p > 0.05$). Furthermore, the prevalence rates of cigarette smoking and family history of hypertension and diabetes were similar ($p > 0.05$) among the

Table 3. Gender-related Differences in the Plasma Lipid Profile of the Hypercholesterolemic Subjects in Different Ethnic Groups

	Subjects					
	African origin (all = 24)		Indian origin (all = 19)		Mixed race (all = 13)	
Parameters	Men (15)	Women (9)	Men (14)	Women (5)	Men (7)	Women (6)
BMI (kg/m^2)	26.2 ± 5.4	29.9 ± 5.3	28.1 ± 4.1	27.9 ± 7.5	27.7 ± 6.3	26.9 ± 2.1
Total cholesterol (mM)	6.0 ± 0.81	5.9 ± 0.31	6.4 ± 0.91	5.8 ± 0.04	6.2 ± 1.13	5.2 ± 0.97
Triglyceride (mM)	1.9 ± 1.4	1.1 ± 0.6*	2.3 ± 1.0	1.4 ± 0.05*	1.8 ± 0.23	1.4 ± 0.63
HDL-cholesterol (mM)	1.2 ± 0.36	1.8 ± 0.67*	0.96 ± 0.26	1.04 ± 0.11	1.3 ± 0.57	1.3 ± 0.28
LDL-cholesterol (mM)	4.0 ± 1.0	3.7 ± 0.76	4.4 ± 0.84	4.1 ± 1.7	4.1 ± 1.7	3.3 ± 0.69
T-chol/HDL	5.6 ± 1.9	3.9 ± 1.7*	6.9 ± 1.2	5.6 ± 0.6	4.5 ± 2.2	4.1 ± 0.7

*$p < 0.05$, comparison between men and women for each ethnic group.

Table 4. Differences Due to Ethnic Origin in the Prevalence Rates (%) of Cigarette Smoking, Alcohol Use, and Family History of Hypertension, Diabetes, and Heart Disease

	Men (n = 101)*			Women (n = 31)*		
Parameters	African origin (56)	Indian origin (28)	Mixed (17)	African origin (16)	Indian origin (5)	Mixed (10)
Mean age (years)	44.3 ± 7.2	41.0 ± 7.2	43.2 ± 6.1	43.3 ± 6.9	40.8 ± 10.0	40.6 ± 4.9
Cigarette smoking (%)	9 (16.7)	8 (28.6)	5 (31.3)	1 (6.3)	1 (20.0)	1 (10.0)
Alcohol use (%)	34 (63.0)	16 (57.1)	11 (68.8)	8 (50.0)	3 (60.0)	5 (50.0)
Positive FHH (%)	19 (33.9)	7 (25.0)	3 (17.6)	9 (56.2)	4 (80.0)	8 (80.0)
Positive FHDM (%)	13 (76.8)	10 (35.5)	4 (23.5)	5 (68.8)	3 (60.0)	5 (50.0)
Positive FHHD (%)	9 (83.9)	11 (39.3)	3 (17.6)†	4 (75.0)	4 (80.0)	3 (30.0)

*There are missing values of 1.0%–1.5%.
†$p < 0.05$, comparison between men and women for each ethnic group.
FHH = family history of hypertension, FHDM = family history of diabetes mellitus, FHHD = family history of heart disease.

men of different ethnic groups. However, men of Indian descent had higher ($p < 0.05$) prevalence rates of heart disease in comparison with men of either African or mixed ethnic groups. Additionally, men of Indian descent had the highest levels of plasma T-chol, LDL, and T-chol/HDL ratios in comparison with men of African or mixed descents, although these were not statistically significant. By contrast, men of the mixed ethnic group had a trend toward highest levels of HDL than did men of either African or Indian descent ($p = 0.058$).

DISCUSSION

The findings suggest:

1. There is increased body mass and a relative hyperlipidemia in the population studied.
2. These CVD risk factors (increased body mass, increased blood cholesterol, TG, and LDL) were more prevalent in the men than in the women.
3. These parameters did not differ significantly when compared among the three ethnic groups.

It is obvious from this study population that a risk profile for CVD can be defined for men based primarily on the dyslipidemia and excess body mass. Hyperlipidemia, especially in the form of increased plasma cholesterol and LDL, is a major determinant of CHD risk in the developed countries[21,22] and constitutes one of the major components of the metabolic syndrome X.[23] The higher prevalence of CVD risk among the men studied was similar to the situation in the developed countries where CHD tends to strike men more than women[24] and is

Table 5. Differences Due to Ethnic Origin in the Plasma Lipid Profile of the Men and Women

	Men (n = 36)			Women (n = 20)		
Parameters	African origin (15)	Indian origin (14)	Mixed (7)	African origin (9)	Indian origin (5)	Mixed (6)
Total cholesterol (mM)	6.0 ± 0.81	6.4 ± 0.91	6.2 ± 1.13	5.9 ± 0.31	5.8 ± 0.04	5.2 ± 0.97
Triglyceride (mM)	1.9 ± 1.4	2.3 ± 1.0	1.8 ± 0.23	1.1 ± 0.60	1.4 ± 0.05	1.4 ± 0.63
HDL-cholesterol (mM)	1.2 ± 0.36	0.96 ± 0.26	1.3 ± 0.57	1.8 ± 0.67	1.04 ± 0.11	1.3 ± 0.28
LDL-cholesterol (mM)	4.0 ± 1.0	4.4 ± 0.84	4.1 ± 1.7	3.7 ± 0.76	4.1 ± 0.11	3.3 ± 0.69
T-chol/HDL	5.6 ± 1.9	6.9 ± 1.2	4.5 ± 2.2	3.9 ± 1.7	5.6 ± 0.6	4.1 ± 0.7

*$p < 0.05$, comparison between men and women for each ethnic group.

consistent with a previous autopsy report study in elderly Nigerian males.[4]

Although both the men and women in the present study were overweight,[25] excess body mass cannot completely explain the higher CVD risk in men, because there was no statistically significant difference between the body mass of the ethnic men and women. Furthermore, it should be noted that this tendency to obesity is more pronounced in the women than men, and this did not counter the excess risk observed in the men on multiple regression analyses controlling for body mass index. This suggests that the risk of CVD observed in the men may not be entirely due to excess body mass. Many African studies have shown greater tendency to obesity in women,[13,26,27] and consequently, women in this population have been shown to be at greater risk for CVD than men.[13] Generalized obesity is one of the important components of insulin resistance syndrome,[23] and it has been shown to be strongly associated with hypertension and diabetes in previous African studies.[26–29]

The observed hyperlipidemia in the men as compared to the women is contrary to some reports from at least one other developing country where increased prevalence of CVD risk has been documented.[13] However, our finding is similar to reports from China,[12] where about 30% of daily calorie intake is from saturated fat. Thus, our data is consistent with the previous observation that antecedent CVD risk factors in populations undergoing economic transition is the initial changes in dietary pattern in the form of increased lipids and decreased carbohydrates.[10–12] Indeed, our study subjects were drawn from a relatively higher income group, and changes in dietary pattern may not be entirely surprising. For instance, Nigerian higher income earners have been shown to have higher cholesterol levels and greater prevalence of obesity and diabetes than do their peers from lower income groups.[30,31] The differential plasma lipid profiles in the men and women in the present study appears to follow the established trend in the developed country.[24] Additionally, it is likely that working-class women in this population are more discretional in dietary choices and possibly visit gymnastic centers more often than their men. The true test of the validity of the present findings would be provided by further cross-sectional studies in the general population.

Our data did not indicate any ethnic-related differences in the prevalence rates of CVD risk factors assessed (Tables 4 and 5). Trinidad and Tobago is a multiethnic (40% black African, 40% Indian descent, and ~20% mixed) country. The population sample for the present study did not represent the three ethnic groups equally, with the result that the small sample size weakened the statistical power of the ethnicity analysis. However, on inspection, our data showed that male descendants of the Indian subcontinent had increased tendency toward higher blood cholesterol, TG, and LDL and low levels of HDL (Table 5) compared with the other groups. This trend is similar to the report of previous studies,[32] where diabetic patients of Indian descent were found to have significantly higher lipid profiles than patients of black African's or mixed descents. The validity of these observations will be tested in enlarged cross-sectional studies as we are presently doing in our laboratory.

One major limitation of the present study was the small sample size of subjects who had full lipid investigation. This made it practically difficult to compare very small numbers with relatively higher figures. This undermined the interpretation of the observations in ethnicity-related analyses, which showed a clear trend of hyperlipidemia in the Indian ethnic group.

CONCLUSION

Our data showed defined CVD risk factors in the form of excess body mass and hyperlipidemia in the industrial workers studied. The prevalence rates of these CVD risk factors were higher in the men than in women and did not differ among the three ethnic groups. It is likely that this observation in the industrial workers might reflect the situation in the general population, especially in the men. We suggest that efforts be directed at reducing excess body mass among the workers and providing advice on increased complex carbohydrate diet in place of saturated fat.

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