Dietary intake and plasma lipid levels: lessons from a study of the diet of health conscious groups

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Abstract

Aim—To re-examine the contentious relation between diet and plasma lipids within a population.

Design—Cross sectional sample from a large prospective cohort study of people eating different diets in Britain. Blood samples and diet records collected from subjects.

Subjects—Volunteers eating one of four distinct diets—namely, vegans, vegetarians, fish eaters who do not eat meat, and meat eaters. 52 Subjects selected from each group.

Methods—Examination of the relation between nutritional intake recorded in a four day dietary record and plasma lipid concentrations of subjects measured in blood samples collected previously.

Results—After controlling for age, sex, and body mass index, the correlation between plasma total cholesterol and the Keys score (which includes dietary cholesterol and saturated and polyunsaturated fat) was 0·37 ($p<0·001$). The mean saturated fat intake in all groups was low (6-14% of energy), but polyunsaturated fat intake was high, so mean total fat intake was generally above that recommended. A high dietary fibre intake was not associated with high carbohydrate intake. Plasma high density lipoprotein values were not associated with any measure of fat intake, but there was a significant correlation of 0·24 between high density lipoprotein values and alcohol intake.

Conclusions—The nature rather than quantity of dietary fat is an important determinant of cholesterol concentrations. Health conscious individuals select a fat modified, rather than a low fat—high carbohydrate diet. National cholesterol lowering dietary advice should be reconsidered.

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Br Med J 1990;**300**:1297-301

Introduction

The relation between plasma cholesterol concentrations and dietary intake within one population remains a matter of contention. We used data from the Oxford Vegetarian Study to examine plasma lipid concentrations and dietary intakes in vegans, vegetarians, fish eaters who do not eat meat, and meat eaters living in Britain. Analysis of the dietary intake of these four groups, most of whom were health-conscious individuals, also allowed us to determine the extent to which the diet of such people accords with current dietary recommendations.

Methods

RECRUITMENT

The Oxford Vegetarian Study is a prospective cohort study of 6000 subjects who do not eat meat and 5000 meat eating controls.[1] The non-meat eating subjects were recruited through the Vegetarian Society, through publicity in national and local media, and by recommendation of those already recruited; they do not belong to any particular religious or ethnic group. The control group consists of their friends and relatives who are meat eaters. All subjects were recruited between 1980 and 1984. At the time of recruitment each subject completed a simple questionnaire which asked about aspects of health, diet, and other lifestyle factors.

BLOOD SAMPLES

Between 1984 and 1986 all participants under the age of 60 were sent a kit consisting of a 10 ml heparinised tube, a syringe, and an explanatory letter for their general practitioner, who was asked to take a blood sample and send it to the laboratory in the special package provided. The collection and analysis of these samples for plasma lipid and lipoprotein concentrations, and the lipid values in the four diet groups, have been reported.[1]

FOUR DAY DIET RECORDS

In 1985-6 all participants were sent a dietary record which they were asked to complete during two weekdays and two weekend days. These diet records were A4 size booklets designed to be self explanatory. At the front were questions about height and weight and aspects of usual diet. These questions were designed to test whether the diet recorded reflected the usual diet and to provide information to help coding of the records—for example, the amount of sugar and milk usually taken with tea and the types of fat used in cooking. There were also careful instructions about recording estimated portion sizes including photographs of small, medium, and large portions of many commonly consumed foods not readily estimated in household measures. The weights of the portions photographed were recorded. Comparison of this four day estimated portion size diet record with a seven day weighed intake record has been described.[2]

SELECTION OF SUBJECTS FOR CURRENT STUDY

Blood samples were received from 114 vegans, 1550 lacto-ovovegetarians, 415 fish eaters who did not eat meat, and 1198 meat eaters. Subjects were assigned to these diet groups on the basis of their replies to questions about their usual diet at initial recruitment to the study.

Completed four day diet records were received from 244 vegans, 2856 vegetarians, 335 fish eaters, and 2116 meat eaters. Subjects were reassigned to these diet groups on the basis of their replies to similar questions to those described above at the front of the diet records. Of the 208 subjects in the present study, 200 were assigned to the same group on both occasions. Eight subjects who had said they ate milk and eggs but not meat or fish when recruited to the study said that they ate fish when completing the diet record and were reassigned to the fish eating group.

This study was restricted to those respondents for whom both a blood sample and a completed dietary record were available. There were 26 vegan men in this category, and they formed the smallest of the groups. We therefore included all the available vegan men and selected 26 vegan women randomly from the 55 for whom there was both a blood sample and a diet record. We then randomly selected age and sex matched comparison groups of 52 vegetarians, fish eaters, and meat eaters (age matched within three years) from among those who fitted all the criteria.

DIETARY ANALYSIS

The diaries were coded by a nutritionist using food codes from McCance and Widdowson's food composition tables supplemented by other published food composition tables[4-6] and, for some brands of food, nutrient analyses supplied by the manufacturers. For foods which contained added fat, such as pastries, cakes, and fried food, an additional code was used to indicate the nature of the added fat—for example, whether a cake was made with polyunsaturated margarine or butter. This permitted more accurate calculation of the ratio of polyunsaturated to saturated fatty acids.

A nutrient analysis computer program, the Nibbles package, was used to calculate total energy, protein, fat, carbohydrate, cholesterol, minerals, and vitamins, together with the quantities of saturated, polyunsaturated, and monounsaturated fatty acids and the polyunsaturated to saturated fatty acid ratio. The intakes for the two weekdays were multiplied by 2·5 to give an appropriate weekly weighting (five weekdays to two weekend days), and the total intake was then divided by seven to provide an estimate of average daily intake.

ESTIMATION OF COMPLETENESS OF DIETARY RECORDS

One possible measure of the completeness of a diet record is a comparison of the total energy intake recorded by a subject with the subject's predicted basal metabolic rate. This was calculated using the formula provided by Schofield.[7] Healthy women have been shown to expend in energy a minimum of 1·2 basal metabolic rate,[8] and we therefore considered that any subject reporting an average energy intake of less than 1·2 basal metabolic rate had not achieved a satisfactory level of recording.

STATISTICAL ANALYSIS

The data were analysed using the SPSSX package[9,10] on a Vax mainframe. The Keys dietary score was calculated by the expression:

$$1{\cdot}26(2S-P)+1{\cdot}5\sqrt{(C)}$$

where S=percentage of energy from saturated fat, P=percentage of energy from polyunsaturated fat, and C=dietary cholesterol in mg/1000 kcals.[11] Significance testing of the mean values of variables in the four groups was done by one way analysis of variance, while testing the significance of the difference between any pair of means was done by the Scheffe multiple comparison procedure for significance at the 0·05 level. The Scheffe procedure adjusts for the effect of examining a number of different pairs of means and produces a conservative estimate of statistical significance. Simple Pearson correlation coefficients with a two tailed test of significance, together with partial correlation coefficients adjusting for the effect of additional variables, were calculated to test for relations between two continuous variables.

The four diet groups were matched for gender and age, both of which are strongly related to plasma lipid values. The matching would therefore have masked some of the relation between dietary factors and plasma lipid values. To examine the extent of this effect coefficients of correlation which allowed for the effect of matching were calculated using the formula:

$$r=\frac{\sum_{i=1}^{52}\left\{\sum_{i=1}^{4}x\sum_{i=1}^{4}y-\frac{\left(\sum_{i=1}^{4}xy\right)}{4}\right\}}{\sqrt{\sum_{i=1}^{52}\left\{\left(\sum_{i=1}^{4}x\right)^{2}-\frac{\left(\sum_{i=1}^{4}x^{2}\right)}{4}\right\}\sum_{i=1}^{52}\left\{\left(\sum_{i=1}^{4}y\right)^{2}-\frac{\left(\sum_{i=1}^{4}y^{2}\right)}{4}\right\}}}$$

where i=1 to 4 represents the diet groups, and j=1 to 52 represents the sets of four matched subjects.

Results

Table I shows the mean age and body mass index in the four diet groups by gender. The groups were age matched and there was no significant difference in mean body mass index. Table II shows the mean daily intake of total energy; the percentage of total energy (including that derived from alcohol) provided by protein, carbohydrate, total fat, and saturated fat; the mean polyunsaturated to saturated fatty acid ratio; and the mean daily intakes of dietary fibre and cholesterol in the four diet groups.

The mean total, low density lipoprotein, and high density lipoprotein cholesterol values of the 208 subjects are shown in table III. The mean values showed the same trends as were apparent in the whole cohort,[1] although few of the differences in this smaller group achieved statistical significance. We previously reported a small but significant increase in the concentration of high density lipoprotein cholesterol in fish eaters over that in the other three groups.[1] The same relation was apparent in these data but did not achieve statistical significance. After controlling for the effects of sex and alcohol intake the adjusted mean level of high density lipoprotein in the fish eaters was 1·75 mmol/l compared with 1·62, 1·63, and 1·64 mmol/l in the vegans, vegetarians, and meat eaters respectively. This difference was still not significant.

Table IV shows the simple Pearson coefficients of correlation between the same variables together with partial correlations adjusting, firstly, for the effect of age, sex, and body mass index and then for the same three variables plus the Keys dietary score. The relation between total plasma cholesterol and dietary fibre was no longer apparent when a partial correlation coefficient was calculated controlling for the Keys dietary score. Table V shows the correlation coefficients adjusting for the effects of matching (calculated by the formula described in the methods section) for the relation between plasma total and high density lipoprotein cholesterol values and dietary variables. For all the relations that were statistically significant in table IV the coefficients of correlation were greater when this adjustment was made. There was no relation between high density lipoprotein cholesterol values and any measure of dietary fat intake but there was a significant relationship between high density lipopro-

TABLE I—*Mean (SD) and range of age, mean (SD) body mass index, and proportions overweight and obese in four age matched diet groups by gender*

Diet group	No	Age (years) Mean (SD)	Age (years) Range	Mean (SD) body mass index (kg/m²)	No (%) overweight (25<BMI<30)	No (%) obese (BMI>30)
			Men			
Vegan	26	40·7 (0·5)	25-70	22·3 (0·1)	4 (15)	0
Vegetarian	26	40·7 (0·5)	24-70	23·1 (0·1)	2 (8)	1 (4)
Fish eater	26	40·6 (0·4)	28-69	23·4 (0·1)	5 (19)	0
Meat eater	26	40·6 (0·4)	26-67	23·1 (0·1)	3 (12)	0
			Women			
Vegan	26	44·0 (0·4)	27-67	21·7 (0·1)	1 (4)	1 (4)
Vegetarian	26	44·7 (0·4)	27-67	21·8 (0·1)	1 (4)	0
Fish eater	26	43·9 (0·4)	27-65	20·6 (0·1)	1 (4)	0
Meat eater	26	43·9 (0·4)	27-66	22·7 (0·1)	4 (15)	1 (4)

TABLE II—*Mean (SD) daily intakes of nutrients by four diet groups by gender*

Diet group	Total energy (MJ)	Protein as % energy	Carbohydrate as % energy	Fat as % energy	Saturated fat as % energy	Polyunsaturated: saturated ratio	Cholesterol (mg)	Dietary fibre (g)
				Men				
Vegan (Vg)	10·8 (0·1)	11·3 (0·1)	52·5 (0·3)	33·5 (0·3)	6·2 (0·4)	1·85 (0·03)	7 (0·6)	55·3 (0·8)
Vegetarian (Vt)	11·0 (0·1)	12·2 (0·1)	47·7 (0·2)	36·4 (0·2)	12·1 (0·6)	0·73 (0·02)	267 (6)	41·8 (0·4)
Fish eater (F)	10·5 (0·1)	13·6 (0·1)	43·8 (0·3)	38·2 (0·2)	12·5 (0·7)	0·73 (0·02)	260 (4)	37·4 (0·5)
Meat eater (M)	10·7 (0·1)	14·6 (0·1)	43·0 (0·2)	38·1 (0·3)	13·2 (0·6)	0·56 (0·01)	306 (5)	35·0 (0·5)
				Women				
Vegan (Vg)	8·0 (0·1)	12·2 (0·1)	51·4 (0·3)	36·2 (0·3)	7·4 (0·5)	1·77 (0·03)	4 (0·2)	42·7 (0·5)
Vegetarian (Vt)	8·2 (0·1)	12·4 (0·1)	46·4 (0·2)	39·6 (0·2)	14·3 (0·6)	0·63 (0·01)	201 (3)	31·3 (0·4)
Fish eater (F)	8·9 (0·1)	12·1 (0·1)	42·9 (0·3)	40·5 (0·2)	13·3 (0·8)	0·75 (0·01)	250 (6)	29·4 (0·4)
Meat eater (M)	8·2 (0·1)	15·5 (0·1)	43·2 (0·2)	38·7 (0·2)	14·2 (0·8)	0·49 (0·01)	266 (4)	26·8 (0·3)
				Analysis of variance				
Men:								
Significance (p)	NS	<0·001	<0·001	0·045	<0·001	<0·001	<0·001	<0·001
Scheffe multiple comparison (significant differences)		Vg<F, M Vt<M	Vg>F, M	None	Vg<Vt, F, M	Vg>Vt, F, M	Vg<Vt, F, M	Vg>Vt, F, M
Women:								
Significance (p)	NS	<0·001	<0·001	0·045	<0·001	<0·001	<0·001	<0·001
Scheffe multiple comparison (significant differences)		Vg, Vt, F, <M	Vg>F, M	None	Vg<Vt, F, M	Vg>Vt, F, M	Vg<Vt, F, M	Vg>Vt, F, M

TABLE III—*Mean (SE) of plasma lipid values in four diet groups by gender*

Diet group	Total cholesterol (mmol/l)	Low density lipoprotein cholesterol (mmol/l)	High density lipoprotein cholesterol (mmol/l)
		Men	
Vegan (Vg)	5·00 (0·15)	2·89 (0·11)	1·56 (0·05)
Vegetarian (Vt)	5·30 (0·15)	3·14 (0·15)	1·57 (0·05)
Fish eater (F)	5·59 (0·20)	3·36 (0·19)	1·64 (0·09)
Meat eater (M)	5·90 (0·18)	3·52 (0·21)	1·56 (0·07)
		Women	
Vegan (Vg)	4·84 (0·16)	2·72 (0·13)	1·62 (0·06)
Vegetarian (Vt)	5·38 (0·16)	3·19 (0·15)	1·68 (0·06)
Fish eater (F)	5·71 (0·19)	3·56 (0·21)	1·85 (0·13)
Meat eater (M)	5·95 (0·20)	3·79 (0·18)	1·73 (0·08)
		Analysis of variance	
Among men (p)	0·003	0·047	NS
Significant difference	Vg<M	None	None
Among women (p)	<0·001	p<0·001	NS
Significant difference	Vg<F, M	Vg<F, M	None

tein values and alcohol as a percentage of energy intake.

According to the criteria for estimating the completeness of a dietary record described in the methods section 79% of the records were adquately completed. When those records that were not adequate (21 men and 18 women, of whom 11 were vegan, 5 vegetarian, 11 fish eaters, and 12 meat eaters) were excluded from the analysis there were no changes in the levels of significance of relations that had been observed. Among those records considered adequate, however, the mean body mass index was lower in all diet and sex groups. Overall, the mean body mass index in women who returned adequate records was 21·3 kg/m^2, and in women who did not return such records it was 24·0 kg/m^2, which was a significant difference ($p<0·001$). In men returning adequate records the mean body mass index was 22·6 kg/m^2, and in men who did not it was 24·2 kg/m^2, but this difference was not significant. In addition, the mean total energy intake recorded in the adequate records was higher: 10·3 MJ compared with 6·8 MJ in the inadequate records ($p<0·001$). A recalculation of the partial correlation between total plasma cholesterol concentration and the Keys dietary score after excluding the inadequate dietary records and controlling for the effect of age, sex, and body mass index yielded a slightly increased coefficient of correlation of 0·42 ($p<0·001$).

Discussion

These data provide important evidence of an association between plasma lipid values and nutrient intake within one population. Moreover, they show the extent to which the dietary intake of health conscious individuals with a wide range of dietary practices accords with current official dietary guidelines.

The 52 vegans in this study represent one of the largest such groups for whom dietary information is available, and, moreover, directly comparable information is available for groups eating other diets. All three of the dietary groups who abstained from meat had made a conscious decision to do so. The participants in this study were volunteers, who may be more conscious of their diet than others who adhere to the same dietary rules, but there is no reason to believe that their diets will differ substantially from those of other vegans, vegetarians, and fish eaters. The diets of the meat eating group, however, are certainly different from the average British diet, particularly in relation to the relatively low intake of saturated fat and the relatively high intake of dietary fibre. The method of recruiting the meat eating control group from among

TABLE V—*Coefficients of correlation for four matched groups (adjusting for the effect of matching) between plasma lipid concentrations and dietary variables*

	Total cholesterol	High density lipoprotein cholesterol
With fat as % of energy	0·17**	0·06
With polyunsaturated: saturated ratio	−0·39***	−0·03
With dietary cholesterol	0·37***	0·10
With Keys dietary score	0·42***	0·01
With dietary fibre	−0·30**	−0·05
With alcohol as % energy	0·04	0·28**

***p<0·001, **p<0·01.

TABLE IV—*Simple coefficients of correlation and partial coefficients controlling for possible confounders between cholesterol measurements and dietary variables*

	Simple correlations		Partial correlations controlling for age, sex, and body mass index		Partial correlations controlling for age, sex, body mass index, and Keys score	
	Total cholesterol	High density lipoprotein cholesterol	Total cholesterol	High density lipoprotein cholesterol	Total cholesterol	High density lipoprotein cholesterol
Fat as % of energy	0·13*	0·08	0·15*	0·04	−0·004	0·02
Polyunsaturated:saturated	−0·30***	−0·06	−0·35***	−0·08	−0·06	−0·07
Dietary cholesterol	0·33***	0·11	0·32***	0·13*	0·06	0·14*
Keys dietary score	0·35***	0·04	0·37***	0·05		
Dietary fibre	−0·26***	−0·11*	0·26***	−0·10	−0·09	−0·09
Alcohol as % energy	0·07	0·24***	0·12*	0·26***	0·10	0·26***

***p<0·001, **p<0·01, *p<0·05.

the friends and relatives of the vegetarians was specifically designed to provide a control group who were similar in age and social class and were conscious of their health and nutrition, while still eating meat, in order to provide mortality data that would be comparable with that of the non-meat eating groups.

Social class has a strong influence on eating habits.[12] The entire study cohort had a greatly skewed social class distribution, with 82% of those in paid employment at recruitment being in non-manual occupations. This was reflected in the group chosen for dietary analysis, where the percentage was 85%. The equivalent percentage for the population of England and Wales is around 35%. Also, the whole cohort was slimmer than would be expected from population figures: 13% were overweight or obese (defined as a body mass index greater than 25 kg/m^2), compared with 32-39% overweight or obese in a recent British survey.[13] Similarly, in the group chosen for dietary analysis only 15% of men and 11% of women were overweight or obese.

The method of assessment of dietary intake used in this study has been shown to be satisfactory when evaluated in comparison with a seven day weighed record.[2] It is also encouraging that when the inadequately completed records were excluded from the analysis none of the levels of significance of relationships were changed.

The extent to which dietary variables can explain within population variation in plasma concentrations of lipids and lipoproteins is much debated. Manipulation of the quantity and nature of dietary fat and cholesterol can predictably influence levels of total and low density lipoprotein cholesterol in individuals. Intake of saturated fatty acids and the ratio of polyunsaturated to saturated fatty acids account for much of the variation in median levels of cholesterol between countries. Furthermore, we and others have shown that vegetarians, vegans, and those eating fish but not meat in Britain have lower cholesterol values than meat eaters. Most within population studies have not, however, been able to relate dietary characteristics of individuals to their plasma lipid values.[11 14] This finding has been used as evidence that diet does not play a major role in determining lipid values within a population. Most studies which have generated such negative findings have used relatively insensitive methods for assessing dietary intake and have used populations with a narrower range of intakes. One recent study of a small group of 46 vegetarians did find a strong association between blood cholesterol concentrations and the Keys score ($r=0{\cdot}51$) as well as other measures of fat intake.[10] In our larger study we found similar, but slightly lower, correlations apart from that with total fat.

The Keys dietary score, which takes into account dietary intakes of cholesterol, saturated fat, and polyunsaturated fat, proved to be the most powerful predictor of plasma total cholesterol concentration, accounting for 13% of the variance in total cholesterol over the whole study population. In women the Keys score accounted for 19% of the variance and in men 8%. Exclusion of apparently incomplete records increased both these figures, to 21% and 9% respectively. It is impossible to determine from this study whether this difference represents a true difference in the relation between diet and plasma lipid concentrations in men and women. The method used for determining whether a diet record had been adequately completed was fairly crude, and even after apparently incomplete records had been excluded, there may still have been some inadequately completed records. There were 27 records from men but just 18 from women which were defined as incomplete, and there may have been more inadequately completed records among the men than the women. Nevertheless, whatever the cause of the different level of relation between diet and plasma lipid values in men and women, many of the studies of the relation between diet and plasma lipid values have concentrated on men and this may have contributed to the failure to find a correlation between the two variables.

The negative relation between dietary fibre and plasma total cholesterol concentration was no longer apparent after controlling for the Keys dietary score, suggesting that the initial observation could be explained by the relation between dietary fibre and the intake of saturated and unsaturated fats. Failure to show an association between total fat intake and plasma lipid values in this study is consistent with the cross cultural comparisons carried out in the seven countries study.[15]

All four diet groups in this study consumed similar amounts of bread, breakfast cereals, cakes, puddings, and biscuits as that reported in the National Food Survey,[12] but cakes, puddings, and biscuits were often either homemade or health food products made with wholewheat flour and polyunsaturated fats. Participants ate more fruit and vegetables, other than potatoes, and substantially more grains, pasta, and nuts. Consumption of nuts among vegans was over 10 times the national average. Non-vegans ate more cheese and yoghurt. The study population consumed less milk (cow, goat, or soya), spreading and cooking fats, sugars and jams, potatoes, and eggs (in non-vegans) than the usual British population. Fish eaters ate the same small amount of fish as the general population, while meat eaters ate about half as much meat and fish. The types of food chosen within each food group differed in the study population. Over 75% of the bread eaten was wholemeal, compared with 21% in the National Food Survey. More than half the study population used semi-skimmed or skimmed milk and a spread high in polyunsaturates. Those who did not use a polyunsaturated spread used butter; very little ordinary soft or hard margarine was used. These comparisons of mean intakes should, however, be interpreted with caution since the National Food Survey is based solely on food bought for consumption at home and the social class distribution differs considerably from that of our study population.

The average percentage of energy derived from total fat was lower in all the groups than in the British population, where the average in 1986 was 43% excluding energy from alcohol.[12] The percentage of energy from fat shown in table II is calculated including alcohol, but none of the groups in this study had a high alcohol intake. In the group with the highest intake (male meat eaters) a recalculation excluding alcohol increased the percentage energy from fat from 38·1% to 39%.

The government report of the Committee on Medical Aspects of Food Policy on Diet and Cardiovascular Disease (the COMA report) recommended a total fat intake of not more than 35% of energy intake, excluding energy from alcohol and assuming a polyunsaturated to saturated fatty acid ratio of 0·45.[16] All the diet groups had an average polyunsaturated: saturated ratio which was above the recommended ratio of 0·45. In vegetarians and fish eaters the average polyunsaturated to saturated fatty acid ratio was similar to that observed in Mediterranean countries of around 0·8,[15] while among vegans the ratio was more than twice as high as this. Only 52% of vegans, 29% of vegetarians, 25% of fish eaters, and 39% of meat eaters were eating as low a percentage of total fat as that recommended in the COMA report. Nevertheless, extrapolating from the method of calculating maximum total fat intake in the COMA report, a polyunsaturated to saturated fatty acid ratio of 0·7, as eaten by the

vegetarian and fish eating groups in this study, would suggest an upper limit of total fat intake of 40% of total energy. The COMA report recommended an absolute limit of 15% of energy derived from saturated fat. All the vegans, 71% of the vegetarians, 67% of the fish eaters, and 71% of the meat eaters were below this limit.

In this study, there was no significant relation between total fat intake and plasma total cholesterol concentrations, but there was a relation between the polyunsaturated to saturated fatty acid ratio and plasma total cholesterol values. A reduction in high density lipoprotein cholesterol in association with a high polyunsaturated to saturated fatty acid ratio has been given as a reason for not recommending an increase in dietary polyunsaturated fatty acids. However, the very much higher polyunsaturated to saturated fatty acid ratio in the vegans was not associated with a lower plasma high density lipoprotein cholesterol.

British dietary recommendations include advice to increase dietary fibre intake above the typical intake of around 18-20 g/day. All the diet groups in this study had a considerably higher mean fibre intake of around 30 g/day or more. The vegans had a particularly high mean intake of fibre: 55 g/day in men and 43 g/day in women. The vegans were consuming the highest average intake of carbohydrate (52% of total energy). In the other three groups the mean intake of carbohydrate was around 43-48% of total energy, which is similar to the British population. Increases in carbohydrate consumption are usually recommended either to replace the energy from saturated fat or to increase the intake of fibre. The non-vegan participants in this study appeared to be consuming a diet low in saturated fat and high in fibre without any great increase in energy from carbohydrate, by eating wholemeal bread and substituting whole grains and wholemeal pasta for potatoes.

The findings of this study show that health conscious free living people can select a diet which fulfils most of the current recommendations whether or not they choose to abstain from meat. It is particularly interesting that the reduction in saturated fat intake was chiefly compensated for by an increase in unsaturated fat rather than by an increase in carbohydrate. A reduction of total fat intake in order to reduce plasma cholesterol values and hence reduce the risk of coronary heart disease might not be necessary. It appears that individuals can choose a diet where total fat and total carbohydrate are similar to that of the general population but where a greater percentage of that fat is polyunsaturated and there is a higher intake of fibre. This diet may prove more acceptable than a low fat, high carbohydrate diet and will increase compliance with dietary advice.

In this study a clear relation has been shown between dietary fat intake and plasma cholesterol concentrations. This emphasises, once again, the importance of dietary change in the British population for reducing the current rates of cardiovascular disease, which are among the highest in the world. The diet described here appears to be more palatable than that proposed by the COMA report, in that fat intake is not so restricted yet it is associated with desirable plasma lipid concentrations. The subjects in this study have not replaced energy derived from fat with energy derived from carbohydrate but have altered the nature of both the fat and carbohydrate foods consumed.

We thank Dr Alison Black and Dr Tim Key for their advice. This study has been supported financially by the Cancer Research Campaign, the Imperial Cancer Research Fund, and the Dr Hadwen Trust for Humane Research. The Nibbles nutrient analysis program is copyright of Dr D Yeates.

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(Accepted 8 March 1990)

ONE HUNDRED YEARS AGO

The fact that the prevailing epidemic of influenza prevails in towns serves to remind us of the insanitary influences of town life. There are sanitary influences as well; there is shelter from cold winds and tempests often disastrous to the ill-nourished in the country, and food is nearer at hand to the multitude. The prevalence of germs, bad odours, and other self-evident sources of grave disease in cities is well known. It is rather the less constantly recognised unhealthy habits of townsfolk that are mostly at fault when the fairly-fed and well-to-do are smitten with colds and with influenza. Diet is abundant, but taken irregularly. The townsman, as a rule, is not a good breakfast eater, and he dines too late and too heavily. He is much addicted to taking alcohol, tea, or coffee between meals. He is a late riser and goes to bed late, so that a large fraction of his "day" is spent at night in artificial light. He seldom takes enough exercise, for the "constitutional" is intolerable to men of a certain temperament, and others have no time for that form of physical exertion. A hurried race to catch a train or omnibus is not hygienic. He is gregarious, and his natural flocking instinct makes him overlook, both in his pleasures as well as his duties, the fact that he works or plays with his fellow man in ill-ventilated or overcrowded rooms. Above all, he is out of training, as he finds out during the first days of a holiday. Many explorers and fighting men have noted that they catch cold readily in towns after bearing cold and damp with impunity in the country. The cockney tourist, on the other hand, is often astonished to discover how he can bear a wetting or a draught at the seaside or in the fields. All the surroundings of the townsman predispose him to attacks of disease like the present epidemic. He can at least rise early and take exercise, and will soon find that such habits will be to his advantage. (*British Medical Journal* 1890;i:195)