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HIGH DENSITY LIPOPROTEIN AND TOTAL SERUM CHOLESTEROL LEVELS IN A GROUP OF BRITISH COLUMBIA NATIVE INDIANS[1],[2]

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ABSTRACT

High density lipoprotein (HDL) and total serum cholesterol levels were evaluated in 202 members of the Nuxalk Nation, a native Indian people residing on the British Columbia (B.C.) coast. Cholesterol was measured enzymically in non-fasting serum, and HDL cholesterol was measured following precipitation of very-low and low-density lipoproteins with polyethylene glycol. Cholesterol levels averaged 202.6 ± 45.7 mg/dl, and HDL cholesterol levels averaged 57.5 ± 17.3 mg/dl. As expected, cholesterol levels were positively correlated with both age ($r=.524$, $p<.001$) and body mass index ($r=.395$, $p<.001$), and HDL cholesterol correlated negatively with body mass index ($r=-.205$, $p<.01$). An unexpected result of the study was that HDL cholesterol levels in Nuxalk men were not different from those in women, but were higher than average values for male Caucasians. This observation could not be explained on the basis of data obtained in this study; it may be a factor in the low coronary mortality rate for B.C. registered Indians.

KEY WORDS: Cholesterol; HDL Cholesterol; Sex differences; Indians, North American

INTRODUCTION

Mortality due to coronary heart disease appears to be significantly lower in British Columbia (B.C.) native Indians than in the Canadian population at

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large: In 1977, the Canadian death rate due to cardiovascular disease was 349.7 per 100,000 population (1), as compared to a death rate of 131 per 100,000 among B.C. registered Indians (2). Similar findings have been noted previously for southwestern American Indians, who were found to have an overall prevalence of myocardial infarction and electrocardiographic evidence of ischemic heart disease that was only 25% of that of the population studies in Framingham (3). In conjunction with lower rates of coronary disease, the southwestern American Indians were also found to have lower serum cholesterol levels than the American Caucasian population (4,5), and to have relatively higher levels of high density lipoprotein (HDL) cholesterol and lower levels of low density lipoprotein (LDL) cholesterol (6). Higher levels of HDL cholesterol are associated with a decreased risk of coronary disease (7-9), whereas elevated LDL cholesterol levels are known to be atherogenic (10).

Relatively few data exist on serum cholesterol levels in B.C. native people. The Nutrition Canada National Survey found that although median cholesterol levels in Canadian native Indians and the general population were not substantially different, fewer native people had cholesterol levels above standards indicating a high risk for heart disease (11). Another report indicates that serum cholesterol levels in B.C. native people are slightly greater than those of the Canadian population (12). HDL cholesterol levels in B.C. native people do not appear to have been reported. Thus, although the data are incomplete, the lower coronary mortality in B.C. native people, in comparison to the general population, may not be associated with substantially lower cholesterol levels. This contrasts with the observations in the southwestern American Indians.

Coronary heart disease is also reported to be relatively rare among the Inuit people (13), and it has been suggested that this may be due to consumption of marine oils containing large amounts of omega-3 fatty acids (14,15). These fatty acids appear to lower both plasma cholesterol and triglyceride levels (16), and to have antithrombotic effects which are likely mediated through an influence on platelet lipid composition and function (17). Significant amounts of omega-3 fatty acids are found in Pacific salmon (18), which have traditionally served as a prominent food for many groups of B.C. native Indians, particularly those residing in coastal communities.

Moderate use of alcohol appears to favourably affect coronary mortality (19), and to result in elevated HDL cholesterol levels (20,21). The mechanism(s) by which alcohol has its effects on lipid levels and coronary mortality is not known at present, although changes in liver function, as assessed by liver enzyme levels, have been related to changes in both lipid levels and alcohol consumption (22). Alcohol use by Canadian native people, as reported by Nutrition Canada, appears to be highest among males aged 20 to 54 (23).

The present study was designed to evaluate the levels of HDL and total serum cholesterol in the people of the Nuxalk Nation, a native Indian community on the B.C. coast. The associations of cholesterol levels with age, body mass index (BMI), and activity of gamma glutamyl transferase (GGT), a liver enzyme, were also assessed.

MATERIALS AND METHODS

Subjects

In May, 1983, a nutrition and health assessment was made available to the people of the Nuxalk Nation living in Bella Coola, British Columbia (24). Bella Coola is located on the central B.C. coast at the head of a deep sea inlet. Of the 592 Bella Coola-resident Band members, a total of 389 individuals of all ages participated in the health assessment. Participation rates were similar among different age groups.

Procedures

Non-fasting blood samples were obtained from 202 of the 228 participants aged 13 years and over. Samples were centrifuged at 4°C to obtain the serum, and were stored in polypropylene tubes at -20°C prior to conducting the analyses. Non-fasting samples were taken in order to enhance participation, as it is generally accepted that serum total and HDL cholesterol levels are not acutely affected following the ingestion of normal meals (25,26). Chylomicronemia was not evident in any samples.

Serum cholesterol levels were determined using a well-established enzymic procedure (27), with reagents obtained from Boehringer Mannheim, and HDL cholesterol levels were determined enzymatically in the supernatant following precipitation of low and very low density lipoproteins with polyethylene glycol (28). Intra- and inter-assay coefficients of variation for these assays were less than 5%.

The activity of gamma-glutamyl transferase was assayed colorimetrically in serum using Boehringer Mannheim reagents (29). Height and weight measurements were completed by a single individual, using a stadiometer and a beam balance. These measurements were used to calculate body mass index (BMI = kg/m^2).

Statistical Analysis

Data analysis was conducted using SPSS (30). Statistical procedures included analysis of variance, t-tests, Pearson correlation analysis, and partial correlation (31).

RESULTS

Serum total and HDL cholesterol levels are presented by sex and age in Table I. The average serum cholesterol level for the entire group was 202.6 mg/dl, whereas HDL cholesterol averaged 57.5 mg/dl. Analysis of variance of the data revealed no sex effects for either total or HDL cholesterol ($p=0.516$ and 0.683 respectively). An age effect was found for total cholesterol ($p<0.001$), but not for HDL cholesterol ($p=0.260$). No age-by-sex interactions were detected in the results for either HDL or total cholesterol.

TABLE 1

Serum Total and HDL Cholesterol by Age and Sex

Age (yrs)	Sex	n	Serum Cholesterol (mg/dl)	HDL Cholesterol (mg/dl)
13 - 19	Male	21	152.4 ± 7.6*	53.3 ± 2.9
	Female	20	166.0 ± 6.5	54.5 ± 2.8
20 - 29	Male	29	201.6 ± 5.6	61.9 ± 3.5
	Female	24	194.3 ± 8.2	60.7 ± 3.1
30 - 39	Male	23	205.9 ± 7.4	55.6 ± 2.6
	Female	18	210.1 ± 10.0	60.9 ± 4.0
40 - 59	Male	24	232.1 ± 8.4	59.7 ± 4.2
	Female	23	219.8 ± 9.2	54.6 ± 4.0
60+	Male	6	260.3 ± 26.6	61.5 ± 11.4
	Female	12	232.6 ± 9.1	51.1 ± 6.2
All Ages	Male	103	203.1 ± 4.7	58.2 ± 1.7
	Female	97	202.2 ± 4.5	56.8 ± 1.7

*Results are expressed as Mean ± S.E.M.

Pearson product-moment correlation coefficients were calculated to examine the associations of age, GGT activity and body mass index with total and HDL cholesterol levels, as shown in Table 2. It can be seen that significant positive correlations existed between serum total cholesterol and all three of these variables. HDL cholesterol levels, in contrast, correlated negatively with body mass index, and were not significantly associated with age. GGT activity correlated positively with HDL cholesterol levels, although the association was not significant ($p=0.06$).

As is obvious from the data presented in Table 2, the independent variables also correlated positively with one another. Partial correlation coefficients were therefore calculated to examine the association of each of the independent variables with total and HDL cholesterol while simultaneously controlling for the effects of the other independent variables. These results, presented in Table 3, indicate that significant positive correlations persisted between total cholesterol and each of age and body mass index, whereas the correlation between GGT and total cholesterol was no longer significant. In contrast, GGT activity was significantly correlated with HDL cholesterol levels when age and body mass index were controlled.

TABLE 2

Pearson Product-Moment Correlation Coefficients
Among HDL and Total Cholesterol, Body Mass Index, Age and GGT

	HDL	Body Mass Index	Age	GGT
Cholesterol	r= 0.159 p= 0.013	r= 0.395 p< 0.001	r= 0.524 p< 0.001	r= 0.191 p= 0.003
HDL		r=-0.205 p= 0.002	r=-0.001 p= 0.437	r= 0.111 p= 0.060
Body Mass Index			r= 0.479 p< 0.001	r= 0.166 p= 0.010
Age				r= 0.154 p= 0.015

TABLE 3

Partial Correlations of Age, BMI and GGT with
Total and HDL Cholesterol Levels

Partial Correlation With:	Cholesterol	HDL Cholesterol
Age*	r = 0.417 p < 0.001	r = 0.091 p = 0.104
BMI†	r = 0.174 p = 0.008	r =-0.245 p < 0.001
GGT†	r = 0.116 p = 0.055	r = 0.145 p = 0.022

*controlling for BMI and GGT
†controlling for age and GGT
†controlling for age and BMI

DISCUSSION

There are relatively few appropriate sources of data to which the results of the present study may be compared. The Nutrition Canada National Survey obtained data on non-fasting serum cholesterol levels in a total of 1808 native Indians, 286 of whom were members of four bands in the Pacific region (11). In this survey, median serum cholesterol levels were similar in the Indian and National (largely Caucasian) components of the study. However, variability in the native Indian group must have been lower, as fewer native Indians were classified as being at high risk for heart disease on the basis of having serum cholesterol levels above age and sex-specific standards. In contrast, greater proportions of Nuxalk native people would be classified as being at high risk on the basis of these standards, as is shown in Figure 1. Caution must be exercised in interpreting these results, as some sample sizes are small: 141 in the case of the Pacific region results of the Nutrition Canada Indian Survey, and 159 in the present study. However, it does appear that a greater proportion of the Nuxalk native people have elevated cholesterol levels than did individuals studied by Nutrition Canada, irrespective of which group the results are compared to.

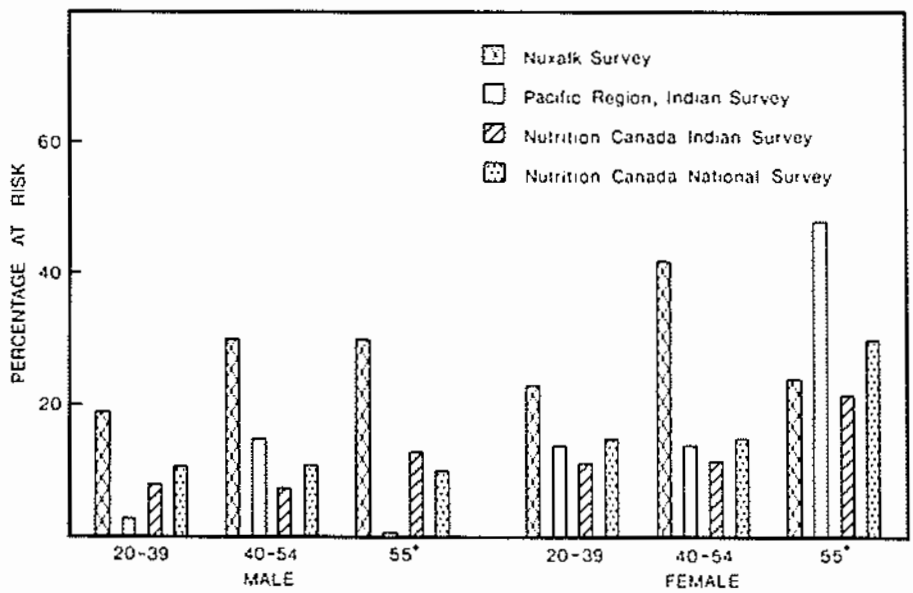

FIG. 1

Percentage of participants with serum cholesterol levels classified at high risk using Nutrition Canada interpretive standards. These levels were $\geq$ 220 mg/dl for women aged up to 39; $\geq$ 230 mg/dl for women aged 40 to 54; $\geq$ 240 mg/dl for men up to 39 years of age; and $\geq$ 250 mg/dl for men 40 and over and women 55 and over. For participants in the Nutrition Canada National Survey (▨), age ranges to which interpretive standards were applied and for which data are displayed were 20-39 years, 40-64 years, and 65 years and over.

Several factors may explain the apparent discrepancy between the Nutrition Canada results and those of the present study. Firstly, the response rate among those initially selected for the Nutrition Canada Indian survey was 30% (11) compared to a 59% response rate by the Nuxalk population. The possibility thus exists that native Indians with higher serum cholesterol levels were less likely to have participated in the Nutrition Canada Survey. Secondly, there may be variability among bands, even within a region. Support for this is provided by data on plasma cholesterol levels of B.C. native Indians residing on the Anaham and Ahousat reserves (12). Mean serum cholesterol levels for individuals over 13 years of age were 229 mg/dl and 245 mg/dl for Anaham and Ahousat residents, respectively, as compared to a mean level of 202.6 mg/dl for Nuxalk people of similar ages.

The lack of a sex difference in HDL cholesterol levels in these subjects was surprising, given the usual finding of higher levels in women than in men (32,33). The method we used for HDL cholesterol determinations could successfully detect a sex difference when one existed: a small in-house study on similarly-treated blood samples from male and female Caucasians revealed a significant ($p<.01$) sex difference (unpublished data). The Nuxalk men included in this study had a mean HDL cholesterol level of 58.2 mg/dl, not significantly different from the average of 56.8 mg/dl in the women. The level in men is substantially higher than average levels in a Caucasian population: The Lipid Research Clinics Prevalence Study reported rounded mean values of 45 mg/dl and 50 mg/dl in men aged 15 to 44 and 45 or older, respectively (34). In contrast, the average level in the Nuxalk women was similar to the LRC averages, which are 55 mg/dl and 60 mg/dl in women aged up to 39 years and over 40, respectively (34). There are few reports in the literature of HDL cholesterol levels in other native Indian populations. A group of ten southwestern American Indians was found to have HDL cholesterol levels averaging 56 mg/dl, although no conclusions could be reached concerning sex differences as there were only three women in this group (6). Plasma and HDL cholesterol levels of the Tarahumara Indians of Mexico have also been reported (35). These people consume a very low cholesterol, low fat, high fibre diet, and have levels of both total and HDL cholesterol that are low, averaging 125 ± 26 mg/dl and 25 ± 8 mg/dl respectively. Although it was reported that gender differences did not exist, only six non-pregnant women between 19 and 70 years of age were studied, as compared to 34 men in the same age range. Finally, the only other report located in the literature which did not detect a sex difference in HDL cholesterol was a study done in New Zealand, which reported that full-blooded Maori males and females had similar HDL cholesterol levels (36). However, this study was confined to adolescents.

There is no obvious explanation for the relatively elevated HDL cholesterol levels in the Nuxalk men. Body mass index correlated negatively with HDL cholesterol levels in the subjects in the present study, a relationship which has been reported in studies of other groups (9,33,37). However, the average body mass index of the Nuxalk men, at 27.8 kg/m^2, was higher than the mean of 24.3 kg/m^2 calculated from Nutrition Canada data for adult men (11). On the basis of the regression equation relating body mass index to HDL cholesterol developed on data from the LRC study (37), one would have expected the mean HDL cholesterol level in the Nuxalk men to be 2 to 3 mg/dl lower than the LRC average, instead of approximately 10 mg/dl higher. It is clear that direct comparisons of the Nuxalk data to the LRC data are not totally appropriate, due to differences between the populations. However, it is equally clear that the higher HDL cholesterol levels in the Nuxalk men cannot be explained on the basis of a lower-than-average body mass index.

It is also unlikely that dietary factors contribute to the relatively elevated HDL cholesterol levels in the Nuxalk men. As a coastal people, the Nuxalk do incorporate salmon into their diets on a frequent basis, and some reports have indicated that omega-3 fatty acids found in marine oils may elevate HDL cholesterol levels (38,39). However, a diet with salmon and salmon oil fed to healthy volunteers did not influence HDL cholesterol, although significant reductions in total cholesterol and triglyceride levels were observed (18). It should be noted that the amount of salmon and salmon oil used in this study (up to one pound of salmon and 3-6 tablespoonsful of salmon oil per day) was considerable. The Nuxalk people may consume a similar amount of salmon seasonally, but they do not use salmon oil as a dietary condiment (40). Furthermore, blood samples for this study were obtained in the spring, whereas the peak salmon season is in late summer. Thus, the relatively elevated HDL cholesterol levels in Nuxalk men would not appear to be accounted for by consumption of large amounts of omega-3 fatty acids from salmon. Ooligan grease is a traditional source of fat included in the Nuxalk diet, but this is a largely monounsaturated fat which contains only 1% polyunsaturates (41). Finally, irrespective of any possible effects of traditional foods on serum lipid levels, there are no data to support (nor any reason to suspect) differential uses of these foods by men and women (40).

Alcohol is felt to be one of the major determinants of HDL cholesterol, and strong positive relationships between alcohol intake and HDL cholesterol levels have been demonstrated (20,21). In this study, accurate data on alcohol consumption were not obtained. However, HDL cholesterol levels were correlated with GGT activity (Table 3), and the activity of this enzyme has previously been found to be elevated in alcoholics as compared to control populations (22, 42). It is not probable, however, that use of alcohol would account for the lack of an expected male-female differential of approximately 10 mg/dl in HDL cholesterol: The average HDL cholesterol level for subjects in the highest quintile for GGT activity was only 6.5 mg/dl greater than the average for those in the lowest quintile, whereas the difference in GGT activity was 88 IU/mL (data not shown). Because the mean difference in GGT activity between the Nuxalk men and women was only 12 IU/mL (unpublished observation), GGT activity as an indicator of alcohol use would not be a major factor in explaining the relatively elevated HDL cholesterol levels in the Nuxalk men. It remains possible that a more valid estimate of alcohol intake would show a stronger relationship to HDL cholesterol levels, but it has been estimated that the maximum proportion of variance accounted for by alcohol use, given a valid and reliable indicator of consumption, would be no more than 10% (42). Thus, the lack of a sex difference in Nuxalk HDL cholesterol levels is not likely to be entirely due to greater alcohol use by the men. Furthermore, it must be remembered that there is a male-female differential in alcohol use in the Caucasian population as well (23), despite the lower HDL cholesterol levels found in Caucasian men as compared to women.

In conclusion, the results of this study indicate that HDL cholesterol levels in Nuxalk men are similar to levels in Nuxalk women, and are substantially higher than mean levels reported for Caucasian populations. These findings could not be explained on the basis of body mass index nor by the use of GGT activity as an index of alcohol use. While the results of this study reflect data gathered from only a single community of B.C. native people, it is tempting to suggest that the elevated HDL cholesterol levels found in men contribute to the low coronary mortality rates observed in the B.C. native Indian population. Studies of other native people living both on and off

reserves would be desirable to support this hypothesis, as would further information on lifestyle and metabolic variables that may influence HDL cholesterol levels.

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