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Dietary fat intake – food sources and dietary correlates in the Malmö Diet and Cancer cohort

Irene Mattisson[1,2,*], Elisabet Wirfält[1], Carin Andrén[1], Bo Gullberg[3] and Göran Berglund[1]
[1]Department of Medicine, Surgery and Orthopaedics, Lund University, Malmö, Sweden: [2]Correspondence address: Malmö Diet and Cancer Study, Department of Community Medicine, Malmö University Hospital, SE-205 02 Malmö, Sweden: [3]Department of Community Medicine, Lund University, Malmö, Sweden

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Abstract

Objectives: To identify food sources of fat, to compare food and nutrient intakes at different levels of relative fat intake, and to examine the contribution of different food groups to the variation in relative fat intake. Relative fat intake was expressed as energy contributed by fat in percentage of non-alcohol energy.
Design: Cross-sectional analysis of baseline data from the Malmö Diet and Cancer Study. An interview-based diet history method, a structured questionnaire and anthropometric measurements were used to obtain data. Analysis of variance compared food and nutrient intakes across quintiles of relative fat intake. Stepwise regression examined the contribution of food groups to the variation in relative fat intake.
Setting: Baseline examinations were conducted between 1991 and 1996 in the city of Malmö, southern Sweden.
Subjects: A sub-sample of 7055 women and 3240 men of the Malmö Diet and Cancer cohort.
Results: The major fat sources were dairy products, margarines, meat & meat products, and cakes & buns. Most plant foods, especially fruit, vegetables and breakfast cereals, were negatively associated with fat intake. Low fat consumers had significantly higher intakes of dietary fibre, vitamin C, β-carotene, folic acid, iron, zinc and calcium. Intakes of all types of fatty acids and fat-soluble vitamins were positively associated with fat consumption.
Conclusions: The results suggest that many food groups and nutrients may confound the associations between relative fat intake and disease. Plant foods, especially, are important to consider in studies of fat intake and disease risk.

Keywords
Dietary fat
Relative fat
Food groups
Nutrients
Non-alcohol energy
Confounders
Cohort study

Dietary fat and its effect on human health is debated intensively, and is a 'hot issue' in both nutrition research and nutrition practice[1–6]. Many studies of the relationship between fat intake and disease risk examine *total fat* as the exposure variable. However, depending on differences in food habits and food supply between populations, the inherent meaning of 'total fat' differs, both in terms of fat quality and in association with potential dietary and non-dietary confounders. In Sweden, the main fat sources are the following food groups: fats & oils, cheese, meat & poultry, buns & cookies, milk (all types) and sausage[7]. In Italy, the five main sources are oils, cheese, full-fat milk, beef and poultry[8]. In the USA, the five main sources are beef, margarine, eggs, full-fat milk (including milk drinks) and cookies & cakes[8]. The types of added fat vary greatly across Europe. Margarines, including butter–vegetable oil blends, are the predominant type of added fat in northern Europe, while vegetable oil, mostly olive oil, is the most common type of added fat in southern Europe[9]. Since added fat contributes substantially to 'total fat', these differences influence fat quality. A meta-analysis found that the association between fat intake and breast cancer varied with geographical location[10]. Such observations could depend partly on the different sources for 'total fat' in different countries. Although 'total fat' is not a well-defined concept and cannot be considered as the same variable in studies from different populations, study outcomes are often compared without a critical discussion of the meaning of 'total fat'. For instance, when interpreting outcomes from pooling projects that use diet information from many different populations, the inherent meaning of 'total fat' needs to be considered carefully[11,12].

'Total fat' is commonly expressed as relative fat intake, either as energy from fat as a percentage of total energy or as the residuals obtained when fat is regressed on energy[13]. It has been shown that these relative fat intake

**Corresponding author:* Email irene.mattisson@smi.mas.lu.se

variables are highly correlated[14]. In addition, these variables behave similarly in the classification of individuals and in the association with sociodemographic and lifestyle factors[15]. Since relative fat includes total energy, both types of variables are influenced by intakes of other energy-contributing nutrients. Thus relative fat intake includes aspects of total diet and is influenced by non-fatty foods[16,17]. The definition of the energy intake variable when calculating relative fat intake is debated. Traditionally, total energy (i.e. including energy from fat, carbohydrates, protein and alcohol) has been used. If non-alcohol energy (i.e. including energy from fat, carbohydrates and protein) is used for the calculation of relative fat intake, a more direct measure of the composition of the diet is obtained[18].

Other nutrients and food groups might confound an association between dietary fat and disease if they are associated with fat intake and are risk factors for the disease under study. Studies investigating the influence of fat on disease risk need to examine, discuss and interpret the underlying associations between fat intake, nutrient intake, food intake and potential non-dietary confounders[19]. Since these associations may vary between populations, it is important that studies report how other dietary exposures are associated both with fat intake and with disease when examining the fat–disease associations. Furthermore, when planning intervention programmes to implement nutrient recommendations in a population, knowledge about food sources for fat and nutrient correlates of fat intake is essential[20].

The aims of this study were to examine (1) food sources of fat, (2) food and nutrient intakes at different levels of relative fat intake and (3) the contribution of different food groups to the explanation of total variation in relative fat intake.

Subjects and methods

Malmö Diet and Cancer study

The Malmö Diet and Cancer (MDC) study is a prospective cohort study in Malmö, a city in the south of Sweden with approximately 250 000 inhabitants. In 1991, the MDC source population was defined as all persons living in the City of Malmö and born between 1926 and 1945. In May 1995, the source population was extended to include all women born between 1923 and 1950, and all men born between 1923 and 1945, in total 74 138 individuals. Inadequate Swedish language skills and mental incapacity were the only exclusion criteria. When the baseline examination closed in October 1996, 28 098 participants had complete datasets. Details of the recruitment procedures and the cohort are given elsewhere[21,22]. The Ethical Committee at Lund University has approved the MDC study (LU 51-90).

The participants visited the MDC screening centre twice. During the first visit, groups of six to eight participants were instructed on how to register meals in the menu book and how to fill out the diet questionnaire and the extensive questionnaire covering socio-economic and lifestyle factors. Project nurses took blood samples, blood pressure and anthropometric measurements. All questionnaires were completed at home. During the second visit, approximately 10 days after the first, the socio-economic questionnaire was checked and the dietary interview conducted.

Study population

This study population is a sub-sample of the MDC cohort. It consists of all participants ($n = 10\,295$) who completed MDC baseline examination during 1995 and 1996. In order to reduce interview time, the processing procedures for dietary data were altered slightly in September 1994[22]. For instance, coding procedures of mixed dishes were simplified and standard portion sizes were introduced for a small number of foods. A revised version of the socio-economic questionnaire was in use from December 1994. All participants in the present study have completed the same versions of dietary data processing and socio-economic questionnaire. Details of non-dietary variables of this sub-sample are described elsewhere[15].

Dietary data

The MDC method is an interview-based, modified diet history method. It combines: (1) a 7-day menu book for registration of lunch and dinner meals, and cold beverages including alcohol; and (2) a questionnaire for assessment of meal pattern, consumption frequencies and portion sizes of foods eaten regularly (i.e. sandwiches, cakes & cookies, fruit, breakfast cereals, milk & yoghurt, coffee/tea, sweets, snacks). Drugs, natural remedies and nutrient supplements were recorded in the menu book. At home, the participant used a booklet with 48 black-and-white photographs to estimate portion sizes in the questionnaire. Usual portion sizes of foods and dishes listed in the menu book were estimated during the interview from a more extensive book with black-and-white photographs. Typically, each set of photographs contained four different portion sizes of a dish. In addition, participants were asked complementary questions on their usual meal pattern, cooking methods and details about food choices; for instance, type of fat used in cooking and on bread. The consistency of the information provided in the questionnaire and menu book was carefully checked. Seventeen trained interviewers performed the interviews. The diet interviewers coded and entered the information from the menu book during the interview, using interactive software (Kostsvar, AIVO, Stockholm, Sweden).

The mean daily intake of foods was calculated based on frequency and portion size estimates from the questionnaire and menu book. The food intake was converted into energy and nutrient intakes using the

MDC nutrient database, where the majority of the nutrient information comes from PC-KOST2-93 from the National Food Administration in Uppsala, Sweden.

The relative validity of the MDC method was evaluated in a sample of Malmö residents, 105 women and 101 men, 50–69 years old, using 18 days of weighed records, three days every second month during a year, as the reference method. The Pearson correlation coefficients, adjusted for total energy, between the reference method and the MDC method administrated after the 12-month reference period, were, in women, 0.55 for energy, 0.69 for fat[23], 0.53 for vegetable and 0.77 for fruit intakes[24]. Corresponding figures in men were 0.55 for energy, 0.64 for fat[23], 0.65 for vegetable and 0.60 for fruit intakes[24]. Reported energy and fat intakes were higher in the MDC method compared with the reference method. In women, both energy and fat intakes were 9% higher. In men, energy intakes were 19% higher and fat intakes 24% higher[23].

Variables

Relative fat intake (E%) was, in this study, defined as the amount of energy contributed by fat expressed as a percentage of non-alcohol energy. Women and men were categorised separately into quintiles of relative fat intake. This definition of fat intake was chosen mainly because energy percentage is the fat intake variable used in public health work. Furthermore, non-alcohol energy is used in the Nordic nutrient recommendations[25], as well as in nutrient recommendations issued in other countries.

Three sets of *food group variables* were calculated. For each participant, the contribution of fat from each food group (FPfat) was calculated as the percentage of the total amount of fat ingested from all foods. Similarly, the contribution of energy from each food group (FPen) was calculated as the percentage of the total amount of energy ingested from all foods. Total amount ingested from each food group (Fgram) was calculated in grams per person per day. Information from all food groups (Appendix) was used in the construction of variables and in the analyses, but not all food groups are reported in the tables.

We selected *nutrient variables* focusing on antioxidative function and fat quality since these aspects receive special interest in current research on nutrition–health relationships. In addition, we selected nutrients originating from both plant foods and animal foods to cover a variety of food sources. Mean daily intakes of the following nutrients were examined: dietary fibre (g), vitamin C (mg), β-carotene (mg), folic acid (μg), vitamin B_{12} (μg), retinol (mg), α-tocopherol (mg), vitamin D (μg), selenium (μg), iron (mg), zinc (mg), calcium (mg), saturated fatty acids (SFA; g), monounsaturated fatty acids (MUFA; g), $n-6$ fatty acids (C18:2 and C20:4; g), $n-3$ fatty acids (C18:3, C20:5, C22:5 and C22:6; g), the ratio of $n-6$ fatty acids to $n-3$ fatty acids ($n-6/n-3$) and the ratio of polyunsaturated fatty acids (PUFA) to SFA (P/S). We calculated nutrient intakes both from diet only and from diet and supplements together (i.e. total nutrient intakes).

Information about *diet interviewer* and *season and year of the interview* was used to control for variation associated with the data-collection procedures.

Information on *age* and *sex* was obtained from the personal identification number. Age was divided into 10-year categories. *Body mass index* (BMI; $kg\,m^{-2}$) was calculated from direct measurements of weight and height. Relative weight categories (BMI < 25, 25–29 and $\geq 30\,kg\,m^{-2}$) were used according to current recommendations of the World Health Organization[26].

A previous study from the MDC cohort concluded that high relative fat intake was associated with smoking, low leisure-time physical activity and living alone in both genders. In men, high fat intake was also associated with low educational level[15]. Thus, multivariate analyses were adjusted for these variables in order to examine the genuine effects of fat.

Participants were divided into four categories according to their highest level of *education*: ≤8 years, 9–10 years, 11–12 years, and college education/university degree.

Cohabitant status was assessed by the question ‘Do you live alone?’ with six response alternatives: (1) yes; (2) no, together with partner without children; (3) no, together with partner and children; (4) no, together with children without partner; (5) no, together with parent; and (6) no, together with another person. Only 7.0% of the women and 2.1% of the men belonged to response alternatives 4–6. In order to obtain categories of approximately the same size, response alternatives 4 to 6 were, together with response alternative 3, collapsed into one category.

Leisure-time physical activity was obtained by asking about 18 different physical activities, separately for the four seasons. The questionnaire was adapted from the Minnesota Leisure Time Physical Activity Questionnaire[27,28]. The number of minutes per week of each activity was multiplied with an intensity coefficient and an overall leisure-time physical activity score was created. The score was divided into quintiles and further categorised as low (quintile 1), moderate (quintiles 2–4) or high (quintile 5).

The *smoking habits* of the participants were defined as (1) current smokers, including irregular smokers, (2) ex-smokers or (3) never smokers.

Statistical analyses

The Statistical Package for the Social Sciences version 10.0 (SPSS, Inc., Chicago, IL, USA) was used for all statistical analyses. All analyses were gender-specific. In order to reduce skewness of the distributions, nutrient and Fgram variables were log-transformed ($\log_{10}$) prior to analysis. A very small amount (0.01) was added to all Fgram variables prior to transformation to handle zero intakes.

First, the means, medians and quartile distributions were calculated for the FPfat variables, and the means of the FPen variable were calculated.

Second, the crude median intakes of nutrients and food groups (Fgram) in each quintile of relative fat were calculated. In addition, the mean intakes of nutrient and food groups (Fgram) were compared across quintiles of relative fat intake, using analysis of variance, adjusted for non-alcohol energy, diet interviewer, season and year of diet interview, age, BMI, leisure-time physical activity, smoking habits, educational level and cohabitation status. Tukey's test, with alpha set to 0.01, was used for the multiple comparisons. To assess the strength of the associations, the partial correlation coefficients between food groups (Fgram) and quintiles of relative fat intake were estimated, with the same adjustments.

Finally, in an exploratory analysis, the contribution of the different food groups to the total variation in relative fat intake was examined. All food groups (Fgram) were entered in a forward stepwise linear regression with relative fat intake as the dependent variable and with simultaneous adjustment for non-alcohol energy, diet interviewer, season and year of diet interview, BMI, leisure-time physical activity, smoking habits, educational level, age and cohabitation status.

Results

Dairy products, meat & meat products, margarines and cakes & buns were the major contributors to fat intake in both men and women, although the rank order of subgroups was slightly different (Tables 1 and 2). The contribution from separate food subgroups appeared to differ between gender groups. High-fat cheese was by far the biggest contributor among women, 12.5%, followed by the margarine subgroups. In men, high-fat cheese contributed 9.7%, which was about the same percentage as the margarine subgroups. When all fats and oils were

Table 1 Percentage contribution of food groups to total fat and energy intakes in a sub-sample of women ($n = 7055$) of the Malmö Diet and Cancer cohort

Food group	Subgroup	Mean	25th percentile	Median	75th percentile	Mean percentage of total energy intake
Dairy products		32.8	22.0	30.5	42.0	21.4
	High-fat cheese	12.5	6.1	11.2	17.3	6.7
	Butter−vegetable oil blends & butter*	7.6	0.0	0.0	13.1	3.1
	Full-fat milk	4.6	1.0	2.5	6.5	4.0
	Cream	4.4	1.7	3.6	6.2	1.8
	Low- & medium-fat milk	2.2	0.1	1.3	3.0	4.8
	Low-fat cheese	1.5	0.0	0.0	1.0	1.0
Meat & meat products		17.5	11.7	16.7	22.3	10.6
	High-fat meat	5.9	2.3	4.7	8.2	3.2
	Low-fat meat	4.9	2.0	4.0	6.9	3.7
	Sausage	3.6	0.0	2.4	5.8	1.8
	Cured-meat products, fatty	2.5	0.0	1.3	3.7	1.2
	Cured-meat products, lean	0.5	0.1	0.3	0.7	0.7
Margarine		17.1	8.8	16.3	23.7	6.4
	High-fat margarine*	9.8	4.9	7.7	11.6	3.6
	Low-fat margarine*	7.5	0.0	5.6	12.9	2.8
Cakes & buns		7.2	3.2	6.2	10.1	6.4
Bread		3.8	2.4	3.4	4.6	13.1
	Low-fibre bread	1.8	0.7	1.5	2.5	6.5
	Crispbread & rusks	1.0	0.3	0.6	1.3	2.9
	High-fibre bread	0.9	0.2	0.6	1.3	3.7
Mayonnaise & dressings		3.5	0.0	1.8	5.1	1.4
Chocolate		2.9	0.5	1.8	3.9	2.0
Fish		2.9	0.7	1.9	4.1	2.7
	Oily fish	2.5	0.3	1.4	3.6	1.5
	Lean fish	0.4	0.1	0.3	0.6	1.2
Eggs		2.7	1.2	2.3	3.7	1.6
Ice cream		1.5	0.3	0.9	2.0	1.1
Fried & deep-fried potatoes		1.4	0.0	0.0	2.1	1.3
Total oil*		1.2	0.0	0.0	1.5	0.4
Nuts		1.0	0.0	0.0	0.9	0.5
Total vegetables		0.8	0.3	0.5	0.9	2.9
Breakfast cereals		0.7	0.0	0.2	1.0	1.8
Total fruit		0.7	0.3	0.6	1.0	6.4
Snacks		0.6	0.0	0.0	0.6	0.5
Sugar & sweets		0.4	0.0	0.1	0.4	2.9
Boiled potatoes		0.3	0.1	0.1	0.5	3.3
Rice & pasta		0.1	0.0	0.1	0.2	2.1
Fruit juice		0.0	0.0	0.0	0.2	1.5

* The total contribution from all fats and oils examined together is 26.1%.

Table 2 Percentage contribution of food groups to total fat and energy intakes in a sub-sample of men ($n = 3240$) of the Malmö Diet and Cancer cohort

Food group	Subgroup	Mean	25th percentile	Median	75th percentile	Mean percentage of total energy intake
Dairy products		30.1	18.5	26.5	40.1	19.1
	High-fat cheese	9.7	4.4	8.6	13.3	5.2
	Butter–vegetable oil blends & butter*	9.3	0.0	0.0	17.6	3.9
	Full-fat milk	4.6	0.8	2.3	6.5	4.0
	Cream	3.7	1.2	2.9	5.2	1.5
	Low- & medium-fat milk	1.7	0.0	0.8	2.5	3.8
	Low-fat cheese	1.0	0.0	0.0	0.3	0.7
Meat & meat products		21.5	15.1	20.6	26.8	12.8
	High-fat meat	7.1	2.9	5.8	9.6	3.9
	Cured-meat products, fatty	4.8	0.9	3.6	7.1	2.4
	Low-fat meat	4.7	2.0	3.7	6.4	3.6
	Sausage	4.5	0.4	3.4	6.9	2.3
	Cured-meat products, lean	0.4	0.0	0.2	0.5	0.6
Margarine		18.0	7.8	17.8	26.1	6.9
	Low-fat margarine*	9.4	0.0	8.1	16.4	3.6
	High-fat margarine*	8.6	4.1	6.6	10.2	3.3
Cakes & buns		6.4	2.3	5.3	9.3	5.7
Bread		4.3	2.8	3.8	5.3	15.2
	Low-fibre bread	2.4	1.0	2.0	3.3	8.5
	High-fibre bread	1.2	0.1	0.7	1.6	4.5
	Crispbread & rusks	0.7	0.2	0.4	0.9	2.2
Fish		3.3	0.8	2.0	4.6	2.8
	Fat fish	2.9	0.4	1.6	4.1	1.8
	Lean fish	0.4	0.0	0.2	0.5	1.0
Mayonnaise & dressings		2.8	0.0	1.1	4.2	1.1
Eggs		2.5	1.1	2.1	3.3	1.5
Chocolate		2.4	0.2	1.2	3.1	1.6
Fried & deep-fried potatoes		1.6	0.0	0.0	2.7	1.7
Ice cream		1.5	0.2	0.7	2.0	1.1
Total oil*		1.1	0.0	0.0	1.0	0.4
Nuts		0.8	0.0	0.0	0.7	0.4
Breakfast cereals		0.8	0.0	0.1	1.1	1.9
Total vegetables		0.5	0.2	0.4	0.6	2.4
Total fruit		0.5	0.2	0.4	0.6	4.2
Snacks		0.4	0.0	0.0	0.2	0.3
Boiled potatoes		0.3	0.1	0.2	0.4	4.0
Sugar & sweets		0.2	0.0	0.0	0.2	2.8
Rice & pasta		0.1	0.0	0.0	0.2	1.6
Fruit juice		0.1	0.0	0.0	0.1	0.9

* The total contribution from all fats and oils examined together is 28.4%.

examined together (i.e. butter–vegetable oil blends & butter and all other dietary fats included into the same group), this group contributed most to fat intake, especially in men.

Intakes of several food groups (Fgram) varied significantly across quintiles of relative fat intake for both genders (Table 3). Most notably, fruit and vegetable intakes were markedly higher in the lower fat intake quintiles. Rice & pasta, breakfast cereals and soft drinks were negatively associated with fat intake. High-fat margarine and high-fat dairy products had positive associations, and low-fat margarines and low-fat dairy products had negative associations with fat intake. Intakes of high-fat meat, sausage and fatty cured-meat products were higher among high fat consumers. Intakes of spirits, wine and beer were positively associated with fat intake. In women, intakes of lean fish were lower in quintile 5 compared with other quintiles, while intakes of oily fish were lowest in quintiles 1 and 3. In men, oily fish intakes were positively associated with fat intake. A few food groups showed no significant difference in intakes across fat quintiles. These were, in women: lean cured-meat products, low-fat meat, high-fibre bread, boiled potatoes and coffee, and in men: lean cured-meat products, low-fat meat, lean fish and ice cream.

In this study, small differences in absolute terms tend to become significant because of the large sample sizes. It is therefore important to also consider the strength of the associations as assessed by partial correlation. Butter–vegetable oil blends & butter and high-fat cheese had the strongest positive associations in women while butter–vegetable oil blends & butter and high-fat margarine had the strongest positive associations in men. In women, low- & medium-fat milk, fruit and breakfast cereals had the strongest negative associations. In men, breakfast cereals, low- & medium-fat milk and low-fat margarine had the strongest negative associations.

All of the selected nutrients, except vitamin B_{12} in women and selenium in men, varied significantly across

Table 3 Food group intakes* across quintiles of relative fat† intake in a sub-sample from the Malmö Diet and Cancer cohort. Geometric means (medians) are shown

Food group (g)	Median‡	Quintile 1	2	3	4	5	*F*-test§ *P*-value	Partial¶ *r*
WOMEN (*n* = 7055)								
Total fruit	173	216[a] (237)	176[b] (200)	151[c] (171)	130[d] (152)	98[e] (126)	<0.001	−0.249
Fruit juice	1.2	2.3[a] (14)	2.2[a] (22)	1.4[b] (1.4)	1.4[b] (1.4)	0.5[c] (0.21)	<0.001	−0.120
Total vegetables	160	175[a] (173)	161[b] (168)	156[b] (162)	147[c] (154)	132[d] (145)	<0.001	−0.157
Cured-meat products, lean	8	2.3 (7)	2.9 (8)	3.0 (8)	2.7 (8)	2.4 (7)	0.038	0.000
Cured-meat products, fatty	4	0.5[a] (2)	0.9[b] (4)	1.1[b,c] (4)	1.1[b,c] (6)	1.3[c] (6)	<0.001	0.096
Sausage	9	1.0[a] (4)	1.6[b] (8)	2.0[b] (11)	2.0[b] (10)	2.2[b] (13)	<0.001	0.075
Low-fat meat	42	25 (39)	26 (42)	28 (42)	25 (43)	25 (43)	0.368	0.004
High-fat meat	24	9[a] (18)	13[b] (23)	14[b] (25)	13[b] (26)	14[b] (27)	<0.001	0.068
Lean fish	22	7.0[a] (25)	6.7[a] (23)	6.4[a] (22)	6.3[a] (22)	4.7[b] (20)	0.003	−0.041
Oily fish	7	2.1[a] (7)	3.0[b] (8)	2.8[a,b] (7)	3.0[b] (8)	2.9[b] (8)	0.003	0.032
Low-fat cheese	0	0.52[a] (2)	0.30[b] (0)	0.17[c] (0)	0.15[c] (0)	0.08[d] (0)	<0.001	−0.171
High-fat cheese	30	9.3[a] (16)	19[b] (26)	23[c] (33)	27[c,d] (37)	29[d] (45)	<0.001	0.214
Low- & medium-fat milk	171	89[a] (292)	59[b] (234)	23[c] (173)	11[d] (117)	3[e] (44)	<0.001	−0.274
Full-fat milk	65	33[a] (39)	50[b] (56)	55[b,c] (71)	61[c] (78)	57[b,c] (95)	<0.001	0.145
Cream	10	4.5[a] (7)	6.3[b] (10)	7.2[b,c] (11)	8.1[c,d] (12)	8.5[d] (13)	<0.001	0.121
Ice cream	7	3.4[a] (6)	3.6[a] (7)	3.3[a] (7)	3.1[a] (7)	2.4[b] (5)	<0.001	−0.051
Low-fat margarine (40−60%)	9	1.6[a] (10)	2.1[a] (13)	1.8[a] (13)	0.9[b] (10)	0.2[c] (0)	<0.001	−0.186
High-fat margarine (80%)	7	5.5[a] (5)	6.8[b] (7)	7.6[c] (8)	7.8[c] (8)	8.8[d] (9)	<0.001	0.183
Butter−vegetable oil blends & butter	0	0.05[a] (0)	0.09[b] (0)	0.16[c] (0)	0.45[d] (2)	1.40[e] (16)	<0.001	0.313
Mayonnaise & dressings	2	0.3[a] (1)	0.5[b] (2)	0.6[b] (2)	0.9[c] (3)	1.1[c] (4)	<0.001	0.150
Low-fibre bread	40	15[a] (30)	21[b] (37)	24[b] (43)	24[b] (43)	24[b] (48)	<0.001	0.068
High-fibre bread	20	6.8 (20)	7.0 (21)	6.1 (19)	5.6 (19)	5.2 (18)	0.093	−0.033
Boiled potatoes	74	46 (68)	50 (75)	53 (75)	48 (74)	47 (75)	0.159	0.002
Fried & deep-fried potatoes	0	0.16[a] (0)	0.26[b] (0)	0.30[b,c] (0)	0.35[b,c] (0)	0.41[c] (0)	<0.001	0.077
Rice & pasta	9	3.2[a] (9)	2.3[b] (9)	2.2[b,c] (9)	1.6[c] (9)	1.1[d] (7)	<0.001	−0.109
Breakfast cereals	5	2.7[a] (11)	2.0[a] (8)	1.1[b] (5)	0.83[b] (4)	0.35[c] (0)	<0.001	−0.217
Cakes & buns	27	17[a] (22)	21[b] (28)	21[b] (30)	21[b] (29)	17[a] (29)	<0.001	0.002
Sugar & sweets	9	7.2[a,b] (8)	7.8[a] (9)	6.6[b,c] (9)	6.1[c] (10)	4.7[d] (9)	<0.001	−0.089
Chocolate	4	1.1[a] (2)	2.0[b] (4)	2.1[b] (4)	2.2[b] (5)	2.2[b] (5)	<0.001	0.088
Snacks	0	0.069[a] (0)	0.082[a,b] (0)	0.081[a,b] (0)	0.095[b,c] (0)	0.11[c] (0)	<0.001	0.051
Spirits	0	0.033[a] (0)	0.054[b] (0)	0.063[b,c] (0)	0.067[b,c] (0)	0.085[c] (0)	<0.001	0.080
Beer	47	2.0[a] (36)	3.8[b] (47)	3.8[b] (47)	4.1[b] (50)	3.6[b] (47)	<0.001	0.026
Wine	29	0.54[a] (0)	1.3[b] (29)	1.6[b,c] (29)	2.1[c] (34)	2.4[c] (36)	<0.001	0.089
Soft drinks	6	2.1[a] (6)	2.0[a] (21)	1.2[b] (4)	1.0[b] (6)	0.58[c] (1)	<0.001	−0.099
Coffee	450	225 (400)	266 (450)	280 (450)	268 (450)	272 (450)	0.084	0.023
Tea	32	2.8[a,b] (48)	3.1[a,b] (64)	2.0[a,b] (32)	1.9[a] (32)	1.1[c] (0)	<0.001	−0.065
MEN (*n* = 3240)								
Total fruit	136	161[a] (180)	122[b] (158)	110[b,c] (140)	96[c] (122)	76[d] (98)	<0.001	−0.179
Fruit juice	0	0.59[a] (0)	0.60[a] (0.23)	0.46[a] (0)	0.36[a,b] (0)	0.25[b] (0)	<0.001	−0.076
Total vegetables	139	147[a] (153)	137[a,b] (142)	130[b] (139)	131[b] (138)	115[c] (126)	<0.001	−0.116
Cured-meat products, lean	8	2.3 (9)	1.6 (7)	1.8 (7)	1.9 (8)	1.9 (8)	0.318	−0.007
Cured-meat products, fatty	13	1.4[a] (6)	3.8[b] (12)	4.1[b] (14)	5.4[b,c] (16)	8.1[c] (20)	0.005	0.184
Sausage	16	1.9[a] (11)	2.8[a,b] (14)	3.3[b,c] (18)	4.7[c] (19)	5.3[c] (21)	<0.001	0.108
Low-fat meat	51	33 (48)	38 (52)	35 (50)	33 (53)	31 (54)	0.383	−0.017
High-fat meat	34	16[a] (26)	21[a,b] (33)	24[b] (36)	24[b] (41)	26[b] (43)	<0.001	0.082
Lean fish	23	5.3 (25)	5.4 (24)	5.5 (25)	4.1 (22)	4.0 (17)	0.215	−0.035
Oily fish	11	2.6[a] (9)	3.9[a,b] (10)	3.5[a,b] (10)	5.2[b] (13)	5.2[b] (13)	<0.001	0.079
Low-fat cheese	0	0.22[a] (0)	0.10[b] (0)	0.08[b,c] (0)	0.06[c,d] (0)	0.04[d] (0)	<0.001	−0.163
High-fat cheese	30	9[a] (19)	16[b] (28)	21[b,c] (31)	22[c] (34)	24[c] (40)	<0.001	0.164
Low- & medium-fat milk	134	60[a] (315)	18[b] (187)	12[b] (144)	4[c] (56)	2[d] (12)	<0.001	−0.267
Full-fat milk	79	41[a] (43)	67[b] (86)	63[b] (81)	60[b] (96)	60[b] (98)	<0.001	0.042
Cream	11	4.1[a] (8)	6.4[b] (10)	7.2[b,c] (11)	8.6[c] (13)	7.4[b,c] (13)	<0.001	0.103
Ice cream	6	2.9 (6)	3.1 (7)	2.7 (6)	2.9 (5)	2.5 (5)	0.521	−0.021
Low-fat margarine (40−60%)	12	2.2[a] (17)	2.3[a] (22)	1.2[b] (17)	0.8[b] (10)	0.1[c] (0)	<0.001	−0.240
High-fat margarine (80%)	8	5.7[a] (6)	8.0[b] (8)	8.4[b,c] (9)	9.2[c] (9)	9.4[c] (9)	<0.001	0.189
Butter−vegetable oil blends & butter	0	0.05[a] (0)	0.09[b] (0)	0.25[c] (0)	0.46[d] (0)	2.93[e] (31)	<0.001	0.355
Mayonnaise & dressings	2	0.18[a] (0)	0.38[b] (1)	0.47[b,c] (2)	0.66[c] (2)	0.63[c] (3)	0.001	0.135
Low-fibre bread	69	25[a] (53)	40[b] (66)	40[b] (73)	39[b] (71)	38[b] (76)	<0.001	0.048
High-fibre bread	29	9.4[a] (36)	7.6[a,b] (31)	5.7[a,b] (30)	6.8[a,b] (30)	4.6[c] (21)	0.004	−0.061
Boiled potatoes	106	73[a] (103)	91[b] (110)	87[a,b] (105)	87[a,b] (110)	79[a,b] (103)	0.045	0.011
Fried & deep-fried potatoes	0	0.33[a] (0)	0.39[a,b] (0)	0.51[a,b] (0)	0.59[b] (0)	0.67[b] (26)	0.011	0.063
Rice & pasta	9	1.7[a] (11)	1.2[a,b] (8)	1.1[a,b] (8)	0.92[b] (8)	0.57[c] (6)	<0.001	−0.100
Breakfast cereals	5	3.0[a] (15)	1.5[b] (8)	0.9[c] (5)	0.5[d] (2)	0.2[e] (0)	<0.001	−0.268
Cakes & buns	30	14[a] (28)	19[a,b] (32)	18[a,b] (31)	16[a] (31)	13[a] (26)	0.008	−0.021

Table 3. *Continued*

Food group (g)	Median‡	Quintile 1	2	3	4	5	*F*-test§ *P*-value	Partial¶ *r*
Sugar & sweets	11	7.7[a] (11)	8.2[a] (12)	8.2[a] (12)	6.5[a,b] (12)	5.1[b] (10)	<0.001	−0.077
Chocolate	4	0.9[a] (2)	1.2[b] (3)	1.6[b] (4)	1.7[b] (4)	1.8[b] (5)	<0.001	0.088
Snacks	0	0.03[a] (0)	0.05[b] (0)	0.05[b] (0)	0.06[b] (0)	0.07[b] (0)	<0.001	0.084
Spirits	0	0.17[a] (0)	0.31[b] (0)	0.40[b] (0)	0.49[b] (4)	0.51[b] (4)	<0.001	0.079
Beer	169	19[a] (140)	30[a,b] (166)	31[a,b] (166)	43[b] (190)	34[b] (184)	0.007	0.039
Wine	0	0.4[a] (0)	0.8[a,b] (0)	0.8[b] (0)	1.1[b] (14)	1.1[b] (0)	<0.001	0.056
Soft drinks	14	2.8[a] (26)	2.3[a] (29)	1.7[a,b] (28)	1.1[b,c] (6)	0.7[c] (1)	<0.001	−0.107
Coffee	420	203[a] (400)	265[a,b] (400)	297[b] (400)	264[a,b] (450)	279[a,b] (450)	0.029	0.039
Tea	0	1.0[a,b] (0)	1.2[a] (0)	1.4[a] (32)	0.9[a,b] (0)	0.5[b] (0)	0.004	−0.045

* Adjusted for non-alcohol energy, diet interviewer, year and season of diet interview, age, body mass index, education, smoking, cohabitation status and leisure-time physical activity.
† Energy contributed by fat as a percentage of non-alcohol energy.
‡ Crude medians, all women, respectively all men.
§ Multiple comparisons with Tukey's test, with $\alpha = 0.01$, homogeneous subsets indicated with letters.
¶ Partial correlation coefficient between food group and relative fat intake quintile, adjusted for non-alcohol energy, diet interviewer, year and season of diet interview, age, body mass index, education, smoking, cohabitation status and leisure-time physical activity.

fat intake quintiles (Table 4), and had the same pattern in both genders. Intakes of dietary fibre, vitamin C, β-carotene, folic acid, iron, zinc and calcium were negatively associated with fat intake. Intakes of retinol, α-tocopherol, vitamin D and all types of fatty acids were positively associated with fat intake. The $n-6/n-3$ ratio and the P/S ratio were negatively associated with fat. Intakes of selenium in women were negatively associated with fat intake and intakes of vitamin B_{12} in men were positively associated with fat intake.

When total nutrient intake (i.e. including nutrients from supplements) was compared across quintiles there was no major change in intake patterns compared with those described above (data not shown). Since supplement intake was lower among high fat consumers (Table 4), the pattern of higher nutrient intakes in the lower quintiles was strengthened. The lower intakes of fat-soluble vitamins in the lower quintiles were somewhat counter-balanced by intakes from supplements.

Food groups that, on average, were either high or low contributors of both fat and energy intakes contributed to the total variation in relative fat intake (E%). Those contributing most were butter–vegetable oil blends & butter, fruit, high-fat margarine, high-fat cheese, low-fat milk and breakfast cereals. The rank order differed slightly between men and women (Table 5).

Discussion

The most important food sources of fat were dairy products, margarines, meat & meat products, and cakes & buns. We observed significant differences in consumption levels for almost all food groups across relative fat intake quintiles. Fruit and vegetable intakes were, for instance, markedly lower among high fat consumers. The choice of low-fat versus high-fat food products, e.g. milk, cheese and margarines, differed between high and low fat consumers. Low fat consumers had higher intakes of breakfast cereals, rice & pasta and soft drinks. Many nutrients also differed across quintiles of relative fat intake. Not surprisingly, intakes of anti-oxidative nutrients, except α-tocopherol in both genders and selenium in men, were lower among high fat consumers. Dietary fibre intake was negatively associated with fat intake. We had no access to intake data of bioactive compounds like flavonoids and phyto-oestrogens. The much higher intakes of plant foods suggest that intakes of many bioactive compounds may be higher among low fat consumers. Intakes of alcoholic beverages were positively associated with fat intake. Ethanol is an energy-contributing macronutrient, and the direction of the association between alcohol and relative fat intakes depends on how energy is defined when calculating relative fat. In a previous study, where relative fat intake was defined as a percentage of total energy, we found alcohol intake to be negatively associated with relative fat intake[15].

In this population, we observed stronger positive associations with relative total fat for SFA and MUFA than for $n-6$ and $n-3$ fatty acids. The $n-6/n-3$ ratio was negatively associated with total fat intake. The differences in intakes of oily fish could partly explain the lower $n-6/n-3$ ratios among high fat consumers. An additional explanation could be the extensive use of butter–vegetable oil blends, with an $n-6/n-3$ ratio of about 2, among high fat consumers, especially in men. The P/S ratio was negatively associated with fat intake. Thus, from health perspectives, the $n-6/n-3$ ratio is more favourable among high fat consumers while the P/S ratio is more favourable among low fat consumers, although the differences are small in absolute terms.

When means of food and nutrient intakes were compared across quintiles of relative fat without adjustment for lifestyle and education, results were largely unchanged (data not shown).

The percentage of energy from fat is a seemingly straightforward and simple entity, easy to calculate.

Table 4 Nutrient intakes* across quintiles of relative fat intake† in a sub-sample of the Malmö Diet and Cancer cohort. Geometric means are shown

Nutrient	Median‡	Quintile 1	2	3	4	5	*F*-test§ *P*-value	Partial¶ *r*
WOMEN ($n=7055$)								
E% fat (median)	38.6	31.3	35.5	38.6	41.6	46.1		
Supplement users (%)	45	46	46	48	45	40		
Dietary fibre (g)	17.2	20.6[a]	18.2[b]	17.1[c]	16.0[d]	14.3[e]	<0.001	−0.448
Vitamin C (mg)	97	124[a]	104[b]	93[c]	86[d]	68[e]	<0.001	−0.352
β-Carotene (mg)	2.76	3.35[a]	2.95[b]	2.75[b]	2.49[c]	2.17[d]	<0.001	−0.188
Folic acid (μg)	216	249[a]	228[b]	214[c]	203[d]	184[e]	<0.001	−0.398
Vitamin B_{12} (μg)	4.72	4.88	4.93	4.84	4.82	4.85	0.810	−0.005
Retinol (mg)	0.802	0.726[a]	0.813[b]	0.859[c]	0.894[c]	1.00[d]	<0.001	0.174
α-Tocopherol (mg)	8.74	8.32[a]	8.67[b]	8.77[b,c]	8.91[c]	9.33[d]	<0.001	0.142
Vitamin D (μg)	5.94	5.35[a]	5.74[b]	5.81[b,c]	5.94[c]	6.30[d]	<0.001	0.125
Selenium (μg)	32.0	32.3[a]	32.2[a]	31.6[a]	31.5[a]	30.5[b]	<0.001	−0.054
Iron (mg)	12.8	13.4[a]	13.2[a,b]	12.9[b]	12.5[c]	11.9[d]	<0.001	−0.204
Zinc (mg)	9.81	9.68[a]	9.66[a]	9.57[a]	9.33[b]	9.20[b]	<0.001	−0.107
Calcium (mg)	1041	1109[a]	1062[b]	1028[c]	979[d]	935[e]	<0.001	−0.212
SFA (g)	34.0	26.0[a]	31.0[b]	34.0[c]	37.1[d]	43.0[e]	<0.001	0.773
MUFA (g)	27.2	21.5[a]	25.2[b]	27.3[c]	29.2[d]	32.4[e]	<0.001	0.813
$n-6$ (g)	9.41	7.76[a]	8.97[b]	9.57[c]	10.1[d]	10.7[e]	<0.001	0.282
$n-3$ (g)	1.92	1.59[a]	1.80[b]	1.91[c]	2.06[d]	2.28[e]	<0.001	0.321
$n-6/n-3$ ratio	5.11	4.88[a]	4.99[a]	5.00[a]	4.92[a]	4.72[b]	<0.001	−0.035
P/S ratio	0.353	0.375[a]	0.361[b]	0.350[c]	0.341[c]	0.314[d]	<0.001	−0.170
MEN ($n=3240$)								
E% fat (median)	39.8	32.1	36.9	39.8	43.1	47.8		
Supplement users (%)	32	37	33	29	31	28		
Dietary fibre (g)	19.0	23.1[a]	20.3[b]	18.8[c]	17.6[d]	15.6[e]	<0.001	−0.473
Vitamin C (mg)	80	100[a]	85[b]	77[c]	72[c]	61[d]	<0.001	−0.245
β-Carotene (mg)	2.19	2.62[a]	2.17[b]	2.06[b]	2.02[b]	1.79[c]	<0.001	−0.143
Folic acid (μg)	240	272[a]	247[b]	229[c]	222[d]	199[e]	<0.001	−0.415
Vitamin B_{12} (μg)	5.98	5.94[a]	6.28[b]	6.19[a,b]	6.37[b]	6.38[b]	0.034	0.049
Retinol (mg)	1.13	0.942[a]	1.15[b]	1.21[b,c]	1.30[c]	1.43[d]	<0.001	0.209
α-Tocopherol (mg)	9.95	9.40[a]	10.02[b]	10.16[b]	10.62[c]	10.64[c]	<0.001	0.154
Vitamin D (μg)	7.90	6.98[a]	7.64[b]	7.75[b]	8.18[c]	8.47[c]	<0.001	0.153
Selenium (μg)	38.2	37.8	38.8	38.1	38.1	37.8	0.501	0.007
Iron (mg)	16.6	17.9[a]	17.3[b]	16.6[c]	16.2[d]	15.3[e]	<0.001	−0.259
Zinc (mg)	11.6	12.2[a]	11.9[b]	11.7[b]	11.5[c]	11.1[d]	<0.001	−0.173
Calcium (mg)	1084	1202[a]	1112[b]	1084[b]	1005[c]	955[d]	<0.001	−0.249
SFA (g)	42.5	32.5[a]	39.3[b]	43.2[c]	46.9[d]	55.8[e]	<0.001	0.758
MUFA (g)	35.7	28.0[a]	33.4[b]	35.7[c]	38.6[d]	42.7[e]	<0.001	0.819
$n-6$ (g)	12.3	10.5[a]	12.0[b]	12.5[c]	13.5[d]	13.5[d]	<0.001	0.221
$n-3$ (g)	2.54	2.08[a]	2.40[b]	2.53[c]	2.79[d]	3.01[e]	<0.001	0.326
$n-6/n-3$ ratio	5.04	5.04[a]	5.01[a]	4.97[a,b]	4.84[b]	4.49[c]	<0.001	−0.119
P/S ratio	0.373	0.403[a]	0.384[a]	0.362[b]	0.361[b]	0.310[c]	<0.001	−0.225

E% – relative fat intake; SFA – saturated fatty acids; MUFA – monounsaturated fatty acids; P/S – ratio of polyunsaturated fatty acids (PUFA) to SFA.
*Adjusted for non-alcohol energy, diet interviewer, year and season of diet interview, age, body mass index, education, smoking, cohabitation status and leisure-time physical activity.
† Energy contributed by fat as a percentage of non-alcohol energy.
‡ Crude median intakes in all women, respectively all men.
§ Multiple comparisons with Tukey's test, with $\alpha=0.01$, homogeneous subsets indicated with letters.
¶ Partial correlation coefficient between nutrient and relative fat intake quintile, adjusted for non-alcohol energy, diet interviewer, year and season of diet interview, age, body mass index, education, smoking, cohabitation status and leisure-time physical activity.

However, this expression includes energy from all foods in the denominator and therefore all foods providing energy might influence the percentage of energy from fat. The contribution to the total variation in relative fat intake was estimated with stepwise forward linear regression. We repeated the procedure with backward linear regression, with only minor differences in outcome (data not shown). This study clearly indicates that not only fat sources are reflected in the relative fat intake variable. Since percentage energy from fat is not an absolute but a relative estimate, not only the total amount of fat ingested influences this expression. The contribution to the total variation in relative fat intake is also influenced by the inter-individual variation in intakes of each food group across relative fat quintiles (Table 3) and the contribution to total energy intakes of each food group (Tables 1 and 2). This information contributes to the explanation and interpretation of Table 5. For instance, in women, fruit that contributes only 0.73% of total fat is the second most important food group explaining the variation in relative fat intake. This can be explained by the large contribution of total energy intake (6.5%) and by the differences in intakes across relative fat intake quintiles. On the other hand, lean meat, which contributes 4.9% of the total fat

Table 5 The contribution* of each food group to the total variation in relative fat† intake in a sub-sample of the Malmö Diet and Cancer cohort

	R^2	R^2 change
WOMEN‡ ($n = 7055$)		
Non-alcohol energy, age, smoking, physical activity, household size, body mass index, education, season and year of baseline examination, diet interviewer	0.091	0.091
+ Butter–vegetable oil blends & butter	0.189	0.098
+ Total fruit	0.249	0.060
+ High-fat margarine	0.298	0.049
+ High-fat cheese	0.343	0.045
+ Low- & medium-fat milk	0.382	0.039
+ Breakfast cereals	0.403	0.021
+ Mayonnaise & dressings	0.422	0.019
+ Fruit juice	0.435	0.013
+ Soft drinks	0.446	0.011
+ Total vegetables	0.457	0.011
+ Fatty cured-meat products, sugar & sweets, cream, chocolate, marmalade	0.491	0.007–0.005 per food group
+ Sausage, rice & pasta, miscellaneous, high-fat meat, boiled potatoes, low-fat margarine, lean fish, nuts, flour, eggs, oil	0.519	0.004–0.002 per food group
+ Wine, tea, full-fat milk, low-fibre bread, fried & deep-fried potatoes, beer, low-fat cheese, snacks, oily fish, lean cured-meat products, water, low-fat meat	0.527	0.001 or below per food group
MEN§ ($n = 3240$)		
Non-alcohol energy, age, smoking, physical activity, household size, body mass index, education, season and year of baseline examination, diet interviewer	0.070	0.070
+ Butter–vegetable oil blends & butter	0.195	0.125
+ High-fat margarine	0.258	0.062
+ Breakfast cereals	0.308	0.050
+ Low- & medium-fat milk	0.337	0.029
+ Fatty cured-meat products	0.364	0.027
+ High-fat cheese	0.390	0.026
+ Total fruit	0.412	0.022
+ Mayonnaise & dressings	0.424	0.012
+ Soft drinks	0.436	0.012
+ Sausage	0.445	0.008
+ Total vegetables, sugar & sweets, marmalade, chocolate, eggs, fruit juice, cream	0.489	0.007–0.005 per food group
+ Lean fish, high-fat meat, nuts, rice & pasta, low-fat cheese, oily fish, boiled potatoes, high-fibre bread	0.508	0.004–0.002 per food group
+ Beer, miscellaneous, tea, wine, low-fat meat, flour, ice cream	0.514	0.001 or below per food group

* Assessed with stepwise regression with all food groups and adjusted for non-alcohol energy, age, smoking, physical activity, household size, body mass index, education, season and year of baseline examination, and diet interviewer.
† Energy contributed by fat as a percentage of non-alcohol energy.
‡ Not significant in the equation for women: high-fibre bread, crispbread & rusks, ice cream, low-fat meat, cakes & buns, spirits, coffee and ketchup.
§ Not significant in the equation for men: snacks, lean cured-meat products, low-fibre bread, crispbread & rusks, full-fat milk, oil, low-fat margarine, cakes & buns, fried & deep-fried potatoes, spirits, coffee, water and ketchup.

and 3.7% of the total energy intake but shows no variation in intakes across relative fat quintiles, is not significantly included in the regression model explaining relative fat intake. Interestingly, breakfast cereals are high on the list of food groups explaining relative fat intake without contributing appreciably to fat (<1%) or energy (2%) intake, but showing strong negative associations across relative fat quintiles. Food groups indicating a certain eating behaviour (i.e. milk and breakfast cereals instead of bread, margarine and cheese) that covaries with fat and energy intakes may contribute to the explanation of total variation in relative fat intake without being a substantial dietary source of fat or energy. Thus, it seems obvious that studies examining the relationship between relative fat intake and disease incorporate a number of components, other than fat, in the dietary behaviour into analyses. In addition, the specific definition of food groups and food subgroups may influence the conclusions of nutritional epidemiological studies[29]. For instance, intakes of low-fat margarine are lower in high fat consumers, intakes of high-fat margarine are higher in high fat consumers, and intakes of total margarine have an inverse U-shaped distribution with lowest intakes in quintiles 1 and 5 in both genders (data not shown). Defining food groups is a balancing act, requiring careful consideration of both aetiological aspects and consumption patterns in the specific population.

Underreporting is a crucial issue in dietary studies[30]. All multivariate analyses in this study were adjusted for a number of variables (age, BMI, physical activity, smoking habits, educational level and cohabitation status) potentially associated with underreporting[31], and these adjustments should therefore reduce the effect of underreporting. When adjusted means of the ratio of energy intake to basal metabolic rate were compared across quintiles of relative fat intake, there were no differences in men (data not shown). In women, the highest quintile of relative fat intake had a slightly, but significantly, higher ratio compared with the other quintiles (1.423 vs. 1.406–1.412). This could be an indication of more underreporting in quintiles 1–4 than in quintile 5. If underreporting in women was specific for fat, this could imply that some women were misclassified as low fat consumers, and that intake differences between quintile 5 and quintiles 1–4 are exaggerated. However, intakes of many food groups and nutrients had a pattern consistent across all five quintiles (i.e. positive or negative associations across all quintiles) and this 'overall' pattern should not be affected substantially.

This study identifies specific food groups which may be important targets for programmes promoting healthy diets. Furthermore, it is also clear that low- and high-fat diets in this cohort differ in many aspects that concern health and disease.

The results suggest that associations between relative fat intake and disease risk might be confounded by intakes of many food groups and consequently by a number of nutrients, including fatty acids and bioactive compounds from plant foods. The large differences in intakes of plant foods, especially fruit and vegetables, across quintiles of relative fat intake are especially important to consider in analyses of disease risk and fat intake.

Epidemiological studies examining the association between fat intake and disease need to explore dietary factors as potential confounders.

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Appendix – Definition of food groups

Mixed dishes (casseroles, soups, etc.) are divided into to their ingredients. All ingredients are classified according to type of food.

Food group	Comment
Beer	Includes cider and all types of beer (1.8, 2.8 and 4.5 wt% alcohol)
Boiled potatoes	
Bread, high-fibre	>4.5% fibre
Bread, low-fibre	≤4.5% fibre
Breakfast cereals	All types of breakfast cereals
Butter–vegetable oil blends & butter	Butter–vegetable oil blend contains 70% dairy fat and 30% rapeseed oil, expressed as a percentage of fat content
Cakes & buns	Includes all buns, cakes and cookies
Chocolate	
Coffee	
Cream, total	
Crispbread & rusks, total	
Cured-meat products, fatty	Includes salami, mettwurst sausage, etc.
Cured-meat products, lean	Includes ham, etc.
Eggs	
Flour, total	
Fried and deep-fried potatoes	
Fruit juice, total	
Fruit total	Includes also all berries
Full-fat milk	Milk, fermented milk >2.4% fat
High-fat cheese	Cheese >20% fat
High-fat margarine	80% fat
High-fat meat	Includes pork, beef and lamb >10% fat
Ice cream, total	
Ketchup	Includes ketchup, tomato paste
Lean fish	Fish, fish products, shellfish ≤5% fat
Low- & medium-fat milk	Milk, fermented milk ≤2.4% fat
Low-fat cheese	Cheese ≤20% fat
Low-fat margarine	≤60% fat
Low-fat meat	Includes pork, beef, lamb, poultry and game ≤10% fat
Marmalade	Includes marmalade, honey, jam
Mayonnaise & dressings	
Miscellaneous	Includes soft drinks with artificial sweetener, gruel, spices, soya products, etc.
Nuts	Includes all nuts, seeds, almond paste
Offal, total	
Oils, total	All vegetable oils
Oily fish	Fish, shellfish >5% fat
Rice & pasta	
Sausage, total	
Snacks	Includes chips, popcorn, etc.
Soft drinks	Sweetened with sugar
Spirits	All types
Sugar & sweets	
Tea	
Vegetable juice, total	
Vegetables, total	Includes all vegetables raw and cooked
Water	Includes tap water and mineral water
Wine	Includes red wine, white wine, fortified wine