High education is associated with low fat and high fibre, beta-carotene and vitamin C –

Computation of nutrient intake based on a short food frequency questionnaire in 17,265 men and women in the Tromsø Study

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ABSTRACT

Educational level has been correlated to the intake of several nutrients. In a population-based study including 17,265 men and women aged 25-69 years, the intake of nutrients were calculated based on 37 questions about food habits. In this paper, we present results from the dietary survey with emphasis on the relationships between dietary habits and educational level. Compared to subjects with low formal education, subjects with high educational level have less fat in their diet and more dietary fibre, beta-carotene, vitamin C and alcohol (p-value for linear trend < 0.001). Our results confirm that high education is associated with healthy food habits and relatively higher alcohol consumption. There is a need for efforts in order to change the food habits of the less educated.

NORSK SAMMENDRAG

Personer med lang utdanning har ofte et bedre kosthold enn personer med kortere utdanning. I denne undersøkelsen har vi estimert inntaket av en rekke næringsstoffer basert på 37 spørsmål om kostvaner som ble stilt til personer som tok del i Tromsø-IV-undersøkelsen (1994/95). Vår studie inkluderer 17 265 menn og kvinner i Tromsø i alderen 25-69 år. Vi presenterer resultater fra denne kostholdsundersøkelsen med vekt på relasjoner mellom kostvaner og utdanningslengde. Sammenlignet med personer med kort formell utdanning, har personer med lang utdanning mindre fett i kosten og høyere inntak av fiber, beta-karoten, vitamin C og alkohol (p < 0.001). Resultatene bekrefter at personer med lang utdanning har et helsemessig gunstigere kosthold, men et høyere alkoholinntak, enn personer med kort utdanning. Funnene understreker behovet for målrettede tiltak for å utjevne sosiale forskjeller i kostvaner i Norge.

INTRODUCTION

It is a rather consistent finding in nutritional epidemiology that higher socio-economic class, often measured as high level of education (1), is associated with a healthy diet. This has been demonstrated in Norway (2-5) and in other countries like Scotland (6), the US (7) and Finland (8). There have, however, been exceptions. In Finland, Roos and co-workers could not confirm that subjects with higher education had lower energy from fats or from saturated fats (8).

In order to show relationships between socio-economic class and food habits as well as nutrient intake in the general population, large population studies are needed. In previous population studies in Tromsø, the ambitions have primarily been to include information about the frequency of intake of some important food items in self-administered questionnaires, not to calculate the intake of nutrients. This focus has given interesting information about relationships between level of education and food and alcohol habits (2,9).

Detailed information about the nutrient intake of an individual can be obtained by applying dietary survey methods like the dietary history, repeated 24-hour recalls, direct recording (or even weighing) of the foods, or a comprehensive food frequency questionnaire (10). Unfortunately, financial and logistic constrains usually make it impossible to use these dietary survey methods in large population samples.

It is, however, known that information about the frequency of intake of a limited number of food items explains a large part of the between-person variation in nutrient intake (11-15). This means that there is a relatively high correlation coefficient between the nutrient intake estimated from a few food items and that estimated from a comprehensive dietary survey method covering the intake of many food items.

Thus, several research groups have estimated energy and nutrient intake from relatively short questionnaires. In a previous Norwegian study, the intakes of nutrients were calculated based on 31 food frequency questions (16). We have in a similar way calculated the nutrient intake of more than 17,000 men and women in Tromsø, Norway, based on information from two self-administered questionnaires included in the fourth Tromsø Study (1994/95).

There were therefore two aims of this study. The first aim was to present relationships between level of education and the intake of fats, dietary fibre, beta-carotene and vitamin C, relationships of interest for preventive medicine. The second aim was to describe how we estimated the intake of nutrients in the fourth Tromsø Study. This is of interest as the dietary survey is the basis for our study.

SUBJECTS AND METHODS

The fourth Tromsø Study took place in 1994 and 1995. It included all subjects aged 25 and above (born in 1969 or earlier) in the municipality of Tromsø, Norway, with approximately 60,000 inhabitants. The great majority of the population lives in the city of Tromsø. Only subjects aged 25-69 are included in the present study. The invitation to participate in the survey came with a questionnaire about alcohol habits (teetotaller, and how much beer, wine and spirits the respondent consumed in a normal two week period). There were also questions about type of table fat, educational level and two questions about physical activity in leisure time (low and high intensity, respectively).

A total of 24,358 men and women aged 25-69 attended the screening (76 % of the eligible population). At the screening, attenders were given another 4-page questionnaire. This questionnaire included a question about physical activity at work. There were also 35 questions about food habits, including the amount of spread fat, type of fats used in the cooking and type of bread used. There were two types of frequency questions. The first type included daily consumption of 14 different food items used daily (e.g., glasses of milk or slices of bread per day) with six consumption categories from “0” to “More than 6”. The second type concerned weekly consumption of 18 different food items/food groups (e.g., lean fish, yoghurt or carrots), also with six consumption categories from “Never” to “About daily”. The questionnaires are available upon request from the authors.

In order to be included in the computation of energy and nutrients, the respondent had to have answered at least 31 of 34 questions: The question about type of table fat used and the frequency of use of 33 food items that contribute to the energy intake. Thus, alcoholic beverages were included, but not coffee, tea and “light” (sugar free) beverages, as they do not contribute to the energy intake.

Missing values, albeit few for each subject, were substituted with a value. This value was either the modal value based on the distribution from the respondents, or the most likely value based on the rest of the answers. For example: If the respondent stated not to eat bread, but failed to answer the question about the number of slices of bread with cheese, we assumed that the respondent does not eat bread with cheese. Similarly, if the respondent had indicated the consumption of whole fat milk, but did not answer the question about skimmed milk, we assumed that the subject did not drink skimmed milk. It should be kept in mind that substitutions for missing values only were performed if at least 31 out of 34 questions had been answered.

The nutrients were estimated based on the 33 food frequency questions, the information about type and amount of table fat, the types of fats used in the cooking and type of bread used. Portion sizes for different types of foods (e.g., slice of bread, dinner courses, vegetables) were estimated for each gender based on data from previous dietary history surveys in northern Norway (17,18). The intakes of food groups like meat, lean fish, fatty fish, fish products (e.g., fish patties) and processed meat products (e.g., sausages) were calculated using recipes. These recipes reflected the usual intake in northern Norway of the food items included in the food group. The nutrient intakes were calculated using the Norwegian food composition table (19). In the case of missing values, data from the corresponding Swedish food composition table were applied (20).

We computed the total energy intake, fats (total fats, saturated-, monounsaturated-, and polyunsaturated fats as well as n-3 fatty acids), protein, carbohydrates, sugar, cholesterol, fibre, iron, calcium, beta-carotene, thiamine, riboflavin, folate and vitamins B_6, B_{12}, A, C, D and E. The intake of nutrients from cod liver oil and supplements were not included.

About 72 % of the subjects who got the questionnaire returned it with at least 31 of the 34 questions answered. Thus, nutrients were calculated for 8486 men and 9132 women. Subjects with very low or very high energy intake (< 1 and > 99 percentile) were excluded from the present analyses. The analyses presented therefore include 8316 men and 8949 women, or about 53 % of the population aged 25-69 in Tromsø. Due to missing values for other variables, the number of subjects included in some of the analysis is somewhat lower.

The statistical analyses, mainly analysis of variance, were performed using the SAS package (21).

RESULTS

The energy intake and the proportion of energy from fat, protein, carbohydrates and alcohol according to age and gender are given in Table 1. Fats contributed 31 % of the energy, protein 17 %, carbohydrates 51 % and alcohol 1 %. Energy from sugar represented 8 % of the total energy intake. The energy intake was inversely related to age and lower in women than in men. Table 2 shows positive statistically significant age-adjusted relationships between physical activity at work and leisure and the total energy intake.

The age-adjusted relationships between level of education and the intake of fats and alcohol (as percent of the energy intake), dietary cholesterol and fibre (as gram per 10 MJ) are displayed in table 3. The intake of fats and cholesterol (in women) was inversely related to educational level, whereas the intake of alcohol and dietary fibre was positively related to the length of education ($p < 0.001$). Mean intake of dietary cholesterol and fibre per 10 MJ were in men 0.30 gram and 27.0 gram, respectively. The corresponding figures from women were 0.31 gram and 27.7 gram. The total dietary cholesterol intake (not as gram per 10 MJ) was statistically significantly ($p < 0.001$) related to educational level in men, but not in women. The relationship was, however, not strong as the mean intake differed < 15 mg/day between the highest and lowest educational levels (results not shown).

The associations between length of education and two nutrients related to consumption of fruits and vegetables (beta-carotene and vitamin C) are shown in table 4. Both for men and women, we found that the intakes of the two nutrients were positively correlated to educational level. Mean intake of beta-carotene and vitamin C per 10 MJ were in men 4.3 mg and 136 mg, respectively. The corresponding figures in women were 7.4 mg and 156 mg. When represented as absolute intake of nutrients (not per 10 MJ), we found for both men and women highly significant relationships between the two nutrients and educational level.

Table 2. Total age-adjusted energy intake per day according to physical activity in leisure (low intensity and high intensity) and work (type of work). Tromsø 1994/95.

	Men		Women	
	Number of subjects	Total energy intake (MJ/day)	Number of subjects	Total energy intake (MJ/day)
Low intensity[1]				
No activity	856	9.2	649	6.6
< 1 hour/week	1423	8.9	1324	6.5
1-2 hours/week	2847	9.1	3307	6.7
≥ 3 hours/week	3150	9.3	3649	6.8
p for linear trend		< 0.001		< 0.001
High intensity[2]				
No activity	2817	9.0	4265	6.7
< 1 hour/week	2099	9.1	2073	6.7
1-2 hours/week	2042	9.2	1912	6.8
≥ 3 hours/week	1333	9.5	641	6.8
p-value for linear trend		< 0.001		0.002
Type of work				
Sedentary work	3655	8.9	3353	6.6
Requiring walking	1706	9.2	2416	6.8
Requiring walking and lifting	1470	9.5	1818	6.9
Heavy manual labour	629	10.1	84	7.2
p-value for linear trend		< 0.001		0.001

[1] Low intensity is physical activity that do not make the respondent breathless and sweating.

[2] High intensity is physical activity that makes the respondent breathless and sweating.

Table 1. Mean (SD) total energy intake, percent energy from all fats, polyunsaturated fats (PUFA), and saturated fats (SFA), protein, carbohydrates and alcohol, according to age and gender. Tromsø, 1994/95.

Age group	Number of subjects	Energy (MJ)	% energy from All fats	PUFA	SFA	protein	carbohydrates	alcohol
			Men					
25-34	2435	9.4 (2.1)	32.5 (6.1)	5.7 (2.1)	13.3 (2.9)	16.4 (2.3)	49.5 (6.2)	1.5 (1.7)
35-44	2494	9.3 (2.1)	30.8 (5.9)	5.3 (1.9)	12.6 (2.8)	16.5 (2.2)	51.1 (6.1)	1.6 (1.8)
45-54	2015	9.0 (2.0)	29.8 (5.7)	5.0 (1.7)	12.2 (2.7)	16.8 (2.2)	51.8 (6.1)	1.6 (2.0)
55-64	1037	9.1 (1.9)	28.7 (5.7)	4.8 (1.6)	11.8 (2.8)	16.9 (2.3)	53.1 (6.1)	1.1 (1.6)
65-69	335	8.7 (1.9)	28.2 (5.6)	4.6 (1.6)	11.7 (2.9)	17.1 (2.3)	53.6 (6.2)	0.9 (1.5)
All	8316	9.2 (2.0)	30.7 (6.0)	5.3 (1.9)	12.6 (2.9)	16.6 (2.3)	51.1 (6.2)	1.5 (1.8)
			Women					
25-34	2977	6.9 (1.6)	33.3 (5.9)	5.4 (2.1)	14.2 (2.9)	16.4 (2.3)	49.4 (5.6)	1.0 (1.3)
35-44	2710	6.8 (1.6)	32.6 (5.8)	5.3 (2.0)	13.8 (2.8)	16.6 (2.3)	49.8 (5.7)	1.1 (1.4)
45-54	1994	6.6 (1.6)	31.1 (5.9)	4.9 (1.7)	13.3 (3.0)	16.9 (2.3)	51.0 (6.0)	1.0 (1.5)
55-64	931	6.7 (1.6)	30.4 (5.6)	4.7 (1.6)	13.0 (2.9)	17.2 (2.4)	51.7 (5.8)	0.8 (1.5)
65-69	337	6.5 (1.6)	31.3 (5.7)	4.7 (1.4)	13.5 (3.0)	17.4 (2.4)	51.0 (6.0)	0.4 (0.9)
All	8949	6.7 (1.6)	32.2 (5.9)	5.1 (1.9)	13.7 (2.9)	16.7 (2.4)	50.2 (5.8)	1.0 (1.4)

Table 3. Age-adjusted relationships between level of education and the percentage of energy from all fats, polyunsaturated fats (PUFA), saturated fats (SFA) and alcohol as well as the intake of dietary cholesterol and fibre per 10 MJ. Tromsø, 1994/95.

Level of education	Number of subjects	% energy from All fats	PUFA	SFA	alcohol	gram cholesterol per 10 MJ	gram fibre per 10 MJ
Men							
7-10 years	2035	30.9	5.4	12.6	1.1	0.30	27.0
11 years	2502	30.5	5.3	12.4	1.3	0.30	27.4
12 years	661	29.8	5.1	12.1	1.6	0.30	27.8
13-15 years	1573	29.7	5.0	12.2	1.5	0.30	28.1
≥ 16 years	1533	29.1	4.5	12.3	1.7	0.30	28.5
p-value for linear trend		< 0.001	< 0.001	< 0.001	< 0.001	0.7	< 0.001
Women							
7-10 years	2350	32.3	5.3	13.6	0.6	0.32	27.5
11 years	2495	32.2	5.2	13.6	0.9	0.32	27.8
12 years	962	31.8	5.0	13.6	1.0	0.32	28.1
13-15 years	1543	31.3	4.8	13.4	1.1	0.31	28.9
≥ 16 years	1581	30.7	4.4	13.4	1.3	0.31	29.7
p-value for linear trend		< 0.001	< 0.001	0.002	< 0.001	0.001	< 0.001

Table 4. Age-adjusted relationships between level of education and the daily intake of beta-carotene and vitamin C (mg per 10 MJ). Tromsø, 1994/95.

	Men			Women		
Level of education	Number of subjects	mg beta-carotene per 10 MJ	mg vitamin C per 10 MJ	Number of subjects	mg beta-carotene per 10 MJ	mg vitamin C per 10 MJ
7-10 years	2035	3.8	133	2350	7.1	154
11 years	2502	4.3	136	2495	7.6	158
12 years	661	4.6	140	962	7.7	156
13-15 years	1573	4.8	144	1543	7.9	164
≥ 16 years	1533	5.1	147	1581	8.2	165
p-value for linear trend		< 0.001	< 0.001		< 0.001	< 0.001

DISCUSSION

The nutrients included in the analysis (energy, fats, dietary cholesterol and fibre, beta-carotene and vitamin C) were selected for two reasons. Firstly, these are important nutrients with regard to risk of major chronic diseases like cardiovascular diseases and cancer. Information about social gradients in the intake of these nutrients is therefore important. Secondly, it is known from previous studies that the intakes of at least some of the nutrients are related to educational level (2-9). Thus, demonstrating these relationships also in this study population may tend to validate nutrient intake data (predictive validity).

Nutrient intake

The dietary survey method used (self-administered questionnaire) has the advantage that information from a large population can be collected. We believe that applying local, gender specific serving sizes in the computations, and not national averages for men and women combined, improves the method. The proportion of energy from fats, protein, carbohydrates and alcohol and mean intakes per 10 MJ of dietary cholesterol, fibre and vitamin C are quite similar to data from the Norkost surveys, which are intended to be representative for the Norwegian population aged 16-79 (5,22). We found, however, in women 6 % higher percentage of the energy from fats and in men 18 % higher intake of vitamin C per 10 MJ than in the Norkost surveys (30.4 % and 115 mg, respectively, in the Norkost survey in 1997) (5).

There are, however, also several limitations in our data. Some food groups (e.g., fast food meals like hot dog and hamburger) were not included in our questionnaire and the information about added fat (e.g., to fish dishes) is limited. This may be a problem in parts of the population with dietary habits that differ from the majority, for example subjects who get a relatively larger proportion of the energy from fast food. Furthermore, the validity of the nutrient information will by necessity differ from one nutrient to the next, depending on how well the food items we have included in the questionnaire contribute to the variation in the nutrient intake.

Our main purpose is, however, to rank the persons according to their nutrient intake. The significant relationships between energy and physical activity and between educational level and the intake of nutrients indicate that we are able to do so. Thus, although the calculation of nutrient intake is based on limited dietary information, several arguments support the validity of this method of assessing the relative nutrient intake of individuals in a population.

Relationships with level of education

We found significant relationships between the level of education and the intake of some nutrients. Our results are, generally speaking, in accordance with other findings from Tromsø (2,9), national Norwegian data (3-5), and some international data (e.g., 6,7). Of particular interest and importance is the inverse relationship between educational level and the proportion of energy from fats. The significant inverse relationship between educational level and the percentage of energy from polyunsaturated fat may be somewhat surprising. However, some national data may indicate a similar trend (5).

We found in men no relationship between dietary cholesterol intake per 10 MJ and level of education. This was also found in the Norkost survey (5). The statistically significant inverse relationship ($p < 0.001$) between level of education and the actual dietary cholesterol intake (not per 10 MJ) in men, but not in women, is in accordance with national data (5).

Norwegian men and women with long education have higher consumption of fruits and vegetables than men and women with less education (2-5). We therefore expected to find positive relationships between level of education and the intake of beta-carotene and vitamin C. This was confirmed. These associations, as well as the relationship found for dietary fibre, are also in accordance with national (4,5) and international (6-8) data.

Thus, subjects with relatively low level of education have dietary habits that may put them at increased risk of chronic diseases like cardiovascular diseases and cancer. Although this is an expected finding, it is still a cause for concern. The national health promotion policy aims at decreasing health differences within the population. The overall quality of the Norwegian diet has in some respect (e.g., the percentage of energy from fats) improved the last 30 years, but our findings along with other studies show that educational gradients persist. Johansson and coworkers (4) have previously shown that although educational level is a predictor for healthy food habits, the degree of attention paid to having a healthy diet was a stronger predictor. Adjusted for this variable, the impact of educational level on the intake of fruits and vegetables, fibre and percent energy from fats was reduced. The variable of interest may therefore not be years of education, but the interest in eating to keep healthy. This calls for amendments of the information strategies applied in the Norwegian nutrition policy in general, and in the health education directed toward persons with low educational level particularly.

In conclusion, we find in this study of more than 17,000 Norwegian men and women aged 25-69 that persons with higher education have more healthy dietary habits than persons with less education. This confirms previous studies. We believe that our findings underline the need for special efforts in order to change the food habits of the less educated.

ACKNOWLEDGEMENT

The study was carried out in cooperation with the National Health Screening Service, Oslo, Norway.

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