Serum Cholesterol, Anthropometric, Electrocardiographic and Dietary Data in Men Living Under Very Similar Conditions

Since the relations of serum cholesterol levels with dietary composition were not always convincing in recent epidemiological studies[1-8], a study was planned the other way round. 137 men with originally widely different habits of life, brought together under the same housing and dietary conditions, volunteered for this investigation. The group consisted of prisoners, aged from 18–52 years, candidate-participants to an indoor training programme. They considered themselves as healthy, and no untoward findings were reported at the routine medical examination. All lived for several weeks, months or even years on the fixed dietary regime of the State's prisons. This regime gives no restriction of calories, furthermore each man can buy limited amounts of a number of listed foodstuffs every week. Altogether the total fat, milkfat and animal protein content is fairly low. Work is usually light (sedentary), but the more active often obtain jobs suiting their readiness for activity.

Data were collected on age, height, weight, relative weight, length of the left upper arm and the circumference over its middle. Skinfolds were measured with Harpenden Skinfold Calipers – pressure 10 g/mm² of face – at the middle of the left upper arm over the triceps and on the back just below the left angulus scapulae. The chest circumference at maximal inspiration and expiration and its difference was determined. Individual dietary data were obtained by the cross check history method[6], and dietary composition was calculated with the help of the Dutch food tables[9]. From the total calories consumed and the calculated basal metabolic rate – according to the formula of HARRIS and BENEDICT[10] – the calories spent for the daily activities (the 'energy' calories) were found by subtracting, assuming that the caloric value of the body did not change. To obtain information on the incidence of cardiac ischaemia, 12 lead electrocardiograms were made while resting and after the Master one-step-test. The electrocardiograms were evaluated according to the criteria of BLACKBURN et al.[11]. Serum cholesterol values were determined according to the method of ANDERSON and KEYS[12].

The Table gives the average data and ranges for the subjects divided according to cholesterol levels lower than 200 mg% and 200 mg% and over. From the averages it can be seen that the low cholesterol group is a few years younger than the high cholesterol group, height is a few centimeters more – demonstrating the general tendency in this respect with age – but the absolute weight is less, which augments the differences in relative weight between the 2 groups. The length of the upper arm shows a difference in concordance with the difference in height.

Arm circumference and skinfolds are less in the low cholesterol group than in the other. Assuming that the skinfolds of the arm have the same thickness as those over the triceps all around the middle of the arm, a bone-plus-muscle circumference can be estimated of 25.9 cm for the low cholesterol group and 25.6 cm for the high cholesterol group. This small difference can be accounted for by the somewhat greater length of the arm and thus of the size of the whole bone in the former group, but maybe also by more muscle tissue, or perhaps both by more bone and muscle tissue in this group than in the high cholesterol group.

Differences in skinfold thickness on the back were even more distinct than those on the arm and showed the same tendency. Usually thick fat layers on the back were seen together with large waist sizes. Chest circumference measurements at maximal inspiration and expiration give the sum of lung-volume, bone and muscle tissue, and subcutaneous fat layers. The difference between these two measurements gives a fairly good measure of the lung capacity. Again, the lowest cholesterol group having the smaller chest circumference had the advantage, since these subjects had a better thorax expansion possibility and thus a larger available lung volume for each deep breath than the others had. According to what was found on training, the larger thorax expansion must be seen largely as a result of more physical activity.

From the dietary data it is seen that the low cholesterol group eats more, in absolute amounts as well as in calories/kg body weight, and also expends more calories for daily activities. Dietary composition varies so little between the groups that no influence on the serum cholesterol levels can be expected – if anything can be mentioned, it is that the low cholesterol group has a slightly higher fat content in its food than the high cholesterol group.

In the resting electrocardiograms of the low cholesterol group ST depressions were absent, while in 7% of the other group an ST depression was found. Post-exercise electrocardiograms did not show a substantial difference in incidence between the 2 groups although ST depressions of 1 mm or more were found only in the high cholesterol group. Flattening T waves on exertion were recorded in one out of the latter 4 cases. Other deviations from the normal were 11 conduction disturbances, mostly incomplete right bundle branch blocks, in 4 men in combination with an ST depression; 1 man showed ventricular premature beats on exertion and developed a complete right bundle branch block within a few weeks. 2 others had more than 30% left axis deviation. Distributions over the low and high cholesterol groups showed the same incidence.

It was found that the differences in the incidence of high and low values between the 2 groups were statistically significant for age, subcutaneous fat layer on the back, and energy calories, giving evidence that the low cholesterol group is younger, leaner, eats more and is

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Average data of the participants

	Serum cholesterol level in mg%				Chi - square of 3 and higher[a]
	< 200 mg%	(range)	200 mg% and higher	(range)	
Number of participants	36		101		
Serum cholesterol level in mg%	178.2	(141–199)	250.4	(200–361)	
Age in years	22.8	(18–37)	26.3	(18–52)	5.8
Height in cm	179.4	(166–194)	175.4	(160–197)	
Weight in kg	73.4	(60–92)	75.2	(56–113)	
Weight in kg/cm height	0.41	(0.34–0.50)	0.43	(0.34–0.59)	
Length of upper arm in cm	36.9	(28–42)	35.4	(27–44)	
Circumference of left upper arm over the middle in cm	28.5	(24–33)	29.4	(24–37)	
Skinfold over the triceps at the middle of the left upper arm in mm	8.2	(4–18)	8.9	(3–25)	
Skinfold just below the left angulus scapulae in mm	9.9	(7–20)	11.5	(6–35)	6.9
Sum of skinfolds in mm	18.1	(11–38)	20.5	(10–60)	
Chest circumference at max. inspiration in cm	95.8	(82–107)	96.8	(85–120)	
Chest circumference at max. expiration in cm	90.5	(78–101)	92.7	(80–113)	
Difference between chest circumference at max. inspiration and expiration in cm	5.3	(2–10)	4.1	(1–12)	
Total calorie consumption	3247	(2048–4966)	3002	(1654–6683)	
Calories/kg of weight	44.5	(25.5–69.6)	40.5	(24.2–72.1)	
Energy calories	1261	(124–2898)	1058	(–149–2984)	3.5
Energy calories/kg weight	17.4	(1.5–37.5)	14.4	(–1.7–45)	
Calories % fat	35.6	(22–53)	34.5	(16–70)	
Calories % milkfat	7.2	(1–15)	7.5	(2–27)	
Calories % proteins	10.6	(7–14)	11.2	(6–18)	
Calories % animal protein	4.4	(2–8)	5.2	(2–16)	
Calories % carbohydrates	50.9	(34–63)	51.8	(26–85)	
Calories % sugar (bought as such)	6.2	(2–17)	6.5	(1–19)	
ST depression in resting ECG	0		7		
ST depression on exertion (Master one-step-test) less than 1 mm	7		24		
ST depression on exertion of 1 mm or more	0		4		

[a] A chi-square of 3.84 means significant at the 5% level, a value of 6.64 means significant at 1% level.

more physically active than the high cholesterol group. All statistically non-significant differences (not reaching the 5% level) point to this same direction and stress, therefore, the conclusions given above.

The incidence of ST depressions in the 2 groups is not significantly different, although there were no ST depressions in the resting electrocardiograms of the low cholesterol group (chi-square 2.5). In larger groups the difference might have been more distinct: some additional information was obtained in an investigation[3] with 100 farmers aged 35–55 (average 44.6 years, energy calories 2200), 12 of whom had a serum cholesterol level below 200 mg%. Only 1 showed ST depression, but this was combined with a conduction disturbance and a heart murmur and was therefore not considered as a case of a primary coronary heart disease. Of the remaining 88 there were 23 with ST depressions, 16 of them on exertion only.

Weight and relative weight, although showing the expected tendency in the average values, are not such important measures. This is conceivable, since with a given weight and height there can be a considerable difference in the relative amounts of muscle and fat tissue. Since the water and calorie content of both tissues are widely different – 1 kg of muscle tissue contains approximately 250 g of protein and 750 g of water, whereas 1 kg of fat tissue contains 870 g of fat and 130 g of water – it is possible that on decreasing the physical activity the weight decreases, even if the calorie consumption is not reduced proportionally to the physical activity. An increase in the amount of subcutaneous fat must be substantial if it is to be found with measurements at a limited number of sites with skinfold calipers[13,14].

Zusammenfassung. Häftlinge verschiedener Herkunft und Lebensweise, unter gleichen Umständen längere Zeit im Gefängnis, wurden in zwei Gruppen geteilt: 36 Männer mit Serumcholesterolwerten niedriger als 200 mg%, und 101 Männer mit Werten von 200 mg% und mehr. Die Daten von Alter, Länge, Gewicht, Armumfang, Subkutanfett, Brustumfang, EKG, Qualität und Quantität der Ernährung und Energieverbrauch bewiesen, dass Männer mit niedrigen Cholesterolwerten signifikant aktiver, weniger fett und jünger waren als Männer mit höheren Cholesterolwerten.

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