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Summary of the Research Activities of the Anti-Coronary Club

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THE BASIC OBJECTIVE of the anti-coronary club study of the New York City Department of Health is to investigate the effect of diet in coronary heart disease prevention. Subsidiary studies, however, have also been undertaken.

Basic Study

The anti-coronary club study began in 1957 with an investigation of the feasibility of maintaining a large group of male New Yorkers on a serum cholesterol-lowering diet (the "prudent diet"). The study diet was designed so that approximately equal quantities of saturated, polyunsaturated, and monounsaturated fats would supply 30 to 32 percent of total calories.

Serum cholesterol studies. By 1959, the initial group of 200 anti-coronary club subjects had demonstrated that the serum cholesterol level could be depressed and maintained at low-risk ranges (*1*). A highly significant drop of about 30 mg. per 100 cc. of blood serum from an average initial level of 260 mg. per 100 cc. was observed after subjects had participated for 1 year in the study; the drop thereafter leveled off to approximately 225 mg. per 100 cc. Once the serum cholesterol-lowering efficacy of the study diet was established, consideration was given to expansion of the project to include a control group. In 1960, therefore, a control group was recruited from patients of three New York City Department of Health cancer detection clinics, the experimental group was expanded to 600 active members, and detailed demographic data were obtained from experimental and control subjects.

More recent analysis of anti-coronary club subjects has provided further evidence that adherence to the study diet effectively lowered the serum cholesterol of the great majority of the subjects within the first year of participation in the club and maintained the lowered levels for periods up to 6 years. After 1 year on the study diet, the average serum cholesterol level in the experimental group had fallen from 260 to 228 mg. per 100 cc. of blood serum and remained at approximately that level. In the control group, the average initial level was 250 mg. per 100 cc. and, after 4 years, was slightly higher, 252 mg. per 100 cc. (*2*).

Coronary heart disease morbidity. By 1964, a significantly lower incidence rate of coronary heart disease was observed in the experimental group compared to the control group who had received no dietary instruction or supervision. During the 2,357 person-years of active experience accumulated by 814 experimental subjects, 8 new coronary events occurred. The 463 men of the control group accumulated 1,224 person-years of experience and 12 new coronary events. The difference in morbidity between the two groups was found to be significant at a confidence level of $.01<p<.02$. The age-specific incidence rates in the experimental group were 196 per 100,000 person-years in the 40–49 year age group and 379 per 100,000 in the 50–59

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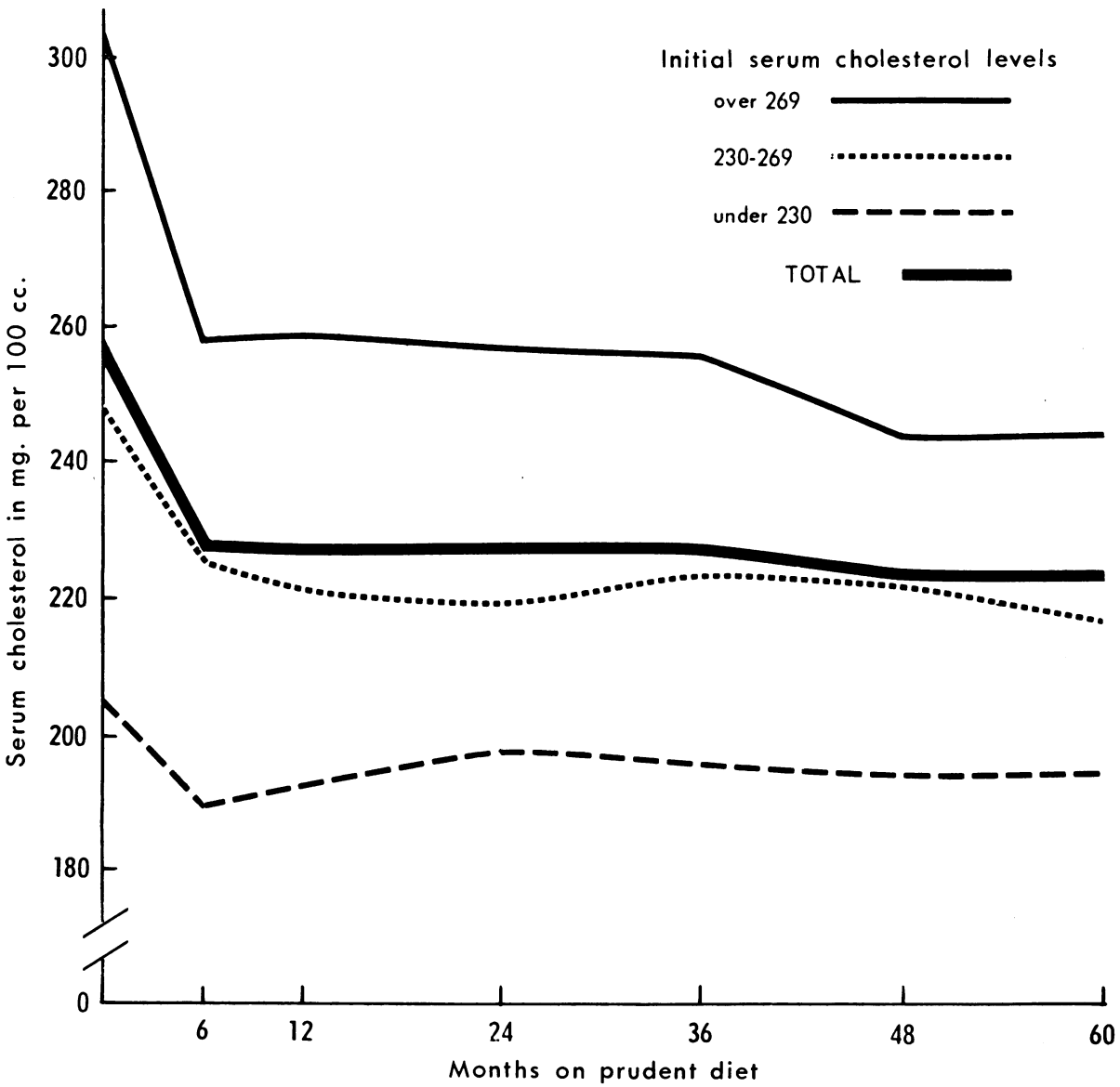
year age group. By contrast, rates in the control group were 642 per 100,000 in the age group 40–49 and 1,331 per 100,000 in the age group 50–59, or more than three times higher in each control group (*2*).

Subsidiary Studies

Corn oil and safflower oil. Once it was established that the anti-coronary club could maintain its membership over the years, metabolic experiments were initiated on this free-living group of subjects. For example, the relative depressant effect of corn oil and safflower oil on serum cholesterol was compared in two groups of 40 subjects each. As new entrants to the study during the period April–August 1961 were placed on the experimental diet, they were alternately assigned to either corn oil or safflower oil as the primary source of polyunsaturated fatty acids. No marked difference in depressant effect was observed between the two vegetable oils.

Weight status and cholesterol. In a further study on the effect of weight status, the hypo-

Figure 1. Serum cholesterol levels in 192 normal-weight men 50–59 years old adhering to the prudent diet

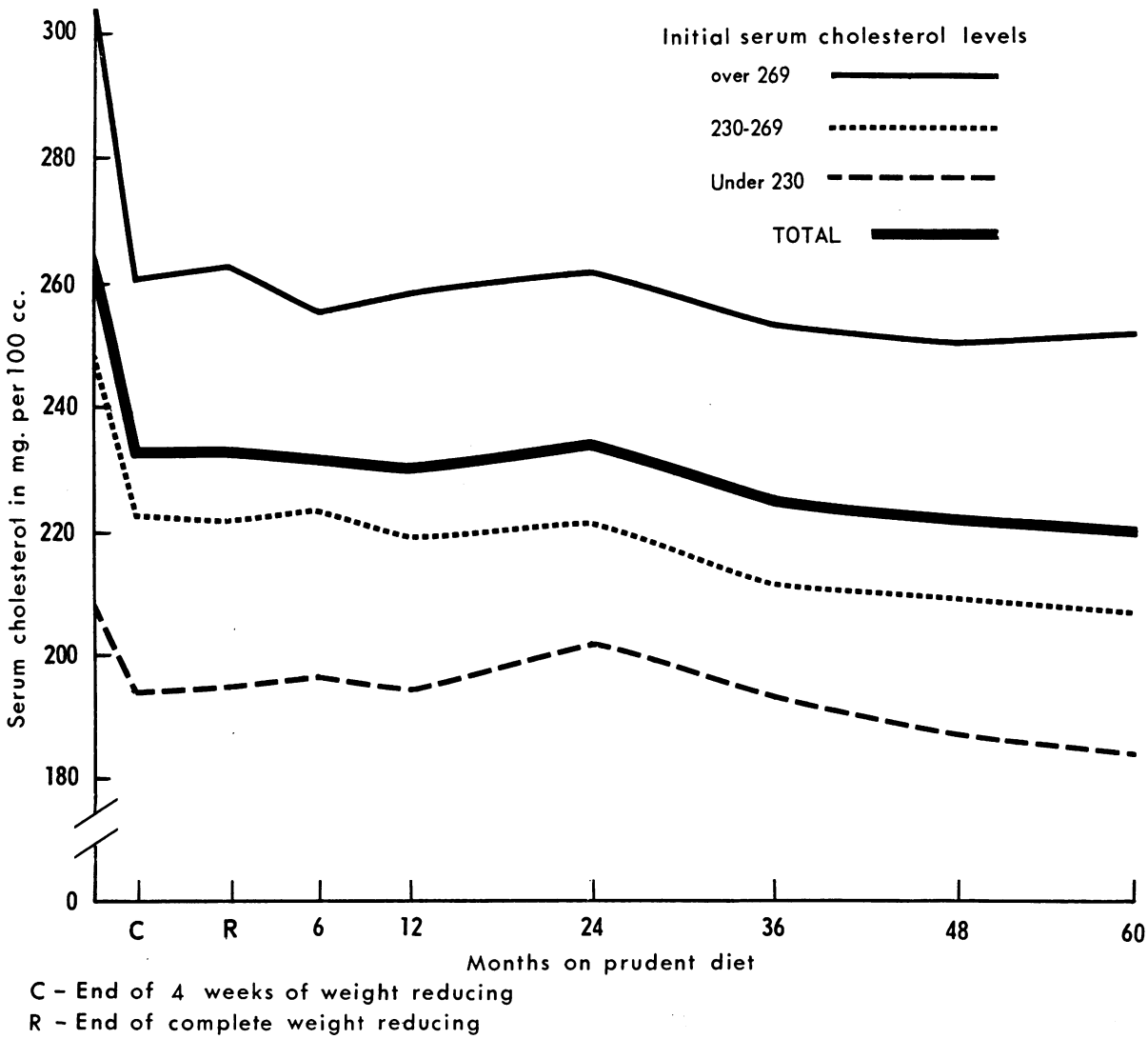


cholesterolemic effect of a modified prudent diet designed to produce a weight loss in obese subjects averaging about 2–2½ pounds per week, was investigated (*3*). The study diet was modified in two ways. In the regular prudent diet, the ratio of polyunsaturated fatty acids to saturated is in the range of 1.25–1.50 to 1.00; in the modified reducing diet, this ratio was about 0.6 to 1.0; the ratio in the usual American diet is 0.3 to 1.0. Depending on the caloric needs of the individual subject, the modified diet was also designed to produce a caloric deficit of 1,000 calories per day.

The effect of the prudent diet on the serum cholesterol level of normal-weight men and that of the prudent reducing diet on obese men are shown in figures 1 and 2. In both groups, the final lowered levels were the same. The subjects on the prudent reducing diet, however, reached the lower levels in one-quarter of the time necessary for the normal-weight men on the regular prudent diet. Subjects of normal weight lowered their serum cholesterol concentration in 4 to 6 months; obese men reached the lower levels within 4 to 6 weeks.

Although the hypocholesterolemic effect of

Figure 2. Serum cholesterol levels in 243 obese men 50–59 years old after weight reduction and adherence to the prudent diet



reducing diets has been reported before, the significant difference between the present research and other studies is that in the anti-coronary club study, the lowered levels of serum cholesterol were maintained beyond the period of weight reduction. Adherence to the regular study diet after desirable weight was attained served to maintain the lower serum cholesterol levels and prevent the rebound to initial levels reported in other studies.

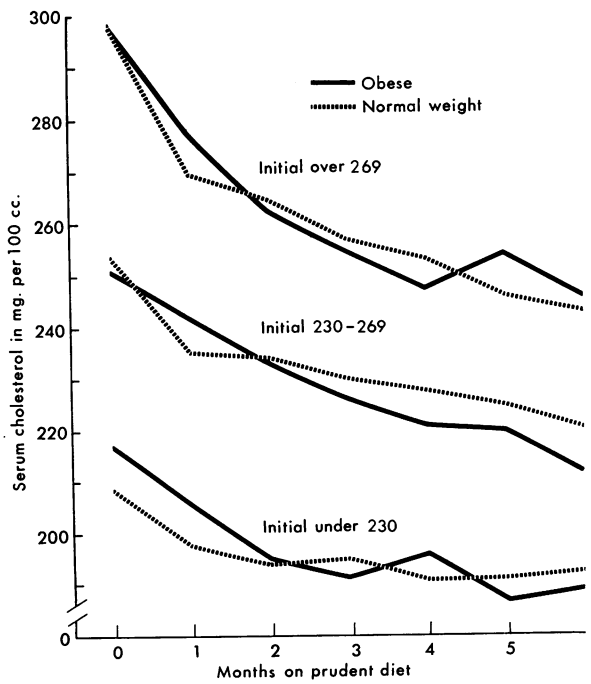
Diet, weight, and cholesterol. To study how weight status affects the capacity of ingested vegetable oil to lower serum cholesterol, a group of 40 normal-weight and 40 obese subjects were compared. The anti-coronary club study diet was administered to both groups. The obese subjects remained overweight by maintaining their usual level of caloric intake. Thus, the effects of the study diet on serum cholesterol levels could be studied apart from changes in weight status. In both groups, serum cholesterol levels were observed for 6 months. Whatever the level of initial cholesterol concentration, the amount and rate of decrease were very similar in the two series of subjects (fig. 3). This result indicated that the hypocholesterolemic effect of the study diet was independent of the subject's weight status.

Serum vitamin E and A levels. If the anti-coronary club study and other diet-heart projects confirm the ability of serum cholesterol-lowering diets to decrease coronary incidence, use of such diets in public health programs can logically be postulated. The metabolic effects of serum cholesterol-lowering diets as well as their nutritional adequacy will, however, have to be established. Accordingly, multiple serum-vitamin determinations were made in our experimental and control groups with special attention to vitamin E and A nutriture (*4*). The data obtained indicated that serum vitamin E and A levels were adequate in 200 subjects who had consumed the prudent diet for up to 4 years (fig. 4). More comprehensive analysis of other serum vitamin levels of a sample of subjects is now in progress.

Serum triglycerides. Concentration of triglycerides in the blood serum has been implicated as a risk factor in coronary heart disease and ascribed a role similar to that of cholesterol. To test the effect of the study diet on serum triglycerides as well as to validate the comparability of the control group from this aspect, we measured triglyceride levels in 30 men who had been members of the experimental group for more than 1 year, in 53 men who were members of the experimental group but had not yet started on the study diet, and in 34 members of the control group. In the experimental group, the average serum triglyceride level was 122.0 mg. per 100 cc. for those who had not yet started the diet, compared with 88.0 mg. per 100 cc. for those already on the diet. This difference is highly significant statistically ($p<.005$). The 34 subjects from the control group had an average level of 120.9 mg. per 100 cc., a level not significantly different from that of the 53 men in the experimental group before they were placed on the prudent diet ($p=0.86$). These results suggest that adherence to the prudent diet may be effective in lowering serum triglyceride levels as well as those of serum cholesterol and that experimental and control group members are initially comparable from this aspect.

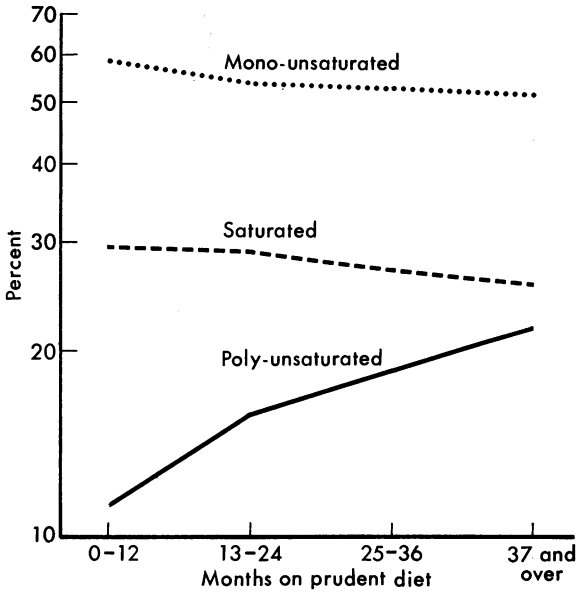
Depot fat composition. The effect of the

Figure 3. Effect of the prudent diet on the serum cholesterol level of normal-weight and obese men aged 50–59 years



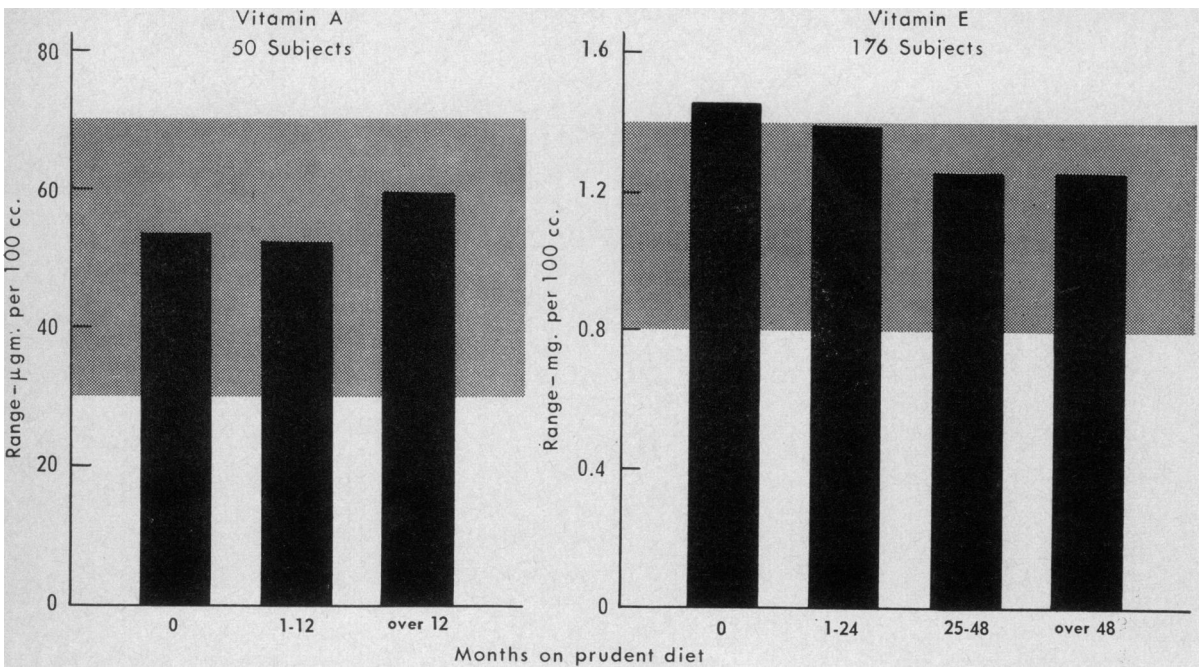
anti-coronary club study diet on the depot fat composition of 87 subjects was also investigated (*5*). This investigation confirmed the observation that a minimum of about 1 year was required for diets relatively rich in polyunsaturated fatty acids to alter depot fat composition. Subjects consuming the study diet from 0 to 4 years showed a progressive increase in depot linoleate from an initial level of 10.2 percent of total fatty acids to 18.3 percent after 4 years. Figure 5 shows the trend in content of polyunsaturated fatty acids in adipose tissue of subjects according to length of time on the study diet. In addition to providing data on linoleic acid, this investigation demonstrated changes in eight other fatty acids present in depot fat. The immediate significance of this study was that the data permitted an objective assessment of adherence to the experimental diet since, according to present knowledge, increases in linoleic acid in depot fat can be derived only from dietary sources of linoleate. Without this objective method of determining whether the experimental subjects were actually consuming the prudent diet, the drop in serum cholesterol could not be definitively attributed to diet.

Figure 5. Change in composition of adipose tissue fatty acids in 78 men 50–59 years old by months on the prudent diet



The active interest of the New York City Bureau of Nutrition in depot fat aspiration procedures and the information they may yield has resulted in development of a special syringe

Figure 4. Serum levels of vitamins A and E by months of adherence to the prudent diet



to facilitate aspiration of adipose tissue under field conditions (*6*). Use of this aspirating syringe has simplified the existing technique and made it more amenable for clinical use and for field procedures in nutritional, cardiovascular, or other epidemiologic surveys.

Diet patterns. As the anti-coronary club accumulated man-years of experience, basic nutritional research was also in progress. Detailed analysis of the diets of the first 540 subjects, conducted before they were administered the prudent diet (*7*), provided a baseline of their prior food patterns as well as insights into diet patterns of New Yorkers in this age group as a whole. The diet histories of 100 randomly selected study and control subjects were also analyzed in detail and their serum cholesterol levels correlated with various dietary components (see table). The only three significant correlations found were (*a*) between the cholesterol levels of obese men and their percent intake of protein, (*b*) between the cholesterol levels of obese men and their intake of saturated fat expressed as a percent of total fats, and (*c*) between the cholesterol levels of normal-weight men and their intake of saturated fats in grams.

Psychological stress. One of the factors implicated in the etiology of coronary heart disease is psychological stress, of which the effects are difficult to evaluate. Individuals react differently to a given set of stimuli, and until recently there has been no objective method of measuring reaction to a stressful situation. Since it is now known, however, that the concentration of a urinary metabolite—vanil mandelic acid (VMA)—usually increases under conditions of psychological stress, an investigation was undertaken making use of this finding. Urinary VMA excretion patterns were determined for 20 randomly selected experimental and 20 control subjects. Statistical analysis of the VMA determinations of this small group of subjects, however, indicated no significant difference between the two groups.

Characteristics of dropouts. To supplement the nutritional and metabolic aspects of the anti-coronary club research project, a 2-year

Correlation of initial serum cholesterol levels with dietary components in 100 randomly selected men 40–59 years old

Dietary and weight factors	Average levels			Linear coefficient of correlation with cholesterol		
	Total	Normal-weight men	Obese men	Total	Normal-weight men	Obese men
Number of subjects	100	42	58			
Initial cholesterol (mg. per 100 cc.)	249.4	249.3	249.5			
Percent of standard weight [3]	116.6	106.6	123.9	−0.110	−0.102	−0.130
Total calories consumed daily	2,385	2,202	2,517	−.020	−.114	−.227
Dietary components, percent of total intake:						
Protein	18.8	18.3	19.2	−.019	−.157	[1] −.278
Carbohydrate	41.5	44.1	39.6	−.113	−.103	−.130
Fat	38.9	36.7	40.6	.105	.154	.093
Saturated fatty acids:						
Grams	48.7	42.7	52.9	[1] .206	.082	.030
Percent of total fat	47.1	47.1	47.0	.049	−.214	[2] .428
Monounsaturated fatty acids:						
Grams	40.1	34.8	43.8	.070	.106	−.052
Percent of total fat	39.2	39.2	39.2	.036	−.141	.155
Polyunsaturated fatty acids:						
Grams	14.0	12.0	15.4	.052	.268	−.074
Percent of total fat	13.7	13.7	13.8	.090	.250	−.034
Ratio of polyunsaturated to saturated fatty acids	.301	.302	.300	.111	−.046	−.076

[1] Significant at .05 level.
[2] Significant at .01 level.
[3] Based on Metropolitan Life Insurance Co. tables of desirable weight for height-sex-frame.

study was conducted to identify sociological and psychological attributes of subjects remaining in the study and those who dropped out. By analysis of 370 interviews with persons from both groups, specific behavioral patterns were delineated for those who remained in the study as opposed to those who dropped out.

Those who dropped out of the study were more closely identified with a "parochial" orientation, that is, belonged to a closed, shared, and traditional social system which apparently made the acceptance of modern concepts of medical care difficult. By contrast, members of the study who remained active showed traits of a "cosmopolitan" orientation—that is, were open, individual, and progressive. Such information will be useful if methods developed by the anti-coronary club are ultimately to be the basis of a public health program for the prevention of coronary heart disease.

Summary

The anti-coronary club study project not only provides a reasonable basis for public health action in dietary prevention of coronary heart disease but also has provided a fertile field for gathering clinical, metabolic, and psychosocial research data.

Substudies to the original project indicate that the "prudent diet," the anti-coronary club study diet, is effective in lowering the level of serum cholesterol for periods up to 6 years and that this reduction is associated with a reduced incidence of coronary heart disease when compared to the incidence in a control group consuming the usual American diet. Preliminary data suggest that the study diet may also lower serum triglycerides.

Subjects consuming the prudent diet exhibited significantly increased levels of linoleic acid in their depot fat. Depot fat aspiration proved useful for objective assessment of adherence to the experimental diet. Long-term adherence to the diet also resulted in normal levels of serum vitamin E and A.

A psychosocial study of anti-coronary club active members and dropouts suggested categorization of the subjects into different types of personality groups, a division which may have predictive value of public health importance.

The results presented in this brief summary report are preliminary and only describe substudies in progress.

REFERENCES

(1) Jolliffe, N., Rinzler, S. H., and Archer, M.: The anti-coronary club: including a discussion of the effects of a prudent diet on the serum cholesterol levels of middle-aged men. Amer J Clin Nutr 7: 451–462, July–August 1959.

(2) Christakis, G., et al.: The anti-coronary club—a dietary approach to the prevention of coronary heart disease. A seven year report. Amer J Public Health. In press.

(3) Jolliffe, N., Rinzler, S. H., and Archer, M.: Prudent reducing diet: effect on serum cholesterol. Study of 111 obese men 50 to 59 years old. Arch Intern Med 109: 566–572, May 1962.

(4) Christakis, G., et al.: Effect of a cholesterol-lowering diet on the serum cholesterol, serum triglycerides, serum vitamin A and E levels, and fatty acid composition of subcutaneous fat in man. Circulation 28: 703 (1963).

(5) Christakis, G., et al.: Effect of a serum cholesterol-lowering diet on composition of depot fat in man. Amer J Clin Nutr 16: 243–251, February 1965.

(6) Christakis, G.: New device for obtaining subcutaneous tissue specimens: the aspirating syringe. J Lipid Res 6: 427, July 1965.

(7) Emmons, L.: The relationship of the quantity and quality of dietary fat to serum cholesterol levels in men of different ages and weights. Unpublished doctoral thesis. University of Minnesota, Minneapolis, December 1962.