Factors Associated with High Density Lipoprotein Cholesterol in a Population with High High Density Lipoprotein Cholesterol Levels

Krisela Steyn, Jean Fourie, A.J. Spinmüller Benadé, Jacques E. Roosouw, Marietjie L. Langenhoven, Gina Joubert, and Derek O. Chalton

A cross-sectional study of a random sample of 976 coloureds (mixed race) of the Cape Peninsula, ages 15 to 64 years old, revealed a population with unexpectedly high levels of high density lipoprotein (HDL) cholesterol. The mean level for men was 55.4±16.1 mg/dl (SD) and for women, 60.8±16.0 mg/dl. The ratio of HDL cholesterol to total cholesterol expressed as a percentage was 26.3%±9.5% for men and 28.1%±9.3% for women. The HDL cholesterol levels were apparently lower than those of black and Negro populations, yet higher than those of Caucasian populations. Men with levels of HDL cholesterol above the median reported a personal history and a family history of coronary heart disease less frequently than did men with lower levels, while women with high levels of HDL cholesterol were less likely to have a history of hypertension or diabetes. Stepwise multiple regression analysis of variables significantly associated with HDL cholesterol levels showed that they explained 29.7% and 24.7%, respectively, of the variation in HDL cholesterol in men and women. Those variables independently associated with HDL cholesterol in both men and women were: serum triglyceride (–), cigarette consumption (–), alcohol, body mass index (–), age, and serum low density lipoprotein cholesterol levels (–). The reasons for the relatively high HDL cholesterol levels in this population are unknown. However, it would seem possible that these levels offer some protection against the high risk factors of smoking, hypertension, and hypercholesterolemia. (Arteriosclerosis 9:390–397, May/June 1989)

The role of the plasma concentration of high density lipoprotein (HDL) cholesterol as a protecting factor against coronary heart disease (CHD) has been strongly suggested in case–control studies1 and in some prospective and cohort studies.2–4 Although recently published results of the prospective British Regional Heart Study6 found a univariate association of HDL cholesterol with CHD, it differed from other studies in that the association did not remain statistically significant when controlled for other risk factors. However, the methodology and conclusions of this study have been challenged.6 The inverse relationship between the direct angiographic measurement of atherosclerosis and HDL cholesterol has repeatedly been reported.7–10 The severity of clinical features of CHD in hypercholesterolemic patients is inversely related to HDL cholesterol levels irrespective of age, blood pressure, other lipoprotein levels, or coronary angiographic findings.11 Kannel12 suggested that the risk for CHD associated with the HDL cholesterol level in individuals is determined by the total cholesterol (TC) level associated with a particular HDL cholesterol level, and the ratio of HDL cholesterol to TC (%HDL/TC) has proved to be an efficient measure of CHD risk within populations with high TC levels.12,13,14

The inverse relationship of HDL cholesterol with CHD found within populations does not hold for comparisons between populations. Marked differences are seen when comparing the HDL cholesterol levels of different populations of all ages.15,16,17 The mean HDL cholesterol concentrations show a distribution similar to that of mean TC levels: relatively low levels and low CHD incidence in the developing countries and relatively high levels and high CHD incidence in the more developed, Westernized countries.

Little was previously known about the HDL cholesterol levels and the %HDL/TC in South African population groups. Physically active South African black people living on a traditional diet seem to have higher HDL cholesterol levels and %HDL/TC (P.L. Jooste, unpublished data) than white people. No information existed about the HDL cholesterol levels of the coloured population, which originated from white, black, and Asian populations in South Africa.

Their increasing CHD mortality, the need to formulate a remedial strategy, and the lack of data on HDL cholesterol and other CHD risk factors in this population prompted the study of coronary risk factors in the coloured population of...
the Cape Peninsula (CRISIC study) of the Republic of South Africa (RSA). 18-21
This article reports on the HDL cholesterol levels, the %HDL/TC, and the proportions of persons with protective HDL cholesterol levels in the study population. The disease profile of persons with and without protective %HDL/TC levels were compared. An attempt is made to identify the variables that contribute to the variation of HDL cholesterol in this population group.

Methods

Study Population

The subjects for the study were an age- and sex-stratified sample of 976 participants randomly selected by a multistaged probability sampling technique. The subjects were drawn from 485 120 coloureds ages 15 to 64 years old who lived in the Cape Peninsula of the RSA (determined by the 1980 census). Only one member per household was selected. Exclusion criteria were pregnancy, being bedridden, mental retardation, carcinoma, leg amputation, antituberculosis drug therapy, hospitalization for more than 1 week during the previous 3 months, and inability or unwillingness to participate. Of those who qualified and were approached, 92.3% participated.

Methods

Trained field workers visited participants in their homes. A risk factor questionnaire and a London School of Hygiene questionnaire 22 for chest pain were completed. The questionnaire covered socioeconomic items including the level of education, number of occupants per habitable room, and classification of employment according to the Centre for Applied Social Sciences' (CASS) occupational category for coding of occupations in South Africa. 23 A short medical history, a family history of ischemic heart disease, smoking habits, and physical activity patterns were recorded. Physical activities at work or leisure were grouped into one of three categories (sedentary, moderate, or vigorous activity) according to the duration and intensity of energy expenditure. The total energy expenditures at work and leisure were calculated by multiplying the average time that each individual spent each week in a particular activity by the average rate of energy expenditure for that activity corrected for body weight. 24,25,26

Blood samples were collected from each participant. The serum was separated within 6 hours of clotting at room temperature and was then frozen at -20°C. The TC and HDL cholesterol levels were measured on a Gilford auto-analyzer (Gilford Instrument Laboratories, Inc., Oberlin, OH) by using the Boehringer CHOD-PAP enzymatic method. HDL cholesterol was measured after precipitation of the apolipoprotein (apo) B containing lipoproteins with MgCl2-dextran sulfate. 27 The triglyceride levels were determined by the Boehringer Peridochrom enzymatic method. In each case, the Gilford auto-analyzer was calibrated against Precipil or Precipil EL control sera, which were corrected by Boehringer Mannheim for the specific test kit in question. Two control samples were included in each batch analyzed. At least 7 days after the first sample, 100 random blood samples were re-collected to determine combined biological and technique variation. For TC values, the correlation coefficient for both samples was 0.88; for HDL cholesterol, 0.87, and for triglycerides, 0.80.

Blood pressures (BP) were recorded by trained field workers after participants had been seated for at least 5 minutes. A mercury manometer connected to a standard 12.5 x 23 cm cuff was used. The American Heart Association guidelines for measuring BP 28 were applied. During the field work, the field workers' standard for BP readings was checked against the reference weekly. End-digit preference was not found on subsequent analysis. At least 7 days after the first reading, 100 random BP readings were repeated to determine any variation. This gave an acceptable reproducibility, as reflected in correlation coefficients of 0.77 for systolic and 0.75 for diastolic readings, which are similar to the findings of other studies. 29

Anthropometric measurements were taken by using a metal measuring tape against a wall and a flat headboard at right angles to the wall to ensure correct readings for heights to the nearest 0.5 cm. Mass was determined on a good quality bathroom scale with the subject in light clothing and without shoes. The bathroom scales were standardized weekly against a beam balance to determine the zero setting. Thereafter, the field worker's own weight was used as a daily check before weighing each participant. Body mass index (BMI) was calculated as weight (kg)/height (m²).

To determine the nutrient intake of the participants, the field workers were trained by experienced dieticians in completing a dietary questionnaire, which included a 24-hour dietary recall. Interviewers were trained with the aid of food models and household measures to accurately record the amounts of food eaten and methods of food preparation. The amounts of food recorded in the 24-hour dietary recall were converted by the dietitians to weights of food eaten and then coded by using the National Research Institute for Nutritional Diseases (NRIND) Food Composition Tables. 30 This enabled an analysis of food intake in terms of nutrient intake.

Univariate analyses were used to identify variables that were significantly associated with HDL cholesterol. These were then entered into a stepwise multiple regression analysis in an effort to explain the variation in HDL cholesterol. The odds ratio was calculated for participants with %HDL/TC levels above and below the median to compare a CHD-related medical history in the two groups. The same two groups were compared with respect to socioeconomic parameters.

Results

The mean HDL cholesterol levels did not increase with age, and the men had somewhat lower levels than the women (Table 1). Because of an increasing TC level with age, the %HDL/TC decreased with age. For both sexes, the %HDL/TC decreased up to the age of 54 years and remained fairly constant thereafter. Women between the ages of 15 and 44 years had a higher %HDL/TC than their male counterparts. Above this age, the ratio was similar for both sexes.
Table 1. HDL Cholesterol Levels and Ratio of HDL Cholesterol to Total Cholesterol in Study Population

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>Mean HDL cholesterol* ±SD</td>
</tr>
<tr>
<td>15-24</td>
<td>94</td>
<td>55.0±12.4</td>
</tr>
<tr>
<td>25-34</td>
<td>96</td>
<td>54.6±13.5</td>
</tr>
<tr>
<td>35-44</td>
<td>103</td>
<td>55.7±22.8</td>
</tr>
<tr>
<td>45-54</td>
<td>95</td>
<td>55.0±17.0</td>
</tr>
<tr>
<td>55-64</td>
<td>90</td>
<td>55.3±18.2</td>
</tr>
<tr>
<td>15-64</td>
<td>478</td>
<td>55.3±16.3</td>
</tr>
</tbody>
</table>

HDL = high density lipoprotein cholesterol, TC = total cholesterol.
%HDL/TC = ratio of HDL cholesterol to total cholesterol. SD = standard deviation.
*Values are mg/dl.

Table 2. Prevalence of Persons in Study Population with Protective and Adverse HDL Cholesterol Levels

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% with protective HDL cholesterol levels &gt;45 mg/dl</td>
<td>% with adverse HDL cholesterol levels &lt;35 mg/dl</td>
</tr>
<tr>
<td>15-24</td>
<td>81.9</td>
<td>3.2</td>
</tr>
<tr>
<td>25-34</td>
<td>74.0</td>
<td>4.2</td>
</tr>
<tr>
<td>35-44</td>
<td>64.0</td>
<td>9.7</td>
</tr>
<tr>
<td>45-54</td>
<td>73.7</td>
<td>7.4</td>
</tr>
<tr>
<td>55-64</td>
<td>67.8</td>
<td>6.7</td>
</tr>
<tr>
<td>15-64 crude rate</td>
<td>72.3</td>
<td>6.1</td>
</tr>
<tr>
<td>SA coloured rate</td>
<td>75.0</td>
<td>8.3</td>
</tr>
</tbody>
</table>

HDL = high density lipoprotein cholesterol. RSA = Republic of South Africa.
*Age-adjusted rates against the coloured population of the RSA, 1980 census.

Table 3. Proportion of Population with CHD-associated Medical History Stratified by Median of HDL to Total Cholesterol Ratio (%HDL/TC)

<table>
<thead>
<tr>
<th>Medical history</th>
<th>Subjects</th>
<th>% of group &gt;median %HDL/TC*</th>
<th>% of group &lt;median %HDL/TC†</th>
<th>Odds ratio</th>
<th>95% confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>% with family history of CHD</td>
<td>All</td>
<td>26.5</td>
<td>30.0</td>
<td>1.2</td>
<td>0.9-1.6</td>
</tr>
<tr>
<td></td>
<td>Men</td>
<td>23.0</td>
<td>31.0</td>
<td>1.5</td>
<td>1.0-2.3</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>30.0</td>
<td>29.0</td>
<td>1.0</td>
<td>0.7-1.4</td>
</tr>
<tr>
<td>% with history of CHD by questionnaire‡</td>
<td>All</td>
<td>13.0</td>
<td>19.6</td>
<td>1.6</td>
<td>1.2-3.2</td>
</tr>
<tr>
<td></td>
<td>Men</td>
<td>11.3</td>
<td>19.7</td>
<td>1.9</td>
<td>1.2-3.2</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>14.6</td>
<td>19.5</td>
<td>1.4</td>
<td>0.9-2.3</td>
</tr>
<tr>
<td>% with self-reported history of CHD</td>
<td>All</td>
<td>3.5</td>
<td>7.1</td>
<td>2.1</td>
<td>1.2-3.8</td>
</tr>
<tr>
<td></td>
<td>Men</td>
<td>2.9</td>
<td>9.6</td>
<td>3.5</td>
<td>1.5-8.4</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>4.1</td>
<td>4.8</td>
<td>1.2</td>
<td>0.5-2.8</td>
</tr>
<tr>
<td>% with hypertension history</td>
<td>All</td>
<td>17.1</td>
<td>23.3</td>
<td>1.5</td>
<td>1.1-2.0</td>
</tr>
<tr>
<td></td>
<td>Men</td>
<td>10.9</td>
<td>15.1</td>
<td>1.5</td>
<td>0.8-2.5</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>23.1</td>
<td>31.1</td>
<td>1.5</td>
<td>1.0-2.2</td>
</tr>
<tr>
<td>% with diabetes history</td>
<td>All</td>
<td>2.9</td>
<td>6.1</td>
<td>2.2</td>
<td>1.2-4.2</td>
</tr>
<tr>
<td></td>
<td>Men</td>
<td>2.9</td>
<td>5.4</td>
<td>1.9</td>
<td>0.7-4.9</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>2.8</td>
<td>6.8</td>
<td>2.5</td>
<td>1.0-6.1</td>
</tr>
</tbody>
</table>

HDL = high density lipoprotein cholesterol, CHD = coronary heart disease.
*N = 239 men and 249 women. †N = 239 men and 251 women. ‡London School of Hygiene questionnaire. Using the cut-off points selected by the Expert Panel of the National Cholesterol Education Program for HDL cholesterol levels, indicating increased CHD risk when HDL cholesterol are below 35 mg/dl, only 6.3% of men and 3.7% of women in the study population had adversely low levels.

Table 2 shows that fewer women (60.9%) than men (75.0%) were found to have "protective" HDL cholesterol levels above 45 mg/dl in men and 55 mg/dl in women. The youngest age group (15 to 24 years old) had a higher prevalence of protective HDL cholesterol levels than did any of the other age groups.
The odds ratios (OR) of CHD-associated medical history of persons above and below the age- and sex-specific median %HDL/TC are shown in Table 3. The male participants with low %HDL/TC had 1.9 times the risk (confidence intervals [CI] 1.2 to 3.2) of reporting CHD (a positive response to the London School of Hygiene questionnaire for chest pain22) of those with high %HDL/TC, and 3.5 times the risk (CI 1.5 to 8.4) of reporting CHD on direct questioning of those with high %HDL/TC. Women failed to show this association. The group with %HDL/TC below the median as a whole had 1.5 times the risk (CI 1.1 to 3.2) of reporting CHD (a positive response to the London School of Hygiene questionnaire for chest pain22) of those with high %HDL/TC, and 2.2 times the risk (CI 1.2 to 4.2) of reporting diabetes, compared to the group with %HDL/TC above the median.

The variables that were found to be significantly associated with HDL cholesterol in either men or women in the univariate analysis were: daily cigarette consumption (inverse), systolic and diastolic BP, uric acid, triglyceride levels (inverse), low density lipoprotein (LDL) cholesterol (inverse), BMI (inverse), physical activity at work, grams of alcohol used, and the following three variables identified from the 24-hour dietary recall: total energy intake per day, percentage energy intake from carbohydrates (inverse), and percentage energy intake from saturated fat. In a stepwise multiple regression analysis, the significantly associated variables “explained” 29.7% and 24.7%, respectively, of the variation in HDL cholesterol in men (Table 4) and women (Table 5). In men, serum triglyceride, daily dietary carbohydrate intake, grams of alcohol used weekly, total energy intake per day, BMI, diastolic BP, number of cigarettes smoked daily, age, and LDL cholesterol levels contributed independently (in this order of selection) to the variation of HDL cholesterol. In women, there were twelve outlying observations characterized by high HDL cholesterol levels. These were deleted from the subsequent analysis. In women, the variables, in order of their independent contribution to HDL cholesterol were: triglyceride levels, number of cigarettes smoked daily, age, BMI, percentage energy from saturated fat, grams of alcohol used weekly, and LDL cholesterol levels.

The group of participants with age- and sex-specific %HDL/TC above the median for low CHD risk had socio-economic parameters indicating lower standing than those below the median. The mean number of occupants per habitable room of those with %HDL/TC above the median was 1.66, while those below the median had a mean occupancy rate of 2.0 (p<0.0001 Mann-Whitney U-test). The mean CASS Occupational Category as defined by Schlemmer et al.23 for those participants who were employed and had %HDL/TC above the median was 3.32 compared to that of 3.06 (p=0.026 Mann-Whitney U-test) for those below the median. (The CASS Occupational Categories range from 1 to 5 and are comparable to Social Class 1 to 5 categories used elsewhere.23) The level of education of the two groups of men was not significantly different, while the women with %HDL/TC above the median had significantly higher levels of education than those below.
**Discussion**

In this study, women older than 44 years had HDL cholesterol levels similar to those of men, thus differing from other studies in which women had higher HDL cholesterol levels than men at all ages. In the coloured population, this could be explained by the high prevalence (72%) of overweight or obese women (BMI > 24). The mean HDL cholesterol level and standard deviation of the coloured men in this study (55.3 ± 16.3 mg/dl) was found to be significantly higher (t test p < 0.0005) than that of white men (47.6 ± 12.0 mg/dl) studied in the southwestern Cape. This study was a total population study in which 82% of the target population ages 15 to 64 years old participated. The HDL cholesterol was determined at the RIND laboratory by the same method and standardization procedures. Higher levels of physical activity and a lower mean BMI in coloureds may have contributed. No significant difference was found when comparing the HDL cholesterol levels of coloured and white women (60.8 ± 15.9 mg/dl vs. 59.3 ± 14.5 mg/dl). Coloured women smoked more cigarettes than white women and obesity was also more common in coloured women than in white women. The benefit of higher HDL cholesterol levels that could have been anticipated for coloured women seems to have been obliterated by these HDL cholesterol-reducing factors.

When the HDL cholesterol levels of the coloured population are compared with those reported for the South African black population, the levels of urban coloureds tend to be lower than those of rural blacks. Walker et al. studied the HDL cholesterol levels of Tswana consuming a traditional diet. The sample size was 50 men and 50 women ages 16 to 18 years, and 98 men and 184 women ages 60 to 69 years. Enzymatic kits similar to the RIND laboratory kits were used, although the precipitation of apo B containing lipoprotein was done with heparin and MgCl2. Sampling procedures were not described. Mean HDL cholesterol levels and SD for young and older men and young and older women were 56.1 ± 11.2 mg/dl and 70.0 ± 13.9 mg/dl, and 65.8 ± 12.0 mg/dl and 80.1 ± 13.2 mg/dl, respectively. Their %HDL/TC levels, in the same order, were 43% and 45%, and 48% and 49%, indicating a low TC, reflective of their traditional diet, which is a strict LDL cholesterol-lowering diet. Vorster et al. found that a group of 50 black farmworkers had a mean and SD of 60 ± 15.5 mg/dl for HDL cholesterol and 35.2 ± 12.1% for %HDL/TC. Laboratory determinations were similar to the results of the present study. Sampling procedures were not reported, but a detailed dietary analysis showed that these rural blacks also consumed a cholesterol-lowering, prudent diet.

Although limited, these two studies are of interest because they illustrate that rural blacks on a traditional low-fat, high-carbohydrate diet have higher HDL cholesterol levels than the urban coloured population who consume a typical Western diet. On the other hand, a group of 218 black manual laborers in a single large industry in Cape Town (ages 18 to 64 years) seemed to have HDL cholesterol levels comparable to those of the coloured population (P.L. Jooste, unpublished data). HDL cholesterol determinations were done at RIND laboratories with identical procedures. This urbanized group represented approximately half of the inhabitants of the company hostel, and their diet was intermediate between that of the traditional blacks and the coloureds. Their mean HDL cholesterol, %HDL/TC, and standard deviations were 55.0 ± 17 mg/dl and 34.0 ± 10.1%, respectively.

The HDL cholesterol levels reported in white and Japanese men from Framingham, Albany, Honolulu, San Francisco, Evans County, and Puerto Rico are similar to those of South African white men studied in the Coris study and, thus, lower than those of the coloured men participating in this study. The South African coloured men, in turn, had lower HDL cholesterol levels than the black men who participated in the Evans County study. The HDL cholesterol levels of the coloured women in this study were similar to those reported for the white participants, but lower than those for the black participants in the Evans County study. However, the methodology used by Castelli et al. for HDL cholesterol determinations were not identical in all their centers and not the same as in the South African studies. These international comparisons should, therefore, be interpreted with some caution.

It would seem that the lack of protection against CHD due to low levels of %HDL/TC is experienced more by men than by women (Table 3). This could be partly explained by lower median cut-off points for men. However, in Table 1 the difference in %HDL/TC between men and women was found only in the younger age groups, while the reporting of CHD was found mainly in the older age groups where the difference in %HDL/TC between men and women had disappeared.

The search for factors that determine the level of HDL cholesterol in individuals and populations has not been completed, as only a small proportion of the variation found in HDL cholesterol levels in populations have been explained by factors studied to date. In an effort to identify any factors in the present data set that may contribute to the level of HDL cholesterol, particularly if such a contributing factor was amenable to change, univariate analyses followed by stepwise multiple regression analysis was done.

The variables that contributed to the variation of HDL cholesterol in the coloured population were those previously described in the literature, with the following exceptions: the very low positive association of HDL cholesterol and diastolic BP in men and the inverse relationship with LDL cholesterol in men and women. The underlying mechanisms involved in most of these associations have not been fully elucidated, but metabolic and clinical studies have suggested some possible explanations.

Pietinen et al., Katan, and others have reported that high-fat diets resulted in high HDL cholesterol levels, irrespective of the fatty acid composition of the diets. In addition, high carbohydrate intake resulted in reduced HDL cholesterol and raised serum triglyceride levels. This inverse relationship of HDL cholesterol and serum triglyceride levels could possibly be mediated via a raised activity of lipoprotein lipase and/or hepatic lipase.
has also been suggested\(^\text{46}\) that weight loss could lead to an increased adipose tissue lipoprotein lipase activity, which could in turn explain the raised HDL cholesterol and reduced triglyceride levels found in persons who lose weight. Induction of liver microsomal enzymes by agents such as ethanol, phenytoin, and phenobarbital have all been shown to increase HDL cholesterol levels\(^\text{46}\) and could be the biological basis of the correlation found between alcohol intake and HDL cholesterol levels in this study. The inverse relationship found between HDL and LDL cholesterol levels could possibly be due to an indirect up-regulation of LDL receptors in a response to a more effective reverse cholesterol transport in participants with higher HDL cholesterol levels. The explanation of the apparently contradictory finding of a direct correlation of HDL cholesterol with increasing calories, but a negative association with BMI, may lie in the increased physical activity of those with high HDL cholesterol levels. In this study, we could not demonstrate an independent contribution of physical activity to HDL variation. Although in men energy expenditure at work was significantly associated with BMI, the method of measuring physical activity was relatively crude. It is possible that the proportion of energy from fat by carbohydrate lowers HDL cholesterol.

In a review by Knuiman et al.\(^\text{15}\) on the dietary factors related to HDL cholesterol, inter- and intrapopulation studies again highlighted the association with BMI, carbohydrate intake, and the proportion of energy from total fat. It has been found quite consistently that replacement of fat by carbohydrate lowers HDL cholesterol.

The diet of the coloured population of the Cape Peninsula, determined by the 24-hour dietary recall method, reflected a typical Western type diet with high animal protein and high fat intake. Fat contributed 37% to total energy intake. The polyunsaturated to saturated fatty acid ratio of the diet was relatively high at 0.8\(^\text{51}\). The value of the 24-hour dietary recall lies mainly in the assessment of the average intake of a group of people,\(^\text{52}\) consisting of at least 50 persons. Due to its speed and relative simplicity, this method is frequently used for dietary intake determinations in large population-based studies. Due to large intraindividual variation, the use of results from the 24-hour recall method for studies of intraindividual correlations with other variables is limited and may fail to identify dietary factors related to, for example, HDL cholesterol levels unless a strong association is present. Therefore, weak dietary associations with HDL cholesterol levels may have been missed in this study, but those factors that have been identified in the multiple linear regression of HDL cholesterol could be considered not only statistically but also biologically significant. In this study, significant independent associations with total energy intake in men and percentage energy from saturated fat in women were found even when physical activity was included in the analysis.

The measures of socioeconomic status did not show a uniform association with %HDL/TC, but overall it would appear that lower socioeconomic status is associated with a more favorable %HDL/TC.

Recently a number of studies have appeared\(^\text{53–57}\) that suggest that a large part of the individual variation of HDL cholesterol could be ascribed to genetic factors. Whether genetics could determine population HDL cholesterol levels is not clear, but it is of interest that the coloured levels are midway between those of American and South African blacks and whites.

The reasons for the relatively high HDL cholesterol in this population are unknown. Genetic or environmental factors not examined in this report will have to be looked for to explain the high HDL cholesterol levels in this population.

Nationally, the CHD mortality of coloured people is lower than that of whites in South Africa,\(^\text{58}\) while in Cape Town it approaches that of the whites (D. Bourne, unpublished observations). This is despite the higher level of risk the Cape Town coloured population carries due to the high prevalence of smoking, hypertension, and hypercholesterolemia\(^\text{18}\) compared to the rural South African whites of the Coris study.\(^\text{34}\) One possible explanation is that it could be due to the protection that coloureds receive from their relatively high HDL cholesterol levels.

Acknowledgments

This study was done in collaboration with the Institute for Communication Research of the Human Sciences Research Council (HSRC). Mariana Steyn and Poet C.J. Jordaan played a central role in the planning and execution of this project. The authors are indebted to the Bureau for Research Support Services of the HSRC. The school nursing sisters of the Regional Office of the Department of National Health contributed greatly to this study. The laboratory assistants of the RIND executed the analysis most ably.

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Index Terms: lipoprotein • HDL cholesterol • Cape Peninsula • South Africa • risk • coronary heart disease
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doi: 10.1161/01.ATV.9.3.390

Arteriosclerosis, Thrombosis, and Vascular Biology is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 1079-5642. Online ISSN: 1524-4636

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