flow resistance, could be reduced. Assistance could be given to muscles labouring to ventilate lungs reduced in compliance by consolidation and collapse. Improved ventilation may even help to overcome infection. This was common in the underventilated infant and much less frequent once adequate ventilation was ensured. When it did occur, survival appeared to be prolonged beyond what might have been expected from the gross post-mortem findings.

Summary

A series of infants with tetanus neonatorum were treated with relaxants and I.P.P.R., with disappointing results. In fatal cases the clinical, electrocardiographic, and pathological changes closely resembled those previously ascribed to overwhelming tetanus intoxication. No improvement followed investigations and treatment based on concepts of tetanus intoxication of the brain-stem or myocardium, nor from lowering the mean intrathoracic pressure to improve venous return to the heart. Only when ventilation was controlled by measuring the alveolar P_{CO_2} and the emphasis changed to respiratory efficiency did deaths from tetanus intoxication virtually cease. The conclusion is that tetanus intoxication is reversible provided that adequate ventilation is maintained.

Two factors were of importance in ensuring efficient ventilation of the totally relaxed infant while on I.P.P.R. They were the changes in pulmonary compliance and the maintenance of a clear airway.

Estimated under optimum conditions, the mean static compliance of totally relaxed infants of over 5 lb. (2.27 kg.) was 2.5 ml./cm. H_2O intratracheal pressure. In the same infant the pulmonary compliance was found to vary directly with the inspiratory pressure. This made the determination of the minimum effective inspiratory pressure quite critical. Compliance tended to fall with prolonged I.P.P.R. but not in all cases. It was unaffected by changes in the rate of ventilation and the posture of the infant.

The airway was kept clear by placing the tracheotomy tube in alignment with the lumen of the trachea, by aspirating bronchial secretions brought up into the trachea by hyperventilation and compression of the lungs, and, when this failed, by direct aspiration using an auriscope to visualize the main bronchi.

At present, total muscle relaxation and I.P.P.R. is the best method of treating tetanus neonatorum. With quite simple equipment the mortality in a consecutive series of 25 cases was 20%.

The wider application of I.P.P.R. to infants in respiratory distress and the relevance of the studies, in particular those on compliance, to the treatment of hyaline membrane disease are discussed.

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DIET AND PLASMA CHOLESTEROL IN 99 BANK MEN

BY

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To-day's main hypothesis on ischaemic heart disease relates the saturated-fat content of the diet through blood-cholesterol level to the production of the disease. Much information is available about *populations* in terms of these variables. In particular, it has been established that peoples at an early stage of social and economic development, and low consumption of saturated fat, have low mean cholesterol levels and suffer little ischaemic heart disease. In Western countries, where ischaemic heart disease is "epidemic," the mean intake of saturated fat and cholesterol levels are both high. There are, however, wide *individual* differences

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in fat-consumption in such countries, and almost nothing is known about the relationships in individuals leading their normal lives of fat intake to the cholesterol level, still less to ischaemic heart disease. Ninety-nine bank men were studied for evidence on the former of these questions—that is, on individual diet and the blood cholesterol.

Material and Methods

During the past few years male bank staff (clerks, cashiers, and managers) aged 40–55 were asked to weigh the food they ate at home during one or two weeks, and to describe in detail food eaten away from home which could not be weighed. The choice of population, methods used, and problems arising are described elsewhere (Marr *et al.*, 1959; Heady, 1961; Marr, 1961). Suffice it to say that there is no completely satisfactory way of estimating individual food consumption of free-living persons. The technique adopted is an accepted one for estimating intake (Garry, *et al.*, 1955; Thomson, 1958; Adelson, 1960). In our view it is preferable to alternatives such as taking a history, because it relies mainly on a form of measurement—namely weighing—as opposed to memory and description without weighing. On the other hand, it did not, and could not, give information about long-term dietary habits.

Food tables (Medical Research Council, 1945; Ministry of Agriculture, Fisheries and Food, 1956; Unilever, 1959; McCance and Widdowson, 1960) were used to derive calorie and "nutrient" values from the recorded weights of foods as eaten. This method introduces inaccuracies over and above those involved in recording the actual food consumed, and it is unfortunate that these inaccuracies may be particularly great for the fatty acids, at present a subject of particular interest. The most valid nutrient values are based on foods that are easily weighed and relatively homogeneous. Thus the derived figure for *dairy fat*, 95% of which was in milk, butter, and cheese eaten as such, is more accurate than values depending on variable or complex foods like meats, stews, or cakes. For this reason many findings are presented in terms of weights of the actual foods eaten.

Blood was taken late in the afternoon, after the banks had closed to the public, but conditions were not otherwise standardized. The blood-cholesterol results might best be considered "casual," as in most epidemiological studies. For several practical reasons the interval between the diet survey and the drawing of blood varied considerably (see Technical Note at end).

Results are given for 99 men from four banks. All the men of the age-group in the branches of three of the banks in several provincial towns were invited to co-operate, and 95% did so, 88% providing reliable weighed surveys. In addition, an appeal was made for 25 volunteers in a large London branch of the fourth bank to carry out the study within a specified time. Surveys were done at all times of the year excepting that periods of illness, and holidays, were avoided.

Seventy-six men carried out two separate weeks' weighed surveys, some at a month's interval, some at six months', and others at intervals of up to a year. Of these 76 men who did two diet surveys, 47 also had two or three cholesterol determinations.

Results

Table I gives figures of the dietary intake of the 99 men. The means for the various items are very similar in the four banks separately, in spite of the wide individual variation shown in the last two columns. This range between individuals is the basis of the present study.

TABLE I.—*Dietary Intake of 99 Bank Men Aged 40-55: Results from Week's Weighed Survey*

Diet	Mean	Standard Deviation	Individual Range
Daily Mean			
Calories	2,852	398	1,860–4,138
Total protein (g.)	82	12	42–117
Animal protein (g.)	54	11	27–88
Carbohydrate (g.)	323	63	157–503
Ratio : $\frac{\text{Protein calories} \times 100}{\text{Non-fat calories}}$	21	3·7	13–32
Total fat (g.)	130	22	84–189
Animal, including dairy, fat (g.)	96	21	55–173
Dairy fat (g.)	50	15	17–114
Marine and vegetable fat (g.)	35	14	10–90
Fatty acid ratio : $\frac{\text{Saturated}}{\text{Polyunsaturated}}$	6·9	1·3	4·0–11
Percentage of calories from fat	41	3·9	30–53
Weekly Mean (oz.)			
Meat*	25	8·7	5·3–55
Milk	88	37	15–276
Butter	7·7	3·7	0·3–25
Eggs	9·7	6·2	0–26
Bread	36	16	0–82
Sugar†	13	8·5	0–34

* "Meat" excludes poultry, game, and offal.
† Sugar added to drinks and foods after cooking.
Technical Note: Technical points throughout are dealt with in the Note at the end.

Table II shows the correlations between consumption in first and second surveys. Many of the values are high; clearly, there is considerable individual stability of food intake in men at this age and in this "industry." In a sense, the stability is understated in Table II, for the odd individual has a disproportionate effect on a correlation coefficient.

TABLE II.—*Repeat Surveys: Correlation (r) Between First and Second Surveys for 76 Men*

Dietary Intake	r	Dietary Intake	r
Calories	0·73	Marine and vegetable fat (g.)	0·68
Total protein (g.)	0·74	Percentage of calories from fat	0·71
Animal protein (g.)	0·78	Milk (oz.)	0·89
Carbohydrate (g.)	0·82	Butter (oz.)	0·62
Ratio: $\frac{\text{Protein calories} \times 100}{\text{Non-fat calories}}$	0·78	Eggs (oz.)	0·68
		Bread (oz.)	0·74
Total fat (g.)	0·66	Sugar (oz.)	0·91
Animal, including dairy, fat (g.)	0·64	Plasma cholesterol	0·59*
Dairy fat (g.)	0·65		

* Between first and second cholesterol estimations for the 47 men whose blood was taken on at least two occasions.
For normally distributed variables the 1 in 1,000 significance level for the correlation coefficient between 76 pairs of observations is 0·36.

Individual Diet and Plasma Cholesterol

Table III presents correlations between individual dietary intake and plasma-cholesterol level, important "nutrients" being presented first, then foods. There is no correlation of any size between diet values and blood for all 99 men in the study (column a), nor (column b) for the 47 individuals with the most substantial information—that is, those who did two diet surveys and also had at least two cholesterol measurements. Column c makes another approach, in an attempt to reduce the possible effects of the interval between diet survey and blood sample. The dietary results were correlated with cholesterol determinations on blood taken during the survey or within a day of its completion. This was possible in 61 *surveys* of 45 *men*; again correlations are small.

There is thus no evidence of any sizable association between what these men ate and their plasma-cholesterol

level. This applies very clearly to the six aspects of fat-consumption presented in the middle of Table III.

Some items in Table III show correlations which, though small, are consistently positive or negative. The observations in the several columns are by no means independent, but such consistency should not be overlooked. Correlations throughout are positive whenever animal protein is involved (milk is the only exception), and animal protein intake in fact shows low positive correlations with cholesterol level

TABLE III.—*Correlation (r) Between Dietary Intake and Plasma Cholesterol (mg./100 ml.)*

Diet	All Men (a)	"Doubles" (b)	Cholesterol Measurement "Close" to Diet (c)
Calories	−0·07	0·00	+0·10
Total protein (g.)	+0·03	+0·13	+0·10
Animal protein (g.)	+0·12	+0·23	+0·20
Carbohydrate (g.)	−0·16	−0·15	−0·17
Ratio : $\frac{\text{Protein calories} \times 100}{\text{Non-fat calories}}$	+0·15	+0·24	+0·24
Total fat (g.)	−0·04	+0·09	+0·15
Animal, including dairy, fat (g.)	−0·04	+0·01	+0·06
Dairy fat (g.)	−0·08	−0·03	+0·10
Marine and vegetable fat (g.)	0·00	+0·13	+0·13
Fatty acid ratio : $\frac{\text{Saturated}}{\text{Polyunsaturated}}$	−0·03	−0·12	—
Percentage of calories from fat	+0·04	+0·13	+0·10
Meat (oz.)	+0·01	+0·03	+0·06
Milk (oz.)	−0·03	−0·11	0·00
Butter (oz.)	−0·10	−0·07	+0·11
Eggs (oz.)	+0·03	+0·23	+0·05
Bread (oz.)	−0·23	−0·26	−0·35
Sugar (oz.)	−0·02	−0·05	−0·03
High carbohydrate foods (oz.)*	−0·19	−0·20	−0·25
Numbers	99	47	61

Column a includes data on all the men in the survey. Column b includes those men who did two diet surveys and had at least two cholesterol estimations. In columns a and b all the information about a man was pooled to provide a mean figure for him. These mean figures for individuals were used for the correlations.

Column c : In 61 surveys of 45 men blood was taken during the survey or within a day of its completion. Correlations in this column are between the results of these surveys and the cholesterol determinations on the associated blood samples. Summer and winter surveys were examined separately, but neither produced higher correlations.

For normally distributed variables the 1 in 20 significance level for the correlation coefficient between 47 pairs of observations is 0.29; between 61, 0.25; between 99, 0.20.

* High carbohydrate foods = Sugar, pastry, cakes, bread and baked and suet puddings.

in all four banks separately. Carbohydrate, on the other hand, and also bread and sugar separately, show consistently low negative correlations with the plasma cholesterol. This again is confirmed in more detailed study. Bread, in fact, provides the only statistically "significant" correlations in the whole of Table III. A similar observation about carbohydrate has been made by Adelson and Keys (1962).

Two other approaches were made. Forty-three men had no more than two unweighed meals a week, thus constituting a group in whom the element of "description" in their diet surveys was minimal. In this group, also, the correlations persisted quite small and irregular.

The possibility was investigated that dietary factors might be working in opposition, cancelling each other's effect. For example, it can be suggested that fat is associated with higher blood-cholesterol values, carbohydrate with lower (and we found some evidence of that). Thus, *total fat, animal fat, proportion of calories from fat,* and the *ratio of saturated to polyunsaturated fat* were each separately correlated with plasma cholesterol, and the effect of carbohydrate was "eliminated" by the method of partial correlation. The resulting changes were trivial, the new values being +0.13, −0.14, +0.01, and +0.07, respectively, compared with figures of +0.09, +0.01, +0.13, and −0.12 when these nutrients are correlated directly with cholesterol (Table III, column b).

The picture thus is one of *lack of association.* This is shown again in the Figures, which ring the changes on the many sums that were done.

Fig. 1 deals with the 47 men with *maximum* data (cf. column b of Table III), and shows no hint of a pattern for three principal aspects of fat consumption—animal fat, the fatty-acid ratio, and hardened fat. With such "snowstorms," calculation of the correlation coefficient is indeed superfluous. The correlation of +0.20 with dietary cholesterol is interesting but not statistically significant.

Fig. 2 illustrates the correlations in the *more "stable"* half of the 76 men who made two diet surveys, the idea being that any relationship between diet and blood cholesterol should show most clearly in the men whose

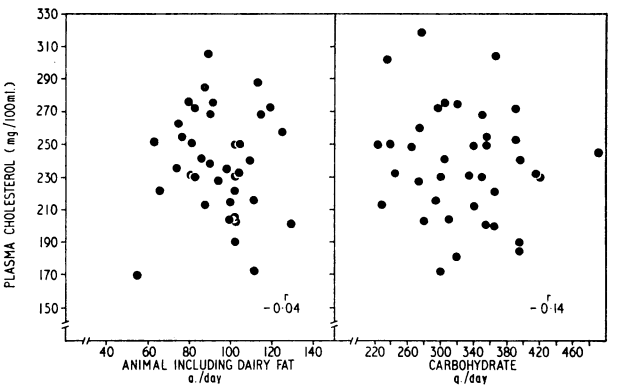

FIG. 2.—Dietary intake and plasma cholesterol of 38 bank men—the more stable half of the men doing two surveys. Mean of two weeks' weighed surveys.

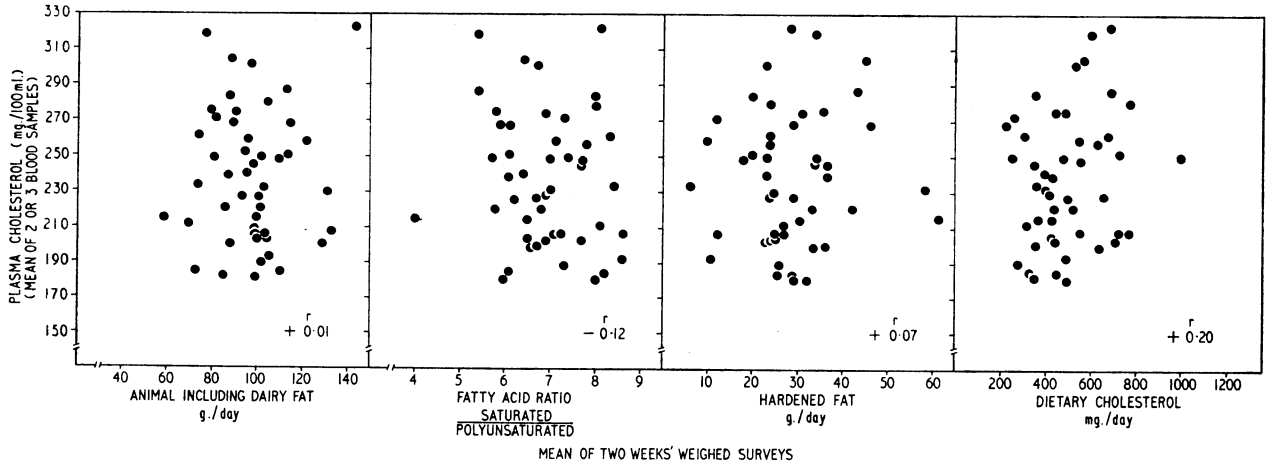

FIG. 1.—Dietary intake and plasma cholesterol of 47 bank men aged 40–55. ("Hardened fat" is estimated from margarine, compound cooking-fat, and fats used in biscuits, pastry, and cakes.)

diet was "stable." For each dietary constituent, the 38 men who showed least variation between their two surveys in that particular constituent were chosen. In animal fat, for instance, the difference between the values for the two surveys in the 38 men who were "stable" was in no instance greater than 9% of the smaller value; in carbohydrate the figure was 7%. The scatter remains widespread and the correlations low in spite of this selection; the two examples chosen for illustration are typical of many such analyses we made.

Fig. 3 shows men at the *extremes* of dietary consumption. For instance, 25 men were identified as being in a "low" consumption group for fish (less than 3 oz. per

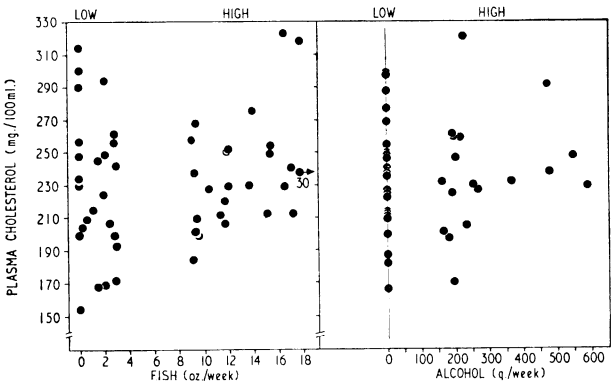

FIG. 3.—Range of plasma cholesterol at extremes of dietary consumption Alcohol = estimated grammes of alcohol in beer, wines, and spirits.

week), and 25 in a "high" group (more than 9 oz.). The 49 men with intermediate consumption are not represented in the Figure. The "low" end includes some men who ate none. With alcohol, the other illustration, the "low" figures are entirely of men who abstained. The range of cholesterol values is similar at both ends of the scale of consumption: there is no sign of a significant (in any sense) association between "dietary" intake and plasma cholesterol.

Fig. 4, in turn, uses the same mode of presentation for the men with the *highest* and *lowest* cholesterol levels; the results again show no relationship. Thus the intake

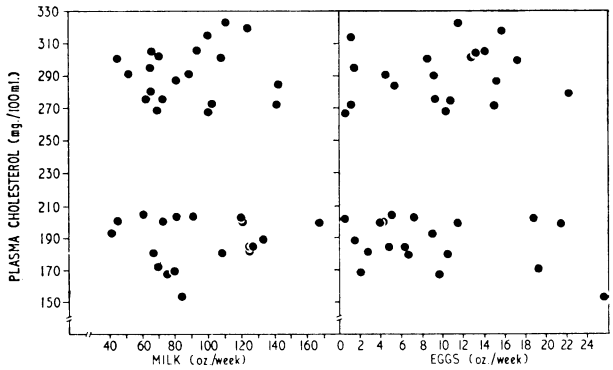

FIG. 4.—Range of dietary consumption at extremes of plasma cholesterol.

of eggs shows the same range in the men with the lowest cholesterol levels as in the men with the highest. It will be noticed that the "low" cholesterol values—that is, the low sets of points on the diagram—are mostly around 200 mg./100 ml., and there are very few readings below 180 mg./100 ml.

Finally, Tables IV and V present more formal data of the kind used in Figs. 3 and 4. Results are as by now expected: there is no hint of a trend. The range of cholesterol values among these men is 154–324 mg./100 ml., and, as Table IV shows, it is very much the same in each of the four "quarters" of the distributions of these main categories of fat intake.

TABLE IV.—*"Quarters" of Dietary Distributions and Mean Plasma-cholesterol Levels*

Dietary Factor	Quarter of Distribution (Intake)	Range of Values	No. of Men	Plasma Cholesterol mg./100 ml.	
				Mean	Range
Animal including dairy fat (g./day)	Lowest ..	55–80	24	242	169–321
	Second ..	81–95	25	241	168–315
	Third ..	96–105	25	229	181–302
	Highest ..	106–173	25	238	154–324
	All ..	55–173g.	99	237	154–324
Percentage of calories from fat	Lowest ..	30–39	25	247	169–315
	Second ..	39–41	25	231	168–291
	Third ..	41–43	25	233	181–321
	Highest ..	43–53	24	239	154–324
	All ..	30–53%	99	237	154–324
Fatty acid ratio: Saturated/polyunsaturated	Lowest ..	4·0–5·9	24	241	181–321
	Second ..	5·9–6·7	25	228	168–304
	Third ..	6·7–7·8	25	242	189–302
	Highest ..	7·8–11	25	239	154–324
	All ..	4·0–11	99	237	154–324

TABLE V.—*"Quarters" of Plasma-cholesterol Distribution and Mean Dietary Intake*

Plasma Cholesterol			Dietary Factor	
Quarter of Distribution	Range of Values mg./100 ml.	No. of Men	Mean Intake	Range
			Animal, including Dairy Fat (g./day)	
Lowest	154–209	24	100	55–173
Second	210–233	25	92	59–131
Third	234–257	25	94	58–125
Highest	258–324	25	97	66–144
All	154–324	99	96	55–173
			Percentage of Calories from Fat	
Lowest	154–209	24	41	30–48
Second	210–233	25	41	33–47
Third	234–257	25	41	35–51
Highest	258–324	25	41	33–53
All	154–324	99	41	30–53
			Fatty Acid Ratio: Saturated/polyunsaturated	
Lowest	154–209	24	7·1	5·4–10
Second	210–233	25	6·5	4·0–9·9
Third	234–257	25	7·0	5·2–10
Highest	258–324	25	7·0	4·4–11
All	154–324	99	6·9	4·0–11

In addition to the correlations here presented, we put a digital computer to work calculating many hundreds more for different groupings of men, and for different foods and nutrients and various combinations of these. No significant associations were found. We hope to report later on the relationships of diet with other plasma-lipid fractions; and to introduce other factors then, such as body weight and individual eating habits and meal patterns.

Discussion

Discussion centres round two questions. Are the inaccuracies in the method of dietary assessment large enough to account for the lack of correlation found with the plasma-cholesterol level? If they are not—what are the implications of these findings for current theorizing about the causes and prevention of ischaemic heart disease?

We believe that the weighed method of dietary assessment used in this study is the best available for a free-living population, but it is conceivable that a more rigorous method or combination of methods could

yield a qualitatively different result. There are, however, a number of positive reasons for believing that defects in the method are not responsible for the low correlations. First, the method is based on a measurement. Second, the results often show considerable stability in individuals from one survey to the next. Before we began the present investigation, much questioning had suggested that by the time they reach their 40's such men's food habits are settled; this stability was a main reason for selecting bank men for study. Third, there could be no systematic bias, since the men did not know their cholesterol levels. Fourth, the results are plausible: they agree with national estimates of food consumption, show no notable inconsistencies under intensive analysis, and are much alike in the different banks (including other branches not reported). The men were good subjects, co-operative, intelligent, and responsible; and accustomed to weighing, measuring, and accurate recording. It is, of course, possible that behaviour may have changed because of the survey, though we tried our best to impress on the men the need to behave "ordinarily." We have been unable to think of a practical way of testing whether they did.

There is, nevertheless, bound to be variability in an individual's recorded food intake due both to "biological"—including seasonal, day-to-day, and even hour-to-hour—variability in the individual, and "observer" variability in the measurement. The same applies to the cholesterol level. The effect of such variability will be to reduce any underlying correlation between diet and cholesterol, and conceivably this could be sufficient to submerge a sizable value. An estimate of the importance of this effect can, however, be made, and, in fact, it indicates clearly that it does not matter in the present context. The argument is given in the Technical Note at the end.

The scatter diagrams showing blood-cholesterol levels at the extremes of food consumption, Fig. 3 and Table IV, should be of particular interest, since, whatever the limitations of the method, differences between extremes are unlikely not to be real. But even here there is no suggestion of any relationship, the range of cholesterol values being quite similar at each extreme. Making the most of the data in other ways—for example, by analysis of the men very stable in their diets, or in whom weighing of food intake was maximal, or where blood was taken close to the diet—did not increase the correlation. Because the correlation coefficient is almost as often negative as positive, moreover, what is being discussed mostly is the absence of association, not merely association that is unexpectedly small.

Aetiology of Ischaemic Heart Disease

The present observations need not conflict with current notions about the relationship of fat in the diet to the production of ischaemic heart disease.

It has been shown (cf. Keys *et al.*, 1958; Stamler, 1960; Morris, 1960–1) that when population groups with very different diets are studied there is a direct relationship between mean levels of fat-consumption and mean levels of blood cholesterol. Thus the percentage of calories derived from fat ranges in such studies from less than 10 to over 40, and the mean cholesterol correspondingly from 125 mg./100 ml. in an Indian population to around 240 mg./100 ml. in the U.S.A. By these international standards, all the men in this study could be regarded as high in fat-consumption; and nearly all the men are high also in blood cholesterol, if the upper level of healthy men is provisionally postulated to be in the region of 180 mg./100 ml. (Experience of comparative national surveys and of American prospective studies suggests that ischaemic heart disease may become common above such a level.) No hint emerges of any closer relationship between fats that were eaten and the blood cholesterol than this general effect on the whole population. Whether these men ate relatively little fat or a great deal, for example, the distribution of cholesterol values in each group is the same, ranging widely from well under 200 to well above 300 mg./100 ml., but, as seen, nearly all over 180 mg./100 ml.; and so on through other constituents of the diet.

A dietary "threshold" of fat intake, above which no simple effect on cholesterol level is exerted, is thus one notion which may help to explain the low correlations that we found: all the men, it may be postulated, were above the threshold. Moreover, different individuals react differently to the same diet, and non-dietary factors also affect the blood-cholesterol level. Conceivably, lifelong diet of a community may shift upwards the entire distribution of its cholesterol values, leaving plenty of room for other factors to produce wide individual variation in cholesterol values within the community.

Whatever the reason, if the present observations are correct, and the diet eaten does not account for the wide range in individual cholesterol values that was found, the great variation in these remains to be explained. Present information on individual physiology, and on the role of meal habits, exercise, occupation, obesity, emotion, and smoking, does not add up to an explanation of the range of cholesterol levels commonly observed in Western populations.

This is not an academic question. The Framingham (Dawber *et al.*, 1962) and other surveys (Doyle *et al.*, 1957; Keys, personal communication, 1962) show that, within the range found in the present study, variations in the casual blood cholesterol may be crucial in predicting the chances of developing ischaemic heart disease: the risk appears to be directly proportional to the cholesterol value. It matters, in other words, not only whether the cholesterol level is over 180 mg./100 ml.—which may be determined by diet—but whether it is 200 or 250 or 300+ mg./100 ml. The aetiology of "high blood cholesterol" remains an urgent problem (Morris, 1961–2) on which both genetic and environmental data at present are grossly deficient.

It is of course true (Gröen *et al.*, 1952; Kinsell *et al.*, 1952; Keys *et al.*, 1957; Pilkington *et al.*, 1960) that *change* in individual diet will *change* the cholesterol level. No evidence is presented here on this aspect; though, in fact, the usual changes introduced in dietary experiments provide much more polyunsaturated fat than was eaten by this group of men on an ordinary British diet, and they reach far below the lowest ratio of 4:1 in saturated to polyunsaturated fatty acids that was found among them.

Summary

Ninety-nine British bank men aged 40–55, whose individual diets were studied by the week's weighed method, showed a wide range in food intake and in casual plasma cholesterol. Total fat-consumption varied from 84 to 189 g. a day, that of animal fat from 55 to 173 g. a day. The cholesterol level varied from 154 to

324 mg./100 ml. All thus had a high consumption of (saturated) fat, and in nearly all the plasma cholesterol also was high if the upper level in health is postulated to be in the region of 180 mg./100 ml. No closer association is evident between what these men ate and their individual cholesterol levels: diet thus does not seem to account for the wide range in cholesterol values that was found. This range may be crucial to the chances of developing ischaemic heart disease, and other causes of it should be sought.

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Technical Note

1. *Means, Ranges, and Standard Deviations.*—Tables I, IV, and V refer to 99 men. In three of the banks studied the 80 men who had completed one survey were asked to do another. They all did so, but because of illness, etc., produced only 76 reliable second surveys. The data therefore refer to 175 (99 + 76) separate weeks' weighed surveys. Whether a man did one survey or two, the whole information was pooled to give his mean (daily or weekly) intake for the period, and the means, ranges, and standard deviations shown in these tables are calculated from these individual, "person"-means. The same applies to the plasma-cholesterol values. Where a man had blood taken on two or more occasions the cholesterol values were averaged, and the means and ranges are calculated from the individual averages. Similarly, in the Figures the points plotted refer to mean values for individual men.

2. *Unweighed Meals.*—Four per cent. of midday meals were eaten in canteens where typical helpings had been weighed. A further 12% of meals—that is, breakfast, midday, dinner, supper—were eaten in restaurants, cafés, etc., and weights of foods were estimated from the detailed descriptions provided by the men.

3. *Cholesterol Estimations.*—Cholesterol was estimated by the method of Bloor (1916), modified according to Dodds and Mills (1959), for the men in three banks; and by the method of Abell *et al.* (1952) for those in the fourth. Moreover, serum and not plasma was used in the latter. Separate correlations on the fourth bank and on the other three banks, however, made no significant difference to the results. Technical laboratory "error," $\sqrt{\Sigma\frac{d^2}{2n}}$, determined on split samples of the same blood was less than 6 mg./100 ml. in each of the two laboratories.

4. *Interval between Diet Survey and Drawing of Blood.*—In the first bank studied there were two diet surveys at intervals of four months to one year, blood being taken once at 5 to 12 months after the second survey; in Table III these men appear only in column a. In the second bank there were two diet surveys three weeks apart, blood also being taken twice—once in the period between the two diet surveys, and once two to three months after the second survey; these men appear in columns a and b and a few of them in column c. In the third bank there was one diet survey, and the blood was taken once, where possible during or within a day of completion of the survey. These men appear in columns a and c. In the fourth bank there were two diet surveys, six months apart; blood being taken, where possible, the day after each survey. In 13 of these men a third sample of blood was examined a week after the second. (The correlation between the second and third cholesterol determinations on these 13 men was 0.92.) The men in this bank appear in all three columns.

5. *Effect of Individual Variability on Correlations Between Diet and Plasma Cholesterol.*—In our data the variability of repeated measurements on the same individual is much less than the variability found between different individuals. For cholesterol, for instance, the variance *within* individual bank men is about one-third of the variance *between* the bank men. The effect of this degree of "within individual" variability will be to reduce any correlation with cholesterol by about 12% ($1.12 \simeq \sqrt{1.33}$). A "true" correlation of +0.5, for example, might be so reduced to +0.44. For most of the dietary factors the "within individual" variance is much less than one-third of the "between individual" variance (though in one or two instances it was nearly half). If a figure of one-third is taken also for the dietary factors, the combined effect of individual variability in both food intake and plasma cholesterol might therefore reduce the value of their correlation by as much as one-third ($1.33 = \sqrt{1.33 \times 1.33}$. In other words, the correlation in Table III of +0.04 between plasma cholesterol and percentage calories from fat may reflect a true value of at most +0.06, and the correlation of −0.04 with animal-fat intake would perhaps be −0.06. The lack of association shown in Table III between fat intake and plasma cholesterol cannot thus be explained, more than trivially, by day-to-day or week-to-week variations in the values obtained, whether these are due to real biological variation or to errors of measurement. Especially is this true of the correlations between means of *two* diet surveys and of *two* or more blood determinations.

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