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Serum Cholesterol and Dietary Data in Middle-Aged White Males

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SUMMARY

The mean daily dietary intake of normocholesterolaemic subjects (serum cholesterol less than 250 mg/100 ml) was compared with that of hypercholesterolaemic subjects (250 mg/100 ml or higher). Apart from a higher polyunsaturated fatty acid (PUFA) intake in the hypercholesterolaemic group, no other significant differences could be demonstrated between the two groups.

Simple linear correlation coefficients (r) were calculated for the total sample, and the positive correlation ($r = 0,29$) between the serum cholesterol and the percentage of kilojoules derived from PUFA, was the only dietary variable to reach a statistically significant value ($P<0,05$).

A stepwise regression analysis was used to calculate a multiple regression relationship (R^2) between the dependent variable and the dietary variables. The results showed PUFA, total protein and saturated fatty acids (SFA) to have the highest cumulative influence on the serum cholesterol concentration. Only 29% of the variation in the serum cholesterol could be explained by the first 6 of 30 dietary variables tested in this survey.

It was concluded that the small differences in the nutritional status among individuals from homogenous sample populations as well as the fact that non-linear relationships would not be reflected in the correlation coefficient, make it difficult to establish significant relationships between the dietary data and serum cholesterol concentration.

S. Afr. med. J., **51**, 91 (1977).

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Date received: 19 July 1976

Dietary factors, among others, have been implicated in the pathogenesis of atherosclerosis, and an intricate relationship has been shown to exist between the serum cholesterol levels (SCL) and some dietary variables. Studies of ethnic groups have indicated that differences in serum lipids are not primarily racial characteristics, but probably arise from differences in diet.[1,2]

Although it is evident from the literature that a relationship between biochemical and dietary data holds among populations but not within a population, this does not imply that such correlation does not exist. Some authors believe that such correlation may be obscured by errors in measurement. Kahn *et al.*[3] recommended that, to test the relationship between dietary variables and SCL, the dietary components should be measured more accurately. Trulson and McCann[4] found that the average daily nutrient intake of a group was comparable with a second survey on the same group after an interval of less than 2 years. Chappel[5] concluded that data from repeated 7-day periods are more reliable than data obtained during one 7-day period only.

No study to correlate SCL in healthy adults in the higher socio-economic classes with their habitual dietary intakes, as assessed by food record methods, was known to us when this survey was started. The present study was therefore undertaken to determine the dietary intake of normo- and hypercholesterolaemic men by means of spaced records obtained over a period of 7 months, and to determine whether any significant relationship exists between dietary variables and SCL in individuals from a homogeneous population.

SUBJECTS AND METHODS

Subjects

The subject in this study were 153 men between the ages of 40 and 59 years. In 45 of the subjects the mean serum cholesterol level (SCL) was 250 mg/100 ml or higher (hypercholesterolaemic group) and in 108 subjects it was less than 250 mg/100 ml (normocholesterolaemic

TABLE I. SERUM CHOLESTEROL CONCENTRATION, AGE, BODY MASS AND RELATIVE MASS FOR THE NORMO- AND HYPERCHOLESTEROLAEMIC GROUPS*

	Serum cholesterol level† (mg/100 ml)	Age (yrs)	Body mass (kg)	Relative mass
Normocholesterolaemic group				
Mean	**212,3**	**49,4**	**90,8**	**1,05**
SD	**± 28,4**	**± 6,2**	**± 10,8**	**± 0,97**
Hypercholesterolaemic group				
Mean	**282,7**	**47,2**	**78,4**	**1,03**
SD	**± 23,1**	**± 8,6**	**± 8,3**	**± 0,43**

* Mean values for 22 subjects in each group.
† Significant difference between normo- and hypercholesterolaemic groups; $P<0,05$.

TABLE II. MEAN VALUES FOR DAILY INTAKE OF DIETARY VARIAELES FOR THE NORMO- AND HYPERCHOLESTEROLAEMIC GROUPS

Variable	Normocholesterolaemic group						Hypercholesterolaemic group					
	Daily intake			% of total kilojoules			Daily intake			% of total kilojoules		
	Mean	±	1 SD	Mean	±	1 SD	Mean	±	1 SD	Mean	±	1 SD
Kilojoules (kJ)	**10 413**	±	**2 338,9**	—		—	**11 054**	±	**2 294,5**	—		—
Ethanol (g)	**23,8**	±	**7,6**	**6,1**	±	**7,8**	**23,4**	±	**22,5**	**6,5**	±	**6,8**
Total protein (g)	**94,5**	±	**26,7**	**15,2**	±	**2,6**	**103,3**	±	**39,0**	**15,7**	±	**5,2**
Animal protein (g)	**69,4**	±	**23,4**	**11,1**	±	**2,8**	**71,4**	±	**29,6**	**11,7**	±	**6,2**
Plant protein (g)	**25,5**	±	**7,4**	**4,1**	±	**0,8**	**27,4**	±	**15,4**	**4,1**	±	**1,5**
Total fat (g)	**103,3**	±	**26,2**	**37,5**	±	**4,6**	**113,9**	±	**25,5**	**39,0**	±	**5,5**
SFA (g)	**38,3**	±	**11,4**	**13,9**	±	**2,7**	**43,9**	±	**11,3**	**15,0**	±	**3,1**
MUFA (g)	**30,5**	±	**8,4**	**11,1**	±	**2,0**	**35,7**	±	**11,0***	**12,2**	±	**2,9**
PUFA (g)	**10,3**	±	**4,1**	**3,7**	±	**1,1**	**14,1**	±	**6,8***	**4,8**	±	**2,3***
P/S ratio	**0,28**	±	**0,08**	—		—	**0,33**	±	**0,13**	—		—
Dietary cholesterol (mg)	**568,0**	±	**189,6**	—		—	**563,5**	±	**155,7**	—		—
Total carbohydrate (g)	**253,3**	±	**58,4**	**41,2**	±	**7,4**	**259,4**	±	**111,0**	**38,9**	±	**11,0**
Mono- and disaccharides (g)	**127,4**	±	**39,5**	**20,9**	±	**6,5**	**127,9**	±	**55,8**	**19,4**	±	**7,7**
Polysaccharides (g)	**135,6**	±	**45,5**	**21,8**	±	**4,9**	**145,8**	±	**91,5**	**21,5**	±	**9,4**
Caffeine (mg)	**303,7**	±	**126,1**	—		—	**342,7**	±	**131,8**	—		—

† Mean values for 22 subjects in each group. Values not adding up to the totals are due to differences in tables used.
* Significance of difference = $P<0,05$.

group). Thirty-one hypercholesterolaemic and 31 normocholesterolaemic subjects were randomly selected and 22 subjects in each group of 31 completed the dietary survey and questionnaire. These 44 subjects, who represent the final total sample, took part in the intercorrelation study. The mean SCL, age, body mass and relative mass* for the normo- and hypercholesterolaemic groups are given in Table I.

Method

The food intake of subjects was recorded on 3 occasions during a 7-month period. On each of these occasions dietary data were collected for a period of 7 days. The detailed information on the methodology for the collection and analysis of the dietary data has been published elsewhere.[6] The total serum cholesterol concentration was determined according to the method described by Engelbrecht *et al.*[7] The SCL determinations before and after the dietary survey were used for calculations of mean values to test whether the subjects belonged to their respective groups. There was no need to regroup participants; consequently these mean values were used for correlation with the various dietary variables.

* relative mass = $\frac{\text{body mass}}{\text{desirable body mass}}$

Statistical Analysis

The statistical analysis was done to determine whether any differences in daily intake of dietary variables existed between the normo- and hypercholesterolaemic groups and to determine the relationship between the serum cholesterol concentration and the dietary data obtained.

The dietary variables were divided into two groups; the 'raw' untransformed and transformed variables, the latter being the dietary intake expressed as a percentage of the total kilojoules. Simple correlation coefficients (r) were computed to provide a measure of linear relationships

between the dietary variables and the SCL. A stepwise regression analysis was carried out to determine the most important dietary influences on the total serum cholesterol concentration.

RESULTS

Table I shows the various characteristics of the normo- and hypercholesterolaemic groups. The serum cholesterol concentration of the normocholesterolaemic group differed significantly from that of the hypercholesterolaemic group ($P<0,05$), but there were no significant differences between the 2 groups as far as the age, body mass and relative mass were concerned.

The mean values (±SD) for intake of dietary variables in the normo- and hypercholesterolaemic groups are given in Table II. There was no significant difference between the 2 groups as far as the intake of total fat, total protein, total carbohydrate and cholesterol were concerned.

The mean daily intake of mono-unsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) as well as the percentage of kilojoules derived from PUFA were, however, significantly higher ($P<0,05$) in the hypercholesterolaemic than in the normocholesterolaemic group.

The simple correlation coefficients between the serum cholesterol concentration and the dietary variables for the final total sample (Table III) were rather low and only the percentage of kilojoules derived from PUFA seemed to reach a statistically significant level ($r = 0,29$; $P<0,05$).

TABLE III. SIMPLE CORRELATION COEFFICIENTS (*r*) BETWEEN SERUM CHOLESTEROL LEVELS AND THE DIETARY VARIABLES FOR THE TOTAL SAMPLE (N = 44)

Variable	Correlation coefficient (*r*)	
	Daily intake	% of total kilojoules
Kilojoules (kJ)	−0,04	—
Ethanol (g)	−0,14	−0,09
Total protein (g)	−0,09	−0,09
Animal protein (g)	−0,19	−0,10
Plant protein (g)	0,06	0,08
Total fat (g)	0,06	0,13
SFA (g)	0,12	0,17
MUFA (g)	0,16	0,22
PUFA (g)	0,24	0,29*
P/S ratio	0,25	—
Dietary cholesterol (mg)	−0,22	—
Total carbohydrate (g)	0,02	0,04
Mono- and disaccharides (g)	0,10	0,09
Polysaccharides (g)	0,02	0,04
Caffeine (mg)	0,03	—

* *r* values $\geq 0,29$; $P<0,05$.

The results of the stepwise regression analysis are summarised in Table IV. Only the statistically significant variables ($P<0,05$) are given. R^2 indicates the total percentage of variance of the dependent variable (SCL) cumulatively explained by the preceding variables. The analysis shows PUFA (as a percentage of total kilojoules), total protein, and the percentage of total kilojoules derived from SFA to have the highest cumulative influence on SCL variance; and that only 29% of the variation in SCL could be explained by the first 6 variables in this survey.

TABLE IV. STEPWISE REGRESSION ANALYSIS FOR SERUM CHOLESTEROL LEVELS AND ALL DIETARY VARIABLES CONSIDERED IN THE SURVEY

Step No.	Variable	*r*	R^2	R^2 change
1	PUFA (% of total kilojoules)	0,29	0,09	0,09
2	Total protein (% of total kilojoules)	−0,09	0,18	0,10
3	SFA (% of total kilojoules)	0,17	0,23	0,05
4	Dietary cholesterol (mg)	−0,22	0,26	0,03
5	Ethanol (% of total kilojoules)	−0,09	0,28	0,01
6	Plant protein (g)	0,06	0,29	0,02
7	Ethanol (g)	−0,14	0,32	0,03
8	Mono- and disaccharides (g)	0,10	0,35	0,04
9	MUFA (% of total kilojoules)	0,22	0,37	0,01

r = simple correlation coefficient; R^2 = multiple correlation.

DISCUSSION

We were unable to establish meaningful differences between normo- and hypercholesterolaemic patients from a homogeneous population, even with meticulous attention given to the three 7-day food records and questionnaire.

Although the higher MUFA content in the diets of the hypercholesterolaemic group is in agreement with the results of other workers,[8] it is thought to have no significant effect on the serum cholesterol level.[9] On the assumption that a raised serum cholesterol concentration could be successfully lowered with diets high in PUFA, many people used margarine and unsaturated oils for the preparation of food, thus increasing the amount of PUFA in the western type of diet. Keys *et al.*[8] pointed out that the western high-fat diets obviously have a concomitantly higher PUFA content and that, for a true comparison between normo- and hypercholesterolaemic groups, the ratio between the intakes (in grams) of PUFA and SFA (P/S ratio) must be examined. The significantly higher PUFA intake in the hypercholesterolaemic group, without a simultaneously higher P/S ratio, does not seem to be biologically meaningful.

Fig. 1. shows the distribution of the total serum cholesterol concentration of the original sample of 175 volunteers to be a unimodal distribution and does not suggest a natural separation into two groups. By taking the subsamples of 22 normo- and 22 hypercholesterolaemic subjects together as one group, the resulting histogram of serum cholesterol concentrations is also unimodal (Fig. 1). When the 2 histograms are compared, however, it is seen that the proportion of hypercholesterolaemic subjects increased from 0,25 in the original sample to 0,5 in the final sample of 44 participants. Although this may be responsible

for a bias in the final total sample, the 44 subjects were considered as one group so as to have a larger sample for the correlation studies.

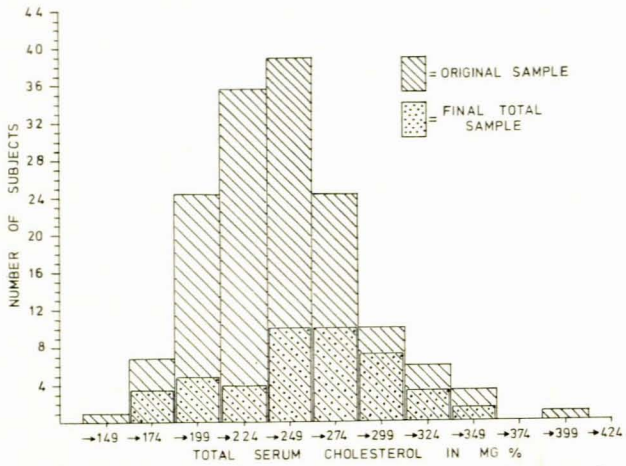

Fig. 1. A composite histogram showing the distribution of the total serum cholesterol concentration in the original and final total sample.

The statistically significant positive correlation coefficient (Table III) of the percentage of kilojoules derived from PUFA, corresponds to a value of 4,3% of the total kilojoules for the total sample.[6] According to Brown,[10] at least 14% of the total kilojoules in a diet should be supplied by PUFA, to result in a significant negative correlation with the SCL.

Because of the influence of intra- and interindividual variations in the serum cholesterol concentration and dietary data, as well as the small differences in the nutritional status among individuals from homogeneous sample populations, it is difficult to establish significant correlations between dietary data and biochemical measurements. Apart from these factors, the low correlations could also be ascribed to the fact that only linear relationships are tested by these methods.

We wish to acknowledge the co-operation of Dr T. J. v. W. Kotze of the Biostatistical Research Institute for the statistical analysis.

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