Relationship of Serum Cholesterol to Socioeconomic and Dietary Factors in Puerto Rican Veterans

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A study of socioeconomic factors, diet, and serum cholesterol in an unselected sample of 240 Puerto Rican veterans hospitalized between 1958 and 1962 was performed. This study was motivated by the reported lower incidence of arteriosclerotic heart disease in rural as compared to urban Puerto Ricans. The results indicated that the rural area veterans had a lower income, spent less money for food, had a lower serum cholesterol and consumed less calories, fat and proteins than veterans from urban areas. The serum cholesterol was significantly associated with the amount of money spent for food. It was also significantly correlated with body weight and with the actual to ideal weight ratio. None of the other predictive factors for coronary disease that were studied discriminated between the two groups. It is believed that socioeconomic factors that affect the nutritional-energy consumption balance may operate to establish the suspected protection from arteriosclerosis in rural Puerto Rican veterans.

In 1954 a review of cases of myocardial infarction admitted to the San Juan V. A. hospital was performed. It was noted that although individuals with a relatively low income were admitted to this hospital 1½ times more frequently than those with a high income, the high income group accounted for close to three fourths of the cases of myocardial infarction.

Because of the highly selected nature of the sample, it was not possible to derive any conclusions for general application from this observation. Nevertheless, a similar pattern had been noted in previous investigations of other Puerto Rican groups. Amadeo's classic paper offering a suggestion to improve coronary collateral circulation was based on his observation of the low prevalence of coronary artery disease in the Puerto Rican countryman. Suarez reported a prevalence of 65.9 percent of arteriosclerotic heart disease among private cardiac patients whereas Francisco found only 20 percent in the same category among charity patients at the Arecibo District Hospital. Since our observations on veterans seemed to be in accord with these authors, a protocol was designed in order to attempt to identify factors of relevant significance in the segment of the Puerto Rican population served by our institution.

Materials and Methods

Patients admitted to the San Juan V. A. Hospital were taken without selection into the study. Intermittent patient intake periods were held from 1958 to 1962 depending on the ability of the participants to take on an additional case load. It is believed that any possible bias arising from the intermittency of the intake periods applies evenly to all groups within the sample. It is also believed that the sample obtained represents a fair cross section of admissions to the hospital during this period.

A complete history and physical examination was performed on all patients. Weight was determined to the nearest pound and height to the nearest half inch. Socioeconomic and dietary interviews were conducted by skilled social workers and dietitians. Special forms were developed to obtain the necessary information, uniformly. Provisions were taken to double check reliability through differently worded questionnaires at separate interviews. An attempt was made to average dietary composition and socioeconomic quantitative factors over the previous five-year period.

Food nutrient composition was calculated using standard reference sources supplemented by data for native foods. Samples of native fried foods as usually prepared were analyzed chemically for fat in order to estimate fat consumption as precisely as possible. Serum cholesterol was determined by the method of Zak.

The data collected were coded and entered into marginal punch cards for statistical study. The X² test was used to determine the significance of the results. For some analyses, Pearson correlation coefficients were calculated. "P" values less than 0.05 were considered to be significant.

Complete data were obtained from over 300 individuals.
but after evaluation of the checks for reliability, 240 remained for statistical study.

Since no attempt was made to select patients, the geographic distribution of the sample corresponded to that expected for the population served by the hospital. The distribution by geographic regions of Puerto Rico as established for the 1940 census was as follows: North Central region, 135; East, 12; South, 23; Northwest, 9; West interior, 12; East interior, 39.

The determination of rural or urban residence was done according to the criteria established by the Department of Preventive Medicine and Public Health of the School of Medicine of the University of Puerto Rico. The proportion of rural and urban residents was approximately the same in all regions except for the North Central region where there were 114 with an urban residence and 23 with a rural residence. Overall, there were 160 urban area residents and 80 rural area residents.

RESULTS
Quantitative Data (Table 1)

The age distribution of the sample was similar to that of the veteran population at large with a bimodal curve corresponding to World Wars I and II (Fig 1). There was no significant age difference between the urban and rural groups. The differences in weight and height between the two groups were not significant either.

There was a wide range of family income levels in the sample. Rural residents had a significantly lower average family income than urban residents. On the other hand, the average rural family was significantly larger than the average urban family. For this reason, the difference in income was particularly striking when computed on a per capita basis. The difference between the mean monthly per capita income of the rural group ($38.60) and the corresponding figure for the urban group ($68.60) was highly significant.

The mean annual income per capita of the total was $703.00. This is not significantly different from the corresponding values for Puerto Rico as a whole during the years covered by the study which were as follows: 1958, $521; 1960, $602; 1962, $724.

There was a close correlation between the family income and the amount of money spent for food. The monthly expense for food per capita was also significantly higher for urban than for rural residents. As would be expected, the personal caloric consumption of the two groups of veterans was significantly different. The mean daily caloric consumption for urban residents was 2,095 calories and for rural residents 1,880 calories. For the overall sample, the average caloric consumption was 30.5 calories per kilogram per day, which is considerably lower than the 37 calories per kilogram per day dietary allowance recommended by the National Research Council.

Thus in our sample, the income and caloric intake parameters were significantly different in veterans residing in urban and rural areas. The ques-
income groups (Fig 2). However, this relationship was not statistically significant. On the other hand, there was a significant difference in fat and protein consumption between urban and rural veterans and a corresponding significant relationship between the amount of money spent for food and the fat and protein consumption of the total sample (Fig 3, 4). Most rural area veterans consumed 70 gm of fat or less per day whereas most urban area veterans consumed over 71 gm. Likewise, most rural area veterans ate 70 gm or less protein per day while most urban area veterans ate more. Fat consumption was also studied according to its animal or vegetable source, but the results did not indicate a statistically significant difference related to income or residence.

Serum cholesterol values were spread over a wide range. The mean serum cholesterol of urban residents was 196.0 mg percent, while that of rural residents was 183.13 mg percent. The difference meets the criterion of $P < 0.05$ for significance. Over 42 percent of the urban group had a serum cholesterol above 200 mg percent, compared to less than 30 percent of the rural residents.

Studies for correlation between serum cholesterol and fat consumption did not show any significant association (Table 2). Likewise, no significant association was found between serum cholesterol and total amount of calories, animal-vegetable fat ratios, and protein consumption. However, a significant association was found between serum cholesterol and food expenditure per capita per month ($r = 0.169, P < 0.025$).

Other correlational studies indicated a significant association between serum cholesterol and weight, and between serum cholesterol and the ratio of the actual weight to the ideal-normal weight (Fig 5). These associations were significant for the total sample as well as within both rural and urban groups indicating that the groups were not different from each other from these points of view. However, it may be noted that at any relative weight

### Table 2—Serum Cholesterol Correlation Studies.

<table>
<thead>
<tr>
<th></th>
<th>Sample</th>
<th>$r$</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Total Sample</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serum cholesterol and fat consumption</td>
<td>0.02528</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Serum cholesterol and calories</td>
<td>0.0093</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Serum cholesterol and proteins</td>
<td>0.00289</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Serum cholesterol and food expenditure per capita per month</td>
<td>0.169</td>
<td>$P &lt; 0.025$</td>
<td></td>
</tr>
<tr>
<td>B. Segregated groups</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>RURAL</td>
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<tr>
<td>Serum cholesterol and weight</td>
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<td>0.2846</td>
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<tr>
<td>Serum cholesterol and actual to ideal weight ratio</td>
<td>0.3169</td>
<td>&lt;0.025</td>
<td>0.239</td>
</tr>
</tbody>
</table>
urban subjects had a higher cholesterol than rural subjects.

Qualitative Data (Table 3)

A search for significant differences in other factors generally regarded as predisposing to coronary disease risk was made. Since the patients entered the study without selection, the prevalence of clinical heart disease and arteriosclerosis in the sample turned out to be about the same as that of the general hospital population. The few cases found were scattered without significant difference among both urban and rural residents.

There were slightly more veterans in the rural group than in the urban group with a diastolic blood pressure above 90 mm Hg. However, the difference was not significant.

Approximately four fifths of both groups were tobacco smokers. The difference between both groups was not significant. Stratification of the sample according to the type or amount of tobacco smoking was not performed.

There were a few more recognized diabetics among urban than rural residents, but the difference was not significant.

In the urban group, 42.2 percent had an actual to ideal weight ratio of 1.1 or above (10 percent or more overweight). In the rural group 29.4 percent fell in this category. The difference does not meet the P < 0.05 criterion of significance.

It is recognized that probably there were important differences in situational and environmental factors such as occupation, education, social attitudes, etc., between the groups. The extent and significance of these differences were not evaluated. No attempt was made either to evaluate "stress" or personality characteristics.

**DISCUSSION**

Since this study was started, additional evidence has been collected to indicate that there is a lower mortality from coronary artery disease in Puerto Rico than in the United States.

In addition, a lower mortality from coronary artery disease among the rural than among the urban population of Puerto Rico has been further substantiated. In this light, the findings of the present study are of considerable interest, keeping in mind that the sample consists of male veterans and therefore, is not necessarily representative of the Puerto Rican population at large.

Of the recognized coronary risk factors that were evaluated (ie, serum cholesterol, diastolic blood pressure, smoking, overweight, diabetes), only the serum cholesterol was significantly different in our urban and rural groups. It is believed that the size of the sample is too small to draw significant conclusions regarding relevance or nonrelevance of these factors. Nevertheless, for the same reason our findings emphasize the discriminative power of the serum cholesterol in our sample.

The presence in the rural group of a relatively low serum cholesterol together with a low fat-protein intake suggests in the light of current knowledge that these factors may be causally interrelated. However, the lack of a significant direct relationship between serum cholesterol and either caloric, protein or fat consumption militates against this simple interpretation. In this connection it is
noted that in the present study a significant relationship between serum cholesterol and body weight was found. Also, although the difference was not statistically significant, the rural group contained a lower proportion of overweight persons than the urban group. In addition, at any relative weight urban subjects had a higher cholesterol level than rural subjects. It seems likely that perhaps other factors influencing nutritional balance besides merely food intake may be involved.

It is generally accepted that nutritional deficiency can lead to malabsorption. Idiopathic malabsorption without nutritional deficiency has been found to be related to a relatively low serum cholesterol in a selected group of Puerto Ricans. It seems reasonable that nutritional deficiency would enhance this effect. Since the caloric-protein intake of our rural groups was relatively poorer than that of the urban group, nutritional deficiency could be a factor inducing and enhancing fat malabsorption in our patients.

In addition, several other differences that could have a bearing on the nutritional-energy consumption balance exist between our urban and rural groups. The types of occupation, the kinds and range of social customs and pressures, the transportation and communication facilities, and the opportunities for education and medical care are among the many possibly significant differences. They could affect the amount and quality of food ingested; but perhaps even more importantly, they could affect the type and amount of physical activity. In other words, they could be determinants of the manner and rate at which food energy is utilized. Therefore, it is possible that the serum cholesterol difference in the present study may be related more properly to the overall nutritional-energy utilization balance of our patients, in which either independently or jointly fat-caloric intake, nutritional deficiency, malabsorption, physical activity, and perhaps other factors play their respective roles.

The other findings of interest in the present study are the significantly lower income of the rural group and the significant association of serum cholesterol with food expense. The findings suggest that an interplay of socioeconomic factors which affect the nutritional-energy consumption balance and consequently the serum cholesterol may be a protective mechanism for atherosclerosis in the rural Puerto Rican veteran.

These data are presented in the hope that they may serve as a complementary contribution to the extensive studies which have been and are being carried out on this subject in Puerto Rico and elsewhere. We hope also that they may serve as a basis of comparison for similar studies that may be performed in the future, as the socioeconomic status of the island continues to improve.

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REFERENCES

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