Relation between diet composition and coronary heart disease risk factors

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Abstract

Study objective—The aim was to evaluate dietary intakes and their correlation to some risk factors for coronary heart disease.

Design—The study was a population based survey with random sample selection stratified by age and sex.

Participants—352 adults living in a small town in Northern Italy took part in the study. Response rate was 46% among females and 48% among males. Refusal to take part was mainly due to the large number of tests involved.

Measurements and main results—Diets were high in protein (animal/vegetable ratio 1.7 in women and 1.4 in men) and in fat and low in carbohydrates. The hypercholesterolaemic and atherogenic potential of the diet, evaluated by the cholesterol/saturated fat index, was high in about 50% of the population. The thiamin and riboflavin intakes were lower than the Italian recommended allowances in more than 60% of the people tested, whereas the vitamin A intake was more than adequate in about 70%. A positive association was found in the younger groups (men and women 20-39 years old) between some nutrient components (energy, alcohol, total and saturated fats) and some blood lipids. In the older people blood lipids were correlated with body mass index.

Conclusions—The overall data indicate that a correlation exists between dietary intake and some risk factors for coronary heart disease; dietary intervention, at least in young adults, is suggested.

Methods

SUBJECTS

The study on the correlation between diet and cardiovascular disease risk factors was conducted on 352 adults (166 men and 186 women) living in Northern Italy (Casteggio, PV).

The sampling frame consisted of the anagraphic records of the whole population of Casteggio aged 20-69 years in 1987 (n=2021 males and 2032 females). They were listed by sex and age decade (20-29; 30-39; 40-49; 50-59; 60-69 years) and the sample was randomised within each age decade in both sexes (stratified sample by age and sex).

The response rate was 46% among females and 48% among males. This response rate should be considered good taking into consideration that the survey involved a large number of tests and was conducted on healthy adult people. The distribution of the final population is given in table I.

PROCEDURE

Each subject was interviewed by expert dietitians using a food frequency questionnaire to estimate food habits and nutrient intake. This method has been extensively used in studies of the relationship between diet and disease.^{4,5} We preferred the interview to the self administered questionnaire, in order to limit the risk of total omission of some foods, even if it is impossible to avoid the inability of people to remember the correct frequency of servings. (This fact can cause an underestimation of nutrient intakes.)

During the interview, people were asked about their weekly consumption of food and beverages, special attention being given to the type of fat used in the preparation of meals and the specific nature of meat, cheese, and vegetables in order to gain precise information about nutrient intakes. Additional questions were asked about the frequency and type of any vitamin supplement or dietetic product used. The amount of the usual serving was determined by means of a book of food reference pictures. These pictures represent at least three or four different portion sizes for each food. The size of each portion was chosen taking into consideration the "average" intake for men and women, as reported in other studies and/or in common menus. Nutrient intake was calculated using food composition data obtained by chemical analysis in our laboratory⁶; when this was not possible data from the Italian food composition tables were used.⁷

The food frequency questionnaire was validated in a previous study estimating protein intake from urine nitrogen with the Mitch formula, and phosphorus intake from urine phosphate.⁸ The results of the evaluation of food

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Previous publications have shown that food habits and dietary intake are foremost among the factors that influence the risk of coronary heart disease. However the specific dietary components responsible for that risk are still poorly understood.

The association between blood lipids and coronary heart disease has been known for some time,¹⁻³ so it is possible that the diet could influence the disease through its effect on blood lipids. For this reason it could be important for the prevention of this disease to study the dietary habits and lipid profile of specific groups of the population.

Our aim was to study the distribution of some of the risk factors for coronary heart disease and to correlate these factors with diet composition. The study was carried out on a random sample of adults living in Northern Italy.

Table I Age and sex distribution of the population tested. Data are numbers of participants

	Age classes (years)					
	20-29	30-39	40-49	50-59	60-69	Total
Men	16	35	48	46	21	166
Women	17	36	51	61	21	186
Total	33	71	99	107	42	352

intake using the questionnaire and a three day weighing method have not yet been published; the correlation coefficient is 0.68 for energy ($p < 0.001$), 0.79 for carbohydrates ($p < 0.001$), 0.51 for fat ($p < 0.005$), 0.53 for fibre ($p < 0.005$), 0.84 for alcohol ($p < 0.001$), 0.57 for retinol ($p < 0.001$).

Height (to the nearest cm) and weight (to the nearest kg) were determined in indoor clothing without shoes, according to standard protocol. Body mass index was then calculated (weight/height², kg/m²).

Systolic and diastolic arterial blood pressures were measured twice by trained observers using a mercury sphygmomanometer (ERKA 300) in a sitting position after a rest of at least five minutes; the mean of the two readings was used for analysis.

Blood specimens were taken from all the participants for lipid and apolipoprotein determination: total serum cholesterol by the CHOD-PAP method; high density lipoprotein and triglycerides using standard laboratory methods; apolipoprotein A-1 and B by a single radial immunodiffusion method.

The hypercholesterolaemic and atherogenic potential of diets consumed by the population tested was evaluated using the cholesterol/saturated fat index (CSI): $(1.01 \times \text{g saturated fat}) + (0.05 \times \text{mg cholesterol})$.⁹

STATISTICAL ANALYSIS

Mean value, standard deviation, and percentile distribution were calculated according to sex and

age for all the variables tested and for nutrient intake. Correlations among body mass index, total cholesterol, high density lipoprotein cholesterol, triglycerides, apolipoproteins A-1 and B, systolic and diastolic blood pressure, and dietary intakes were evaluated by simple regression analysis for sex (M and F) and two age groups (20-39 and 40-59 years).

Results

Mean, standard deviation, and percentile distribution of dietary intake for men and women are shown in table II.

PROTEIN AND ENERGY

Compared to the Italian recommended daily allowance, our population's diet contained average energy but excess protein. The protein intake was higher than the recommended levels in about 80% of the people, the mean animal/vegetable protein ratio being 1.7 in women and 1.4 in men.

LIPIDS

In relation to the 50th percentile, fat consumption was about 36% of the total energy intake in women and 30% in men; the polyunsaturated/saturated fatty acid ratio increased with age from 0.34 in women and men aged 20-29 years to 0.39 in women and 0.44 in men aged 60-69 years. At the 50th percentile the women's cholesterol intake was 267 mg/day, the highest intake being in the 30-39 year decade (328 mg); in men, the cholesterol intake was higher than 300 mg/day for all the age groups considered.

The saturated fatty acid and cholesterol content of each diet was used to calculate CSI as an index of the hypercholesterolaemic and atherogenic potential of the diet. At the 50th percentile the

Table II Mean, standard deviation, and percentile distribution of dietary intake.

Variables	Women (n=186)						Men (n=166)					
	Mean (SD)	Percentile distribution					Mean (SD)	Percentile distribution				
		10°	20°	50°	80°	90°		10°	20°	50°	80°	90°
Energy (mJ)	8.47 (2.43)	5.39	6.47	8.24	10.41	11.42	11.62 (3.13)	7.74	8.99	11.50	13.91	15.80
Protein (g)	72 (19)	48	57	70	91	96	90 (23)	62	70	89	110	119
Animal protein (g)	45 (14)	29	34	44	55	63	52 (15)	35	40	51	65	70
Vegetable protein (g)	27 (9)	16	20	26	34	38	38 (12)	23	27	37	49	54
Fat (g)	82 (27)	51	58	80	100	116	92 (28)	61	67	91	112	126
Saturated fat (g)	27 (10)	15	19	25	34	39	31 (11)	18	22	31	37	43
Polyunsaturated fat (g)	11 (5)	5	7	10	14	18	12 (6)	6	7	11	16	20
Carbohydrates (g)	247 (80)	152	183	240	316	345	339 (110)	203	236	329	425	479
Alcohol (ethanol)* (g)	20 (12)	6	11	16	32	32	53 (41)	7	18	48	80	106
Fibre (total) (g)	24 (8)	15	18	23	30	34	28 (9)	17	20	27	35	40
Cholesterol (mg)	297 (107)	155	193	267	361	397	337 (122)	191	233	317	433	489
CSI†	41 (14)	24	29	39	51	59	48 (19)	29	33	47	58	69
CSI/mJ	4.8 (1.0)	3.6	4.1	4.8	5.5	6.0	4.1 (1.0)	2.9	3.3	4.1	5.0	5.5
Thiamin (mg)	0.8 (0.2)	0.5	0.6	0.7	0.9	1.0	0.9 (0.2)	0.6	0.7	0.8	1.1	1.2
Riboflavin (mg)	1.2 (0.5)	0.7	0.9	1.2	1.6	1.7	1.4 (0.5)	0.9	1	1.3	1.7	1.8
Retinol equivalents (µg)	1340 (1606)	389	554	840	1770	2725	1466 (1374)	445	594	924	2294	3088

*Non-drinkers (50% of women; 14.5% of men) are excluded from the distribution.

†CSI = $(1.01 \times \text{g saturated fat}) + (0.05 \times \text{mg cholesterol})$.

Table III Mean, standard deviation, and percentile distribution of blood variables.

Variables	Women (n=186)						Men (n=166)					
	Mean (SD)	Percentile distribution					Mean (SD)	Percentile distribution				
		10°	20°	50°	80°	90°		10°	20°	50°	80°	90°
Apo A-1 (mg/dl)	138 (18)	115	123	136	155	159	129 (14)	112	118	128	142	148
Apo B (mg/dl)	106 (20)	79	88	103	122	133	113 (22)	88	98	112	128	146
Cholesterol (mg/dl)	226 (41)	180	191	222	261	281	224 (42)	174	188	220	258	279
HDL cholesterol (mg/dl)	51 (10)	40	42	50	60	66	46 (10)	35	38	46	54	59
Triglycerides (mg/dl)	96 (68)	47	52	80	111	163	119 (89)	49	62	96	156	208
Systolic BP (mm Hg)	133 (22)	88	113	129	154	163	132 (17)	112	117	130	144	157
Diastolic BP (mm Hg)	82 (12)	68	70	81	92	98	84 (9)	72	78	84	90	97
BMI (kg/m ²)	26 (5)	20	22	24	29	32	26 (3)	22	23	26	29	30

Apo = apolipoprotein; HDL = high density lipoprotein; BP = blood pressure; BMI = body mass index

CSI per mJ was about 4.8 in all the women's age groups and between 4.8 (20–29 years) and 3.8 (60–69 years) in the men.

CARBOHYDRATES

Carbohydrates represented only about 45% of the energy consumption.

ALCOHOL

The percentile distribution of alcohol intake reported in table II refers only to drinkers (93 women and 143 men). It was found that 50% of the women did not drink, while 10% consumed more than 30 g. In the men the consumption of alcohol greatly increased with age and was more than 50 g in about 40%. It is interesting to note that in the first group (20–29 years) 50% of the men tested did not drink or drank little alcohol (less than 10 g/day); in the 60–69 year group this was true for only 20% of men.

VITAMINS

In women the mean values of thiamin and riboflavin intake were respectively 11% and 8% lower than recommended but the percentile distribution indicates that only 20% and 40% of the women consumed, respectively, thiamin and riboflavin in amounts comparable to or higher than the recommended values. The situation for the men was worse as only 10% had thiamin and riboflavin intakes higher than those recommended, thus indicating that their vitamin nutritional status could be more inadequate than that of the women. For vitamin A the situation is different, the intake being more than adequate in about 70% of the population. With regard to these data it is important to note that vitamin intake via food has been calculated using food composition data obtained by chemical analyses carried out in our laboratory on cooked foods⁶; thus cooking and storage losses are accounted for.

FIBRE

Some epidemiological studies carried out on different populations have shown that the dietary intake of fibre is inversely related to coronary heart disease.^{10–11} Morris *et al*¹² found that a high fibre intake protects against coronary artery disease, independently of other nutrients and other risk factors. The median fibre intake of the population we tested, 23 g/day in women and 27 g/day in men, was lower than the value of 30 g/day recommended by the National Advisory Committee on Nutrition Education proposals for nutritional guidelines for health education in Britain for the prevention of intestinal diseases,¹³ but is higher than the intake commonly found in western populations, corresponding to about 20 g/day.

BLOOD MEASUREMENTS

Mean, standard deviation, and percentile distribution of some blood variables are given in table III.

The percentile distribution of blood cholesterol levels was similar in women and men while high density lipoprotein cholesterol was only slightly higher in women. The 50th percentile value for male total cholesterol was about 200 mg/dl up to 40 years of age, it then increased to 230 mg/dl to 50 years, falling to 220 mg/dl in the oldest age groups. In women there was a continuous increase from 182 mg/dl in the first decade considered (20–29 years) to 253 mg/dl in the 60–69 decade.

Triglycerides show a similar trend although they were lower than in other Italian groups of the same age. In men the highest values were present between ages 40 and 49 years (50th percentile value = 99 mg/dl) while in women values increased with age (from 52 to 91 mg/dl).

The 50th percentile value for the apolipoprotein A1 level in men was 152 mg/dl; apolipoprotein B was 125 mg/dl and increased

Table IV Regression coefficients between blood variables and dietary intake of women.

	Total cholesterol		HDL cholesterol		Triglycerides		Apo A-1		Apo B		Systolic pressure		Diastolic pressure	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Energy	0.224	-0.076	0.060	-0.028	0.196	-0.113	0.124	-0.097	0.207	-0.038	-0.001	-0.181*	-0.124	-0.156
Total fat	0.306*	0.025	0.050	-0.073	0.203	-0.028	0.159	-0.125	0.317*	0.075	0.056	-0.128	-0.100	-0.076
Saturated fat	0.394†	0.059	0.148	-0.032	0.213	-0.028	0.231	-0.128	0.361†	0.087	0.095	-0.059	-0.020	-0.005
Polyunsaturated fat	0.184	0.002	0.029	-0.134	0.233	0.122	0.236	-0.214	0.238	0.116	0.218	-0.059	-0.033	-0.013
Animal fat	0.312*	0.060	0.162	0.026	0.175	-0.093	0.127	-0.063	0.329*	0.057	0.119	-0.054	0.050	-0.017
Vegetable fat	0.187	-0.036	-0.045	-0.138	0.145	0.034	0.121*	-0.154	0.188	0.071	-0.008	-0.174	-0.164	-0.120
Cholesterol	0.361†	-0.011	0.072	-0.228*	0.222	-0.038	0.138	-0.271†	0.354†	0.056	-0.009	0.107	-0.091	0.146
Fibre	0.065	-0.126	0.067	-0.063	-0.016	-0.109	-0.064	-0.123	0.073	-0.066	0.184	-0.231†	0.031	-0.189*
Alcohol	-0.290	0.073	0.009	0.195*	0.019	-0.110	0.021	0.204*	-0.285*	0.012	-0.151	0.133	-0.156	0.054
BMI	0.108	0.142	-0.273	-0.377†	0.226	0.200*	-0.193	-0.249†	0.168	0.351†	0.306*	0.505†	0.385†	0.582†

A = age range 20–39 years; B = age range 40–59 years

HDL = high density lipoprotein; Apo = apolipoprotein; BMI = body mass index

* $p < 0.05$; † $p < 0.001$

Table V Regression coefficients between blood variables and dietary intake of men.

	Total cholesterol		HDL cholesterol		Triglycerides		Apo A-1		Apo B		Systolic pressure		Diastolic pressure	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Energy	0.227	-0.038	-0.202	0.124	0.261	0.023	-0.127	0.211*	0.309*	-0.082	-0.014	-0.133	-0.097	-0.073
Total fat	0.139	-0.061	-0.406†	-0.023	0.208	0.034	-0.428†	0.011	0.275*	-0.079	-0.075	-0.206*	-0.101	-0.119
Saturated fat	0.121	-0.058	-0.376†	0.047	0.142	-0.061	-0.378†	0.102	0.196	-0.112	0.079	-0.223*	-0.095	-0.109
Polyunsaturated fat	0.317*	-0.081	-0.176	0.044	0.179	0.112	-0.053	0.025	0.415†	-0.092	-0.136	-0.130	-0.034	-0.030
Animal fat	0.193	-0.103	-0.365†	0.046	0.140	-0.079	-0.373†	0.076	0.240	-0.148	0.001	-0.270†	0.009	-0.149
Vegetable fat	0.046	-0.009	0.322*	-0.074	0.209	0.120	-0.352*	-0.047	0.226	0.000	-0.125	-0.094	-0.175	-0.060
Cholesterol	0.155	-0.169	-0.301*	0.103	0.269	-0.107	-0.309*	0.067	0.215	-0.182	-0.086	-0.219*	-0.165	-0.206*
Fibre	-0.057	-0.094	-0.254	0.005	0.174	-0.014	-0.275*	0.100	0.062	-0.060	-0.035	0.091	-0.066	0.058
Alcohol	0.298*	0.108	0.355†	0.152	-0.067	0.103	0.503†	0.210*	0.197	0.069	0.079	-0.125	0.048	-0.061
BMI	0.334*	0.091	-0.221	-0.282†	0.296*	0.225*	-0.185	-0.289†	0.331*	0.232*	0.399†	0.268†	0.481†	0.330†

A = age range 20–39 years; B = age range 40–59 years

HDL = high density lipoprotein; Apo = apolipoprotein; BMI = body mass index

* $p < 0.05$; † $p < 0.001$

slightly with age. Apolipoprotein A1 in women was higher than in men (162 mg/dl), while apolipoprotein B was 114 mg/dl; both increased with age.

BLOOD PRESSURE

The systolic and diastolic pressures had similar values in men and women and increased with age (table III), especially in women, where the 50th percentile values were 109 and 72 mm Hg in the 20–29 year decade and 156 and 91 in the 60–69 year decade.

BODY MASS INDEX

Data on body mass index are given in table III. The percentage of all women with an index higher than 24 kg/m² was 50%, increasing from 10% in the first decade (20–29 years) to 60% in the last two decades (50–59 and 60–69 years). Men presented a similar picture, but the groups with the highest percentage of overweight people were the 40–49 and 50–59 year decades, 60% of the values being higher than 25 kg/m².

CORRELATIONS WITH DIETARY INTAKE

Regression coefficients calculated between blood variables and dietary intakes are reported in tables IV and V. Some interesting correlations were found in men aged 20–39 years. In this group the total energy consumption and the fat intake were positively related ($p < 0.05$) to apolipoprotein B levels. The alcohol intake in this group of men was positively correlated with both total blood cholesterol ($p < 0.05$) and high density lipoprotein cholesterol ($p < 0.01$). In women of the same age, total and saturated fat intake were positively correlated ($p < 0.05$ and 0.01 respectively) with total blood cholesterol and apolipoprotein B. These correlations were not present in the older groups.

Body mass index was positively correlated ($p < 0.01$) with blood pressure, both in men and women. In older people there was also a positive correlation between body mass index, apolipoprotein B, and triglycerides, and an inverse correlation with apolipoprotein A-1 and high density lipoprotein cholesterol.

Discussion

Analysis of our results shows that the physiological reduction in basal metabolism with age is not followed by a decrease in energy intake in either the men or the women of the population tested. Consequently body mass index values higher than desired are present only at the 80th–90th percentile in the youngest decade of men and women, while they are present at the 60th percentile in the 30–39 year age groups and at the 40th percentile for the oldest decades. At the same time it should be noted that cholesterol and triglyceride levels, as well as systolic and diastolic pressures, increase with age. The correlations we found between body mass index and plasma cholesterol, triglycerides, apolipoprotein B and high density lipoprotein cholesterol, as well as blood pressure are in agreement with the findings of Jacobsen *et al.*¹⁴ who showed that the standardised regression coefficients for these associations were higher than for the food items.

As regards the food composition of diets, it is important to emphasize that generally the women

we interviewed answered the questions regarding the type of fat and the quality of the meat used for cooking in greater detail. This is ascribable to the living habits of the community we tested, where meals are generally prepared by women. The results obtained point out that for all the age groups the protein consumption is slightly higher in women than in men (medially 14% of total energy in women and 13% in men); furthermore animal protein intake is particularly high in women over 50 years of age (animal/vegetable protein = 1.7). Similarly, cholesterol intake is higher in women than in men (32 g/mJ and 28 g/mJ respectively), as is total fat intake.

Alcohol consumption is almost negligible in women while in men it accounts for 13% of the total energy intake.

As regards the hypercholesterolaemic and atherogenic potential of the diet, depending on the saturated fatty acid and cholesterol content of the food, 50% of all the population tested had CSI values which indicated a risk of coronary heart disease. Referring to the relation reported by Connor *et al.*⁹ between CSI/1000 kcal and the death rate for ischaemic heart disease in men aged 55–64 years, the male population we tested is comparable with the Italian average.

In spite of these results the total blood cholesterol/high density lipoprotein cholesterol ratio of our population is within the acceptable range (2.0–6.0) and is higher in men (4.9) than in women (4.4).

In conclusion, the values of the risk factors analysed are typical of a Western population; considering this, we think it should be useful to correct the dietary intake, especially as regards fat, cholesterol, and alcohol, for the prevention of coronary heart disease.

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