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ORIGINAL COMMUNICATION

A systematic review of socioeconomic differences in food habits in Europe: consumption of cheese and milk

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Objective: To assess differences in cheese and milk consumption across socioeconomic groups in representative samples from several European countries.
Design: A meta-analysis of published and unpublished surveys of food habits performed in nine European countries between 1985 and 1999. Educational and occupational levels were used as indicators of socio-economic status.
Results: A higher socioeconomic status was associated with a greater consumption of cheese. The pooled estimate of the difference in cheese consumption between women in the highest *vs* the lowest educational level was 9.0 g/day (95% CI: 7.1 to 11.0). The parallel observation in men was 6.8 g/day (95% CI: 3.4 to 10.1). Similar results were obtained using occupation as an indicator of socioeconomic status. The pooled estimates of the higher cheese consumption among subjects belonging to the highest (*vs* the lowest) occupational level were 5.1 g/day (95% CI: 3.7 to 6.5) in women and 4.6 g/day (95% CI: 2.1 to 7.0) in men. No statistically significant associations were found for milk consumption concerning educational or occupational level.
Conclusions: Our findings suggest that consumption of cheese is likely to be higher among subjects belonging to higher socioeconomic levels. We did not find enough evidence to support that milk intake is different according to educational or social levels.
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Introduction

Studies undertaken in developed countries have shown social class differences in health and life expectancy (Kunst & Mackenbach, 1994a,b; Mackenbach *et al*, 1997; Roos *et al*, 2001). Furthermore, there are socioeconomic disparities in mortality and morbidity from several diseases such as osteoporosis (del Rio-Barquero *et al*, 1992), coronary heart disease, stroke, digestive diseases, diabetes, obesity, and some cancers (US, Department of Health and Human Services, 2000). Some reasons may explain this mortality and morbidity inequalities, since lower social groups are exposed to more difficult and risky tasks and do not have such a great interest in their future health. Other important reasons associated with socioeconomic factors are nutrition-related and lifestyle characteristics such as physical activity, alcohol, smoking, and diet (Hulshof *et al*, 1991; Prätälä *et al*, 1994; Borrell *et al*, 2000).

Many studies have reported social differences in food consumption as well as the quantity and quality of the diet composition (Erkkilä *et al*, 1999; Fraser *et al*, 2000; Hupkens *et al*, 2000). On average, a higher socioeconomic level has been associated with healthier dietary patterns. A healthier dietary pattern is believed to include a higher consumption of fruits and vegetables and a lower intake of fat and meat. Thus, people with a higher socioeconomic level tend to show

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a higher consumption of vegetables, fruits and fiber products and a lower consumption of meat, meat products, and fats than people from a lower socioeconomic level (Erkkilä *et al*, 1999; Fraser *et al*, 2000; Irala-Estévez *et al*, 2000). In fact, there is available evidence supporting the assumption that a lower intake of meat and fat is associated with a higher socioeconomic level in Europe (Johansson *et al*, 1999; Roos *et al*, 1999; Groth *et al*, 2001).

A low intake of calcium and dairy products has been associated with several diseases such as osteoporosis (Gennari, 2001), hypertension (Ascherio *et al*, 1996), stroke (Iso *et al*, 1999) or even the insulin-resistance syndrome (Pereira *et al*, 2002). It is logical to think that part of the social inequalities in health in Europe could be associated with a lower intake of dairy products among socially deprived subjects.

Various measures of social status have been used to investigate their association with food intake in population samples from developed countries such as Australia (Baghurst *et al*, 1990), USA (Popkin *et al*, 1989), Great Britain (James *et al*, 1997; Fraser *et al*, 2000), The Netherlands (van Rossum *et al*, 2000), Spain (Arija *et al*, 1996), and Finland (Roos *et al*, 2001).

In this context, systematic reviews have been conducted to establish if there were substantial differences across social groups in several European countries with respect to several food items consumption (Roos *et al*, 1999). Roos *et al* reviewed published data dealing with differences in fruit and vegetable consumption across Europe (Roos *et al*, 2001) while Irala-Estévez *et al* carried out an analysis based on the differences in the consumption of fruits and vegetables across educational and occupational levels (Irala-Estévez *et al*, 2000). This new analysis is also a systematic review aimed to assess differences in consumption based on socioeconomic differences across European countries. We systematically assessed the differences in cheese and milk consumption according to socioeconomic status (divided into educational and occupational levels) in nutritional surveys conducted in nine European countries.

Methods

Some of the methods for this meta-analysis have been reported elsewhere (Irala-Estévez *et al*, 2000).

Identification of studies

To systematically review differences in the consumption of cheese and milk across educational/occupational levels, we used a formal meta-analysis (Greenland, 1998). Procedures of formal meta-analysis most often have been applied to combine the results from previously reported studies (Dickersin, 2002). However, in the current meta-analysis, we also included data from several European countries that have not yet been published.

An international network of European investigators was established (Compatibility of the household and individual nutrition surveys in Europe and disparities in food habits, FAIR-97-3096 funded by the DG-XII of the European Union) to prepare this report. The aim was to perform a comprehensive search of available data about disparities in food habits in Europe (the Disparities group). The two main methods to identify relevant studies were bibliography searches, and a questionnaire mailed to researchers working in this field in each country, in order to identify unpublished studies, or those published in the gray literature. The aim of this search was to identify relevant studies and to explore if there were large-scale comparative studies of the nature and magnitude of educational and/or occupational differences in food habits in 12 European countries participating in the FAIR 97-3096 project (Belgium, Denmark, Estonia, Finland, Germany, Greece, Ireland, Lithuania, The Netherlands, Norway, Spain, Sweden, and UK). The bibliography search on disparities in food habits was developed based on literature searches and information from researchers on references and relevant studies. References were located by conducting a computerized literature search (MEDLINE database) based on the objectives of the study and discussions among the participants via the following keywords regarding disparities: 'socio-economic status', 'education', 'occupation', 'social class', 'income', 'employment', 'poverty', 'gender', and 'region'; and regarding food habits and the intake of the specific nutrients: 'cheese', 'milk', 'food', 'meal', 'nutrients', 'nutrition', 'diet', and 'eating'. European researchers were also contacted following a snow-ball sampling approach and we also manually reviewed documentation centers, books and journals. Researchers from each participating country were asked in a questionnaire to provide information on key references, relevant studies, and names of other researchers in the field of their country. For a more detailed description of the searching process, see Roos *et al* (1999).

Criteria for selecting studies to be included in the meta-analysis were defined by the Disparities group and are as follows:

- a validated method for assessing dietary intake at the individual level;
- a nationwide sample or a representative sample of a region;
- the subjects were adults (11–85 y);
- the period of the study was between 1985 and 1999;
- information was provided on the mean and standard deviation (or standard error) of cheese and milk consumption across extreme levels of education and/or occupation (i.e. the mean and standard deviation for each educational or occupational level), and separately for men and women.

Altogether 32 studies from 15 countries were identified, but only 12 studies from nine countries met all the criteria to be included in this meta-analysis, that is, they provided separate information for men and women on means and standard deviations of individual food items consumption (cheese and/or milk) across levels of education or occupation.

Data abstraction

As occupation and education are intrinsically related and often serve as proxy measures of each other (US Department of Health and Human Services, 2000), the socioeconomic status was classified depending on two indicators: education and occupational class. From each selected study we identified the highest level of education (university or college) and the lowest level (primary education), and calculated the mean and standard deviations of the consumption of cheese and milk separately for men and women for each of both levels. Similarly, we calculated the mean and standard deviations of cheese and milk consumption from the highest and the lowest socioeconomic levels according to the classification by occupation used in the survey. The validity of each procedure used in individual studies for the classification of education levels and occupational levels was subjected to a panel revision by the Disparities group (Roos *et al*, 1999). A document was elaborated by this group after reviewing the relevant literature on classification of socioeconomic status in the participating countries (Roos *et al*, 1999).

We used four different methods to assess dietary habits: 24- or 48-h dietary recalls, non-weighted dietary record methods, food frequency questionnaires, and diet history (Buzzard, 1998). We also took into account the year in which the survey was performed and the participation rate in each survey.

Statistical Analysis

After critically assessing the nature, extent, and comparability of the data sources, the estimates of 12 studies from nine countries were considered appropriate to be included in the meta-analysis. The meta-analysis provides a logical structure for systematically quantifying evidence and for exploring bias and diversity in research (Greenland, 1998).

In our meta-analysis, socioeconomic status was considered as exposure (we did separate meta-analyses using educational and occupational levels), whereas consumption of cheese and milk was considered as the outcome. The average difference in cheese and milk consumption between individuals with the highest and the lowest socioeconomic levels (education and occupation) was used as the variable to be compared between socioeconomic levels (effect size, d_i). All comparisons were done separately for each gender. Country, year of the study, and method of dietary assessment were considered as variables which could act as effect modifiers.

We estimated a summary difference (d_s) as the weighted effect size (Hedges, 1982):

$$d_s = \sum d_i w_i / \sum w_i$$

where d_s is the pooled estimate of the difference in the consumption of cheese or milk between the highest and the lowest levels of education or occupation, w_i is the weight assigned to each study (w_i is the inverse of the variance for the difference of consumption found in each study), and d_i is the effect size in each individual study. Besides this, we calculated a 95% confidence interval for the pooled estimate of effect size.

$$95\%\ \mathrm{CI} = d_s \pm (1.96 \times \mathrm{s.e.})$$

where s.e. is the standard error of the pooled estimate (Greenland, 1998).

A test of heterogeneity was calculated, estimating a Q statistic, which follows a chi-square distribution with degrees of freedom n-1, n being the number of studies included in the analysis. A low P value for this statistic indicates the presence of heterogeneity, which somewhat compromises the validity of the pooled estimates (Takkouche *et al*, 1999). To pool the individual estimates we used the DerSimonian and Laird's random effect model (DerSimonian & Laird, 1986).

Because significant heterogeneity was clearly evident in the pooled difference estimates for all studies combined, we evaluated potential sources of heterogeneity by subset analysis and linear meta-regressions (Greenland, 1998). We analyzed subgroups and fitted a meta-regression using the year of the study, the response rate, the dietary assessment method (24–48 h recall, 7-day non-weighted dietary record, food frequency questionnaire and diet history) and the adjustment for total energy intake (yes or no) as independent variables. The difference of means in cheese and milk consumption (effect size, d_i) was used as the dependent variable.

Finally, sensitivity analyses were also conducted. We excluded the studies considered outliers and recalculated the pooled estimate of the differences in consumption.

Results

Thirteen studies were selected but only 12 of them fulfilled all the criteria to be included in this study. The EPIC study (EPIC Group in Spain, 1999) cannot be considered as a representative sample of the Spanish adult population and it was not included in the meta-analyses. Descriptive characteristics of the 13 studies are presented in Table 1.

The number of subjects included in these studies varied from 704 to 23 209. The range of the response rate in individual studies was 55 – 95%. Even though age was not individually available in each of these studies, the global age range was 11 – 85 y.

As shown in Table 2, regarding cheese consumption, we found a positive and statistically significant association between a higher level of education and a greater consumption of cheese both in women and men in most of the studies with some exceptions such as Denmark and Norway,

Table 1 Characteristics of studies

Country, region	*Study year*	*Sample (age range)*	*Response rate (%)*	*Effective sample size in the meta-analyses (n)**	*Dietary assessment method*
Finland	1992	Random sample (25–64 y)	66	Education (*n*= 1249)	3-day non-weighted dietary record
Norway	1993–1994	Random sample (16–79 y)	63	Education (*n*=1325)/occupation (*n*=1690)	Food frequency questionnaire
Sweden	1989	Random sample (19–74 y)	70	Education (*n*=1541)/occupation (*n*=892)	7-day non-weighted dietary record
Estonia	1997	Random sample (19–64 y)	67	Education (*n*=1093)/occupation (*n*=758)	24-h recalls
Denmark	1995	Random sample stratified by sex and age (18–65 y)	61	Education (*n*=462)/occupation (*n*=288)	7-day estimated food record
Ireland	1998	Multistage random sample (18–64 y)	62.2	Education (*n*=3032)/occupation (*n*=570)	Food frequency questionnaire
The Netherlands	1987–1988	Random sample (19–85 y)	79	Education (*n*=1647)	2-day non-weighted dietary record
Germany	1985–1989	Multistage stratified random sample (18–65 y)	74	Education (*n*=12199)/occupation (*n*=13157)	Food frequency questionnaire
Spain (Basque Country)	1990	Multistage random sample (25–60 y)	73	Education (*n*=624)/occupation (*n*=1337)	Three 24-h recall
Spain (Navarre)	1989–1990	Two-stage random stratified sample (≥ 15 y)	95	Education (*n*=534)/occupation (*n*=611)	Diet history
Spain (Catalonia)	1993	Multistage random sample (11–66 y)	55	Education (*n*=874)/occupation (*n*=840)	24-h recall
Spain (Andalusia)	1997–1999	Multistage sample (25–60 y)	93	Education (*n*=2610)	48-h recall
Spain+ (EPIC)	1995–1997	(29–69 y)	55–60	Education (*n*=34624)	Diet history

*We report the actual number of subjects included in extreme levels of education or occupation, and not the overall sample size of the respective survey.
+The EPIC study corresponds to the baseline dietary assessment of the Spanish EPIC cohort. This study cannot be considered as a representative sample of the Spanish adult population and, therefore, it was not initially included in the meta-analyses. But it is the only study in Spain including population from different regions, and for this reason it was included in a second step to provide a sensitivity analysis of the estimations.

where the trends were negative for men although they were not statistically significant. We also found positive associations between a higher level of occupation and a greater consumption of cheese in both women and men, but there were no statistically significant differences in most of the individual studies. We did not find an association between the level of education or occupation and the consumption of milk when we pooled the estimates from the different countries.

Although the EPIC study was based on a non-representative sample, this study is the only one in Spain including population from different regions and including a very large sample. Therefore, we decided to repeat the analyses including also the EPIC to provide a sensitivity analysis of the estimations. Nonetheless, neither the significance of the Q statistic for heterogeneity nor the significance of the estimations changed when this study was included in the analyses (Table 3).

As displayed in Table 3, the pooled estimates for cheese consumption followed a similar positive and statistically significant association. The average difference in the consumption of cheese between women belonging to extreme educational levels was 9.0 g/day (95% CI: 7.1 to 11.0). The analog observation in men was 6.8 g/day (95% CI: 3.4 to 10.1). The pooled estimates of the differences between subjects belonging to the highest and the lowest occupational levels were 5.1 g/day (95% CI: 3.7 to 6.5) in women and 4.6 g/day (95% CI: 2.1 to 7.0) in men. However, calculating the Q statistic for heterogeneity, we found that there was heterogeneity among the studies included in the meta-analysis.

When we assessed differences in milk consumption we observed a positive association between a higher level of education and a greater consumption of milk; however, this association was not statistically significant. The difference in the consumption of milk in women and men was 5.9 g/day (95% CI: -18.6 to 30.3) and 4.2 g/day (95% CI: −23.9 to 32.3), respectively. On the other hand, the pooled estimate when we used occupational level was negative and not statistically significant in both genders: −33.4 g/day (95% CI: −71.0 to 4.2) in men and −12.1 g/day (95% CI: −36.8 to 12.7) in women.

The survey from Finland was considered as an outlier in the analysis regarding milk intake and educational level because the limits of the difference were very wide ranging from −201.4 to −79.4 g/day. When we excluded this study, the positive association previously seen persisted with a higher effect size, 16.8 g/day (95% CI: -6.9 to 40.6) for men and 13.7 g/day (95% CI: -7.5 to 34.8) for women.

The difference of means across educational and occupational levels and their confidence intervals (95%) for each study and for the pooled estimate for cheese consumption are shown in Figures 1 (education) and 2 (occupation) and for milk consumption in Figures 3 (education) and 4 (occupation) (Figures 1–4).

Table 2 Mean and difference with the 95% CI of overall cheese and overall milk consumption (g/day) across extreme levels of education and/or occupation and separately for men and women

	Education						*Occupation*					
	Men			*Women*			*Men*			*Women*		
	High	*Low*	*Difference (95% CI)*	*High*	*Low*	*Difference (95% CI)*	*High*	*Low*	*Difference (95% CI)*	*High*	*Low*	*Difference (95% CI)*
Cheese												
Finland	36.9	28.2	+8.7 (+2.9 to +14.6)	40.3	33.8	+6.5 (+1.6 to +11.4)						
Norway	34.7	35.6	−0.9 (−5.0 to +3.2)	32.8	26.7	+6.1 (+3.1 to +9.1)	34.5	32.4	+2.1 (−1.5 to +5.7)	31.2	26.0	+5.2 (+2.1 to +8.3)
Sweden	44.0	40.0	+4.0 (−1.5 to +9.5)	44.0	34.0	+10.0 (+4.9 to +15.1)	46.0	41.0	+5.0 (0.0 to +10.0)	43.0	37.0	+6.0 (+1.8 to +10.2)
Estonia	15.0	6.0	+9.0 (+3.0 to +15.0)	9.0	2.0	+7.0 (+3.7 to +10.3)	12.0	5.0	+7.0 (+2.3 to +11.7)	10.0	7.0	+3.0 (−1.4 to +7.4)
Denmark	31.0	38.0	−7.0 (−22.5 to +8.5)	38.0	31.0	+7.0 (−0.2 to +14.2)	33.0	39.0	−6.0 (−13.6 to +1.6)	38.0	37.0	+1.0 (−7.8 to +9.8)
Ireland	17.4	10.8	+6.6 (+4.2 to +9.0)	26.8	13.8	+13.0 (+9.2 to +16.8)	16.8	13.8	+3.0 (−1.5 to +7.5)	24.8	18.3	+6.5 (−1.2 to +14.2)
The Netherlands	43.0	34.0	+9.0 (+3.6 to +14.4)	37.0	28.0	+9.0 (+5.0 to +12.9)						
Germany	50.3	36.1	+14.2 (+12.2 to +16.2)	48.6	34.7	+13.9 (+11.9 to +15.9)	42.8	35.7	+7.1 (+5.3 to +8.9)	39.6	33.2	+6.4 (+4.5 to +8.3)
Spain (Basque Country)	25.7	11.3	+14.3 (+5.1 to +23.6)	23.7	12.3	+11.4 (+4.1 to +18.6)	23.1	12.1	+11.1 (+2.2 to +20.0)	19.5	13.6	+5.9 (-0.1 to +11.9)
Spain (Navarre)	13.4	11.0	+2.5 (−4.1 to +9.0)	13.7	8.2	+5.5 (+0.4 to +10.6)	17.5	13.4	+4.1 (−3.3 to +11.6)	12.3	14.3	−1.9 (−8.8 to +5.0)
Spain (Catalonia)	28.5	19.9	+8.6 (+2.4 to +14.7)	23.6	15.6	+8.0 (+3.6 to +12.5)	26.1	19.7	+6.4 (+0.9 to +11.9)	20.3	16.3	+4.0 (−0.2 to +8.3)
Spain (Andalusia)	27.9	18.4	+9.5 (+4.9 to +14.1)	27.5	17.9	+9.6 (+5.3 to +13.9)						
Spain (EPIC)	35.2	27.8	+7.4 (+5.6 to +9.2)	36.3	28.4	+7.8 (+6.3 to +9.3)						
Milk												
Finland	407.7	548.1	−140.4 (−201.4 to –79.4)	265.0	344.2	−79.2 (−114.7to –43.7)						
Norway	538.4	548.4	−10.0 (−64.4 to +44.4)	408.3	394.4	+13.9 (−25.8 to +53.6)	524.3	642.4	−118.1 (−165.0 to –71.2)	401.8	422.4	−20.6 (−57.0 to +15.8)
Sweden	370.0	439.0	−69.0 (−134.2 to –3.8)	307.0	333.0	−26.0 (−67.8 to +15.8)	409.0	497.0	−88.0 (−148.0 to –27.8)	315.0	346.0	−31.0 (−68.0 to +6.4)
Estonia	204.0	217.0	−13.0 (−72.2 to +46.2)	169.0	175.0	−6.0 (−47.0 to +35.0)	164.0	215.0	−51.0 (−118.0 to +16.0)	114.0	196.0	−82.0 (−141.6 to –22.4)
Denmark	287	323	−36.0 (−147.5 to +75.5)	374	296	+78.0 (−27.5 to +183.5)	320.0	396.0	−76.0 (−200.1 to +48.1)	324.0	262.0	+62.0 (−8.3 to +132.3)
Ireland	386.8	342.0	+44.8 (+18.8 to +70.8)	296.2	305.8	−9.6 (−32.4 to +13.2)	328.1	370.6	−42.5 (−100.2 to +15.2)	278.6	302.7	−24.1 (−73.1 to +24.9)
The Netherlands	370.0	342.0	+28.0 (−13.0 to +69.0)	336.0	301.0	+35.0 (+3.9 to +66.1)						
Germany	201.3	145.4	+55.9 (+45.7 to +66.1)	182.4	131.9	+50.5 (+42.7 to +58.3)	162.0	147.5	+14.5 (+5.3 to +23.7)	151.3	134.2	+17.1 (+9.2 to +25.0)
Spain (Basque Country)	318.6	248.3	+70.4 (+10.8 to +130.0)	291.0	304.6	−13.6 (−55.6 to +28.4)	329.7	283.0	+46.7 (−7.1 to +100.1)	263.1	301.1	−38.0 (−80.0 to +3.7)
Spain (Navarre)	340.8	271.8	+69.0 (−0.2 to +138.3)	357.0	325.5	+31.5 (−63.3 to +126.3)	317.5	317.3	+0.3 (−80.0 to +80.2)	339.2	323.0	+16.2 (−54.0 to +86.4)
Spain (Catalonia)	228.9	232.4	−3.5 (−42.3 to +35.3)	258.5	243.4	+15.1 (−18.1 to +48.2)	222.6	233.3	−10.8 (−45.6 to +24.1)	259.0	246.6	+12.4 (−19.6 to +44.3)
Spain (Andalusia)	242.8	244.8	−2.0 (−31.1 to +27.1)	259.5	253.7	+5.8 (−19.9 to +31.5)						
Spain (EPIC)	215.4	194.1	+21.4 (+13.4 to +29.3)	245.8	249.1	−3.4 (−10.4 to +3.7)						

Table 3 Pooled differences in cheese and milk consumption (g/day) between individuals with the highest and the lowest educational/occupational levels in 13 European dietary surveys 1985–1995 (95% confidence intervals)

	Education				Occupation			
	Men		*Women*		*Men*		*Women*	
	Pooled estimates	*Q statistic (df, P)*	*Pooled estimates*	*Q statistic (df, P)*	*Pooled estimates*	*Q statistic (df, P)*	*Pooled estimates*	*Q statistic (df, P)*
Cheese								
All studies (n_1=12/n_2=9)	+6.76 (+3.40 to +10.12)	68.6 (11; <0.01)	+9.03 (+7.06 to +11.00)	32.2 (11, <0.01)	+4.56 (+2.13 to +7.00)	18.0 (8, 0.02)	+5.08 (+3.65 to +6.50)	9.0 (8, 0.342)
All studies + EPIC (n_1=13)	+6.88 (+4.10 to +9.67)	69.5 (12, <0.01)	+8.91 (+7.20 to +10.61)	34.1 (12, <0.01)				
Milk								
All studies (n_1=12/n_2=9)	+4.18 (−23.94 to +32.31)	79.8 (11, <0.01)	+5.85 (−18.55 to +30.25)	90.5 (11, <0.01)	−33.44 (−71.03 to +4.16)	49.2 (8, <0.01)	−12.06 (−36.81 to +12.7)	35.7 (8, <0.01)
All studies excluding Finland (n=11/n=9)	+16.84 (−6.93 to +40.61)	48.3 (10, <0.01)	+13.66 (−7.46 to +34.78)	55.2 (10, <0.01)	−33.44 (−71.03 to +4.16)	49.2 (8, <0.01)	−12.06 (−36.81 to +12.7)	35.7 (8, <0.01)
All studies + EPIC (n_1=13)	+8.66 (−12.04 to +29.35)	85.8 (12, <0.01)	+4.81 (−16.02 to +25.64)	138.4 (12, <0.01)				

A negative difference means a higher consumption by those in the lower socioeconomic level.
n_1: Number of studies by educational level, n_2: number of studies by occupational level.

In the subgroup analyses, when the data were stratified according to dietary assessment method, adjustment for total energy intake, response rate, and year of study, we found homogeneity in the comparison of cheese consumption between occupational levels among women. Homogeneity was also found in the comparison of cheese consumption according to occupation among men, when we stratified according to adjustment for total energy intake, response rate, and year of study (Table 4). With regard to milk consumption we observed this homogeneity in the comparison by education among men, when we stratified according to adjustment for the dietary assessment method (Table 4).

In order to find out those variables, which may be potential effect modifiers, we performed a meta-regression (Greenland, 1998) (Table 5). Among men, we found that differences in cheese and milk consumption between higher and lower educational levels and/or occupational levels decreased if the study had been developed after 1990, if the response rate had been lower than 70%, and if the consumption had been adjusted by total energy intake. Among women, we found a similar trend but only for the educational level.

Table 6 shows the results obtained when the milk consumption was divided into full-fat milk and skimmed milk. Only four studies collected data about types of milk consumption and educational level and only three of them about types of milk consumption and occupational level.

The pooled estimates for skimmed milk consumption followed a positive and statistically significant association only when occupational level was used to assess socioeconomic differences. The differences in the consumption of skimmed milk between the highest and the lowest level were 35.0 g/day (95% CI: 9.1 to 61.0) and 32.9 g/day (95% CI: 15.7 to 50.1) for women and men, respectively.

Analyzing full-fat milk consumption regarding occupational level, we found an inverse significant association with educational level, but only among women.

Discussion

A positive and statistically significant association was found between a higher level of education or occupation and a greater consumption of cheese. Those belonging to higher social classes may disregard the fat cheese provides in favor of its pleasure value (Prätälä *et al*, in press). However, the absolute magnitude of the association, although statistically significant, was quite low. The differences in consumption between the higher and the lower educational and occupational levels ranged from 5 to 9 g/day. Besides this, we did not have enough information to establish whether people from higher social classes consume low-fat cheese while people of the lower ones do it with high-fat cheese (Prätälä *et al*, in press).

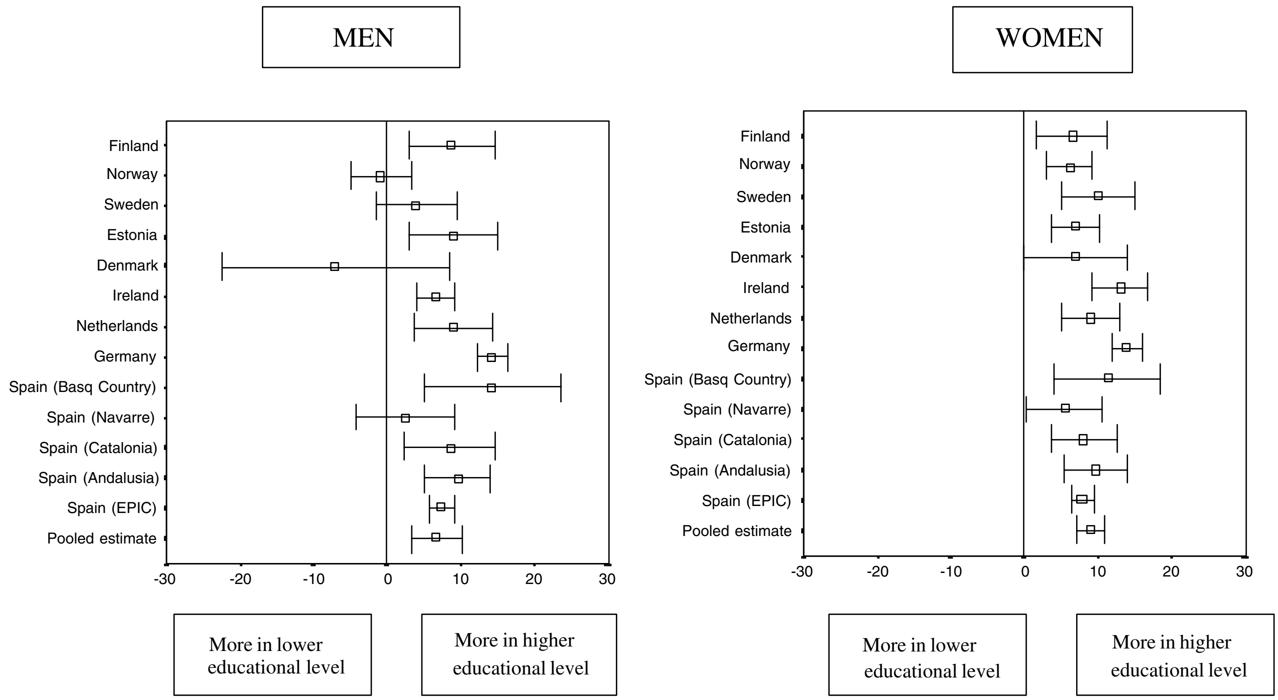

Figure 1 Cheese consumption (differences between the highest and the lowest educational levels).

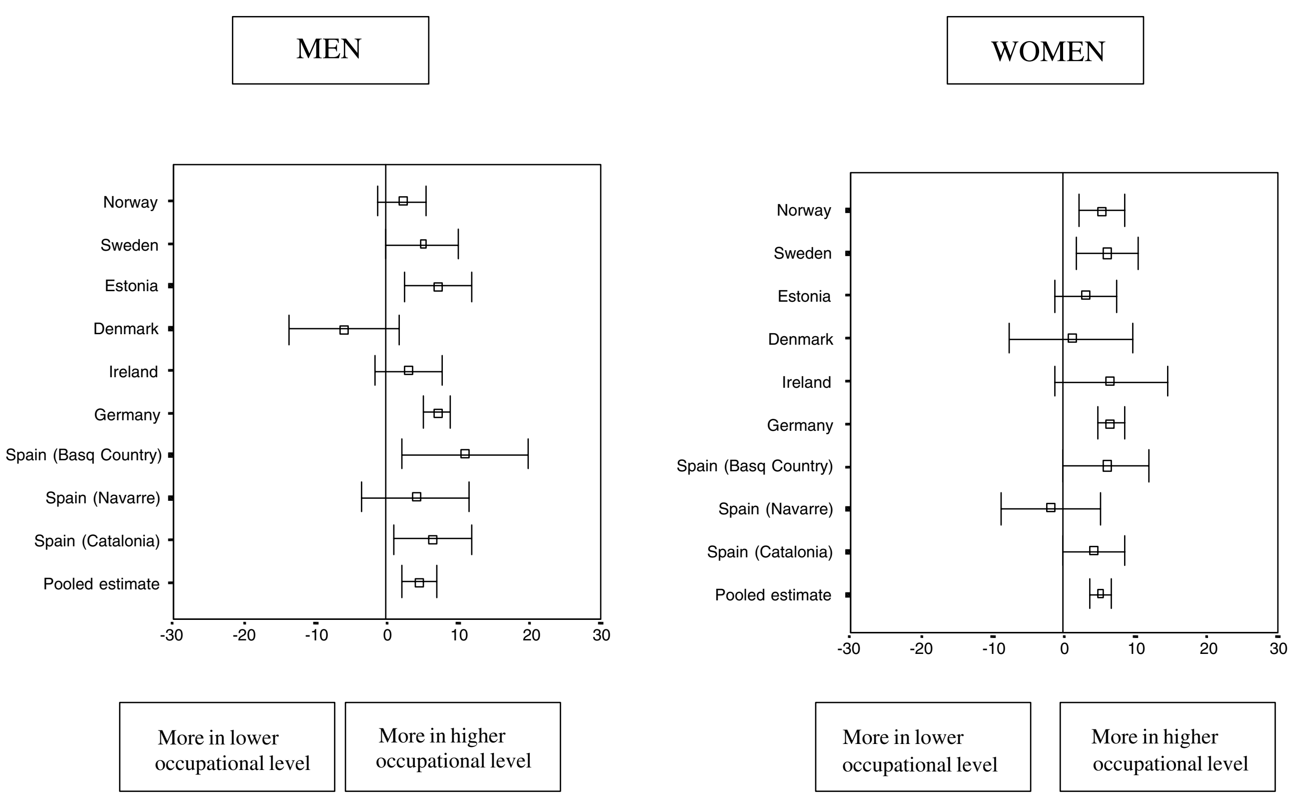

Figure 2 Cheese consumption (differences between the highest and the lowest occupational levels).

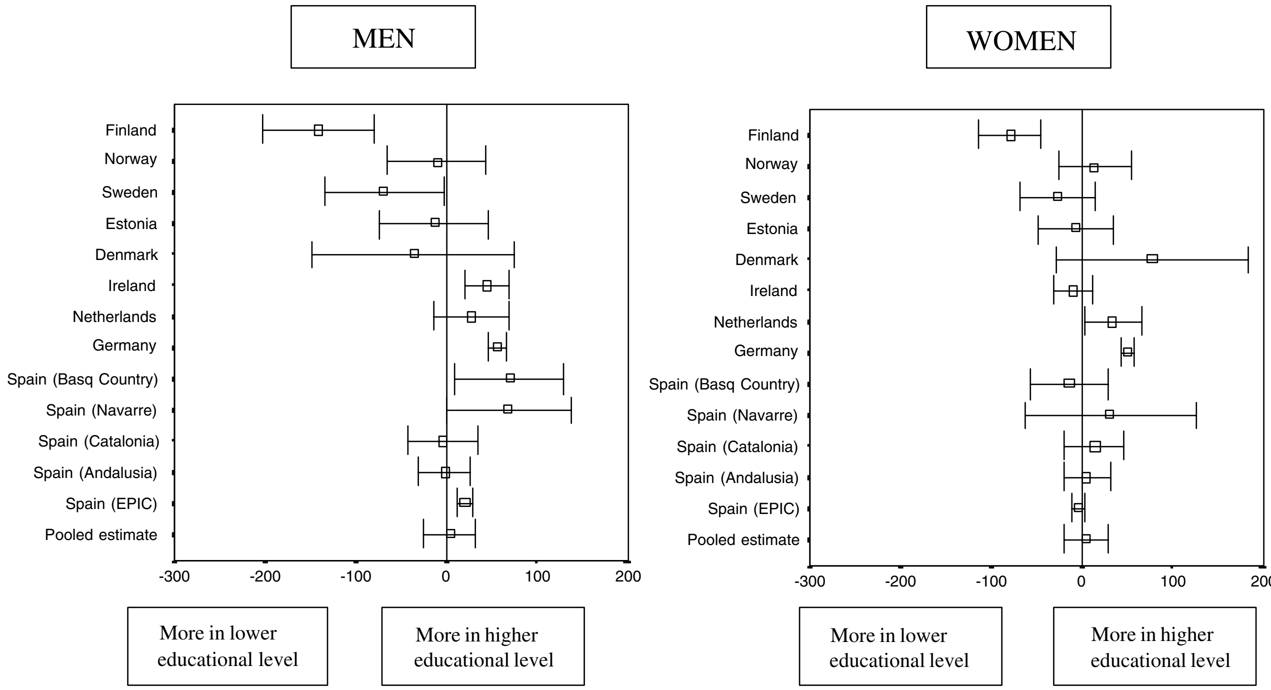

Figure 3 Milk consumption (differences between the highest and the lowest educational levels).

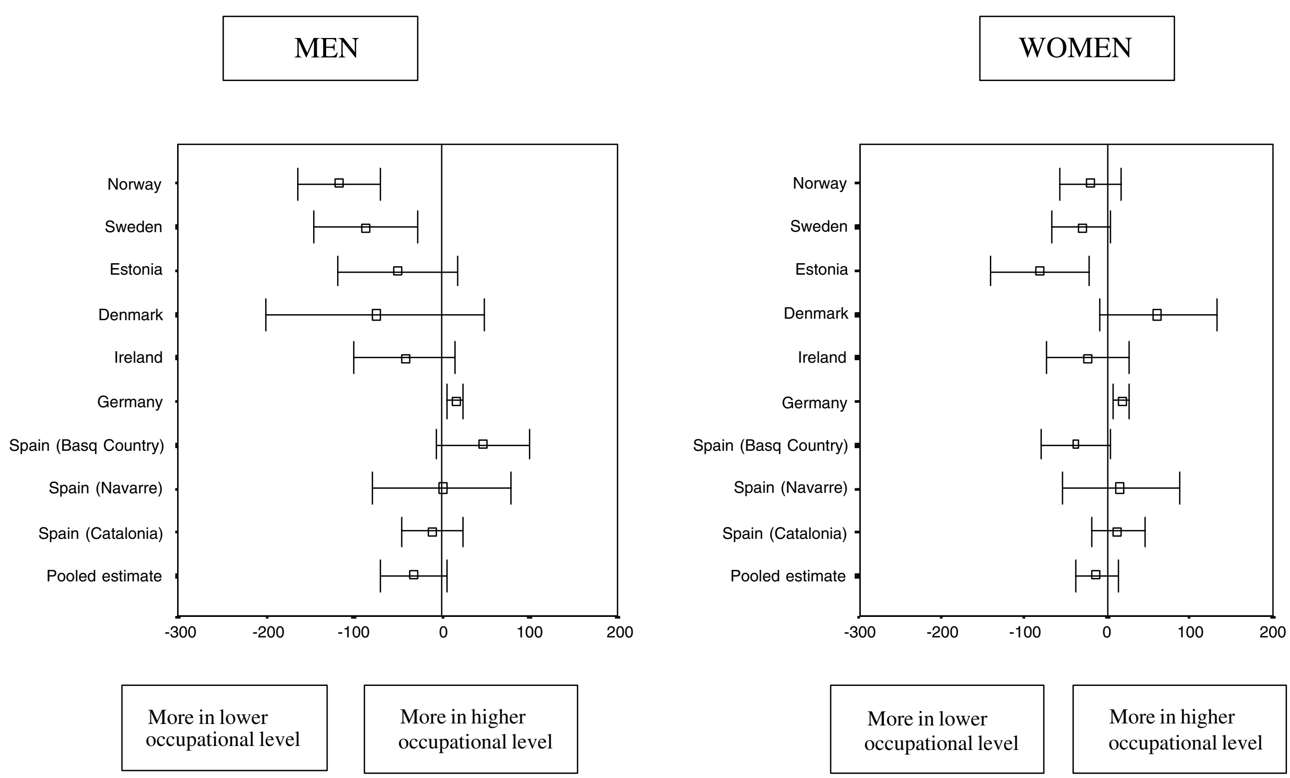

Figure 4 Milk consumption (differences between the highest and the lowest occupational levels).

Table 4 Pooled differences in cheese and milk consumption (g/day) between individuals with the highest and the lowest educational/occupational levels in 12 European dietary surveys 1985–1995 (95% confidence intervals); subgroup of analysis

	Education				*Occupation*			
	Men		*Women*		*Men*		*Women*	
	Pooled estimates	*Q statistic (df , P)*	*Pooled estimates*	*Q statistic (df , P)*	*Pooled estimates*	*Q statistic (df, P)*	*Pooled estimates*	*Q statistic (df, P)*
Cheese								
All studies (n_1=12/n_2=9)	+6.76 (+3.40 to +10.12)	68.6 (11; <0.01)	+9.03 (+7.06 to +11.00)	32.2 (11, <0.01)	+4.56 (+2.13 to +7.00)	18.0 (8, 0.02)	+5.08 (+3.65 to +6.50)	9.0 (8, 0.34)
By dietary assessment method								
24–48 h recall (n_1=5/n_2=3)	+9.61 (+6.87 to +12.35)	1.3 (4, 0.86)	+7.94 (+6.32 to +9.56)	2.3 (4, 0.67)	+7.24 (+3.7 to +10.79)	0.6 (2, 0.74)	+4.08 (+1.17 to + 6.99)	0.5 (2, 0.78)
7-day non-weighted dietary record (n_1=3/n_2=2)	+2.59 (−5.40 to +10.58)	9.5 (2, 0.01)	+7.94 (+4.85 to +11.03)	1.1 (2, 0.59)	−0.09 (−10.84 to +10.66)	5.5 (1, 0.02)	+4.72 (+0.43 to +9.00)	1.2 (1, 0.28)
Food frequency questionnaire (n_1=3/n_2=3)	+6.80 (−0.95 to +14.55)	47.8 (2, <0.01)	+11.02 (+6.03 to +16.00)	16.9 (2, <0.01)	+4.40 (+0.80 to +8.01)	7.8 (2, 0.02)	+6.12 (+4.63 to +7.61)	0.5 (2, 0.80)
Diet history (n_1=1/n_2=1)*	+2.46 (−4.11 to +9.03)		+5.48 (+0.36 to +10.60)		+4.11 (−3.35 to +11.57)		−1.92 (−8.85 to +5.01)	
By adjustment for total energy intake								
Yes (n_1=3/n_2=2)	+0.78 (−7.45 to +9.00)	12.7 (2, <0.01)	+6.31 (+3.91 to +8.71)	0.0 (2, 0.97)	−1.19 (−8.99 to +6.60)	3.5 (1, 0.06)	+4.67 (+1.82 to +7.52)	0.92 (1, 0.34)
No (n_1=9/n_2=7)	+8.68 (+5.58 to +11.78)	32.6 (8, <0.01)	+9.82 (+7.53 to +12.11)	24.8 (8, <0.01)	+6.48 (+5.06 to +7.90)	4.2 (6, 0.66)	+4.96 (+3.10 to +6.82)	7.8 (6, 0.25)
By response rate (%)								
≥70% (n_1=6/n_2=4)	+9.06 (+4.78 to +13.34)	21.6 (5, <0.01)	+10.22 (+7.48 to +12.97)	11.5 (5, 0.04)	+6.90 (+5.27 to +8.53)	1.5 (3, 0.68)	+4.90 (+1.87 to +7.94)	6.2 (3, 0.10)
<70% (n_1=6/n_2=5)	+4.58 (+0.39 to +8.78)	21.5 (5, <0.01)	+7.95 (+5.77 to +10.14)	9.9 (5, 0.08)	+3.05 (−0.36 to +6.47)	9.24 (4, 0.06)	+4.37 (+2.29 to +6.44)	1.5 (4, 0.82)
By year of study								
Before 1990 (n_1=5/n_2=4)	+8.89 (+3.56 to +14.23)	164.9 (4, <0.01)	+10.26 (+6.99 to + 13.53)	172.6 (4, 0.03)	+6.90 (+5.27 to +8.53)	1.5 (3, 0.68)	+4.90 (+1.87 to +7.94)	6.2 (3, 0.10)
After 1990 (n_1=7/n_2=5)	+5.35 (+1.65 to +9.06)	24.1 (6, <0.01)	+8.13 (+6.19 to +10.07)	10.4 (6, 0.11)	+3.05 (−0.36 to +6.47)	9.2 (4, 0.06)	+4.37 (+2.29 to +6.44)	1.5 (4, 0.82)
Milk								
All studies (n_1=12/n_2=9)	+4.18 (−23.94 to +32.31)	79.8 (11, <0.01)	+5.85 (−18.55 to +30.25)	90.5 (11, <0.01)	−33.44 (−171.03 to +4.16)	49.2 (8, <0.01)	−12.06 (−36.81 to +12.70)	35.7 (8, <0.01)
By dietary assessment method								
24–48 h recall (n_1=5/n_2=3)	+11.80 (−12.05 to +35.65)	7.0 (4, 0.14)	+9.47 (−4.93 to +23.87)	4.1 (4, 0.40)	−5.96 (−53.23 to +41.30)	5.2 (2, 0.07)	−34.00 (−86.82 to +18.82)	11.0 (2, <0.01)
7-day non-weighted dietary record(n_1=3/n_2=2)	−84.68 (−145.25 to –24.10)	4.8 (2, 0.09)	−16.16 (−89.23 to +56.91)	14.2 (2, <0.01)	−85.92 (−140.56 to –31.27)	0.0 (1, 0.87)	+10.40 (−80.19 to +100.99)	5.1 (1, 0.02)
Food frequency questionnaire (n_1=3/n_2=3)	+41.69 (+16.12 to +67.25)	5.8 (2, 0.06)	+19.47 (−24.65 to +63.60)	24.8 (2, <0.01)	−46.67 (−133.66 to +40.32)	32.1 (2, <0.01)	−3.15 (−34.40 to +28.1)	6.3 (2, 0.04)
Diet history (n_1=1/n_2=1)*	+69.04 (−0.25 to +138.33)		+31.51 (−63.28 to +126.30)		+0.27 (−79.67 to +80.21)		+16.18 (−54.01 to +86.37)	
By adjustment for total energy intake								
Yes (n_1=3/n_2=2)	−62.16 (−144.96 to +20.65)	10.1 (2, 0.01)	−0.48 (−84.72 to +83.76)	19.3 (2, <0.01)	−113.25 (−157.77 to –68.72)	0.4 (1, 0.55)	+14.84 (−65.29 to +94.96)	4.1 (1, 0.04)
No (n_1=9/n_2=7)	+22.87 (−2.14 to +47.89)	41.3 (8, <0.01)	+9.87 (−13.66 to +33.40)	52.9 (8, <0.01)	−15.96 (−47.07 to +15.15)	21.1 (6, <0.01)	−17.45 (−46.30 to +11.41)	31.0 (6, <0.01)
By response rate (%)								
≥70% (n_1=6/n_2=4)	+27.21 (−7.43 to +61.84)	31.8 (5, <0.01)	+15.09 (−13.97 to +44.15)	32.4 (5, <0.01)	−4.82 (−56.37 to +46.72)	12.2 (3, 0.01)	−9.23 (−44.45 to +26.00)	13.3 (3, <0.01)
<70% (n_1=6/n_2=5)	−22.39 (−71.27 to +26.49)	32.3 (5, <0.01)	-3.66 (−36.54 to +29.22)	22.6 (5, <0.01)	−56.43 (−101.86 to –11.00)	13.0 (4, 0.01)	−13.92 (−53.20 to +25.37)	15.3 (4, <0.01)
By year of study								
Before 1990 (n_1=5/n_2=4)	+35.02 (−1.91 to +71.95)	16.2 (4, <0.01)	+17.08 (−17.31 to +51.46)	21.9 (4, <0.01)	−4.82 (−56.37 to +46.72)	12.2 (3, 0.01)	−9.23 (−44.45 to +26.00)	13.3 (3, <0.01)
After 1990 (n_1=7/n_2=5)	−17.16 (−53.78 to +19.46)	32.5 (6, <0.01)	−2.82 (−28.71 to +23.08)	23.7 (6, <0.01)	−56.43 (−101.86 to –11.00)	13.0 (4, 0.01)	−13.92 (−53.20 to +25.37)	15.3 (4, <0.01)

A negative difference means a higher consumption by those in the lower socioeconomic level.
n_1: number of studies by educational level; n_2: number of studies by occupational level.
*Navarre.

Table 5 Meta-regression of the difference of means of overall cheese and overall milk consumption (g/day) across extreme levels of education and/or occupation and separately for men and women

	Education				*Occupation*			
	Men		*Women*		*Men*		*Women*	
	b	*CI (95%)*	*b*	*CI (95%)*	*b*	*CI (95%)*	*b*	*CI (95%)*
Cheese								
Dietary assessment method								
24–48 h recall	0 (ref.)		0		0 (ref.)		0	
7-day non-weighted dietary record	+0.06	−8.67 to +8.79	+3.35	−1.02 to +7.72	−1.64	−9.66 to +6.39	+2.09	−0.53 to +4.71
Food frequency questionnaire	−4.11	−17.78 to +9.56	−0.51	−7.16 to +6.15	−5.68	−17.36 to +6.00	+1.05	−2.86 to +4.97
Diet history	−2.46	−11.68 to +6.76	−0.83	−5.11 to +3.45	−3.25	−21.20 to +14.69	−5.91	−12.11 to +0.29
Adjustment for total energy intake								
No	0		0		0		0	
Yes	−7.26	−15.4 to +0.88	−3.37	−8.39 to +1.66	−5.84*	−10.41 to −1.27	−0.65	−4.81 to +3.52
Response rate								
<70%	0		0		0		0	
≥70%	+5.17*	+0.76 to +9.59	+3.80*	+0.87 to +6.72	+3.57	−0.64 to +7.78	+1.54	−1.52 to +4.61
Year of study								
Before 1990	0		0		0		0	
After 1990	−5.25*	−9.82 to −0.68	−3.96*	−6.94 to −0.97	−3.57	−7.78 to +0.64	−1.54	−4.61 to +1.52
Milk								
Dietary assessment method								
24–48 h recall	0 (ref.)		0		0 (ref.)		0	
7-day non-weighted dietary record	+43.07*	+9.85 to +76.28	+33.00	−6.79 to +72.78	+12.05	−88.98 to +113.08	+32.31	−32.86 to +97.47
Food frequency questionnaire	−106.39*	−180.36 to −32.42	−60.15	−133.13 to +12.84	−82.50	−299.97 to +134.98	+8.10	−99.69 to +115.89
Diet history	+12.58	−19.60 to 44.76	−13.49	−53.08 to +26.11	+3.96	−298.97 to +306.89	+34.04	−160.60 to +228.68
Adjustment for total energy intake								
No	0		0		0		0	
Yes	−94.99	−198.04 to +8.06	−50.50	−153.00 to +52.00	−122.79*	−219.77 to −25.81	−13.85	−93.72 to +66.02
Response rate								
<70%	0		0		0	0		
≥70%	+28.23	−2.67 to +59.15	47.39**	+24.53 to +70.24	+61.11*	+3.66 to +118.55	+22.38	−24.49 to +69.25
Year of study								
Before 1990	0		0		0			
After 1990	−34.71*	−63.57 to −5.84	−49.69**	−70.94 to −28.44	−61.11*	−118.55 to −3.66	−22.38	−69.25 to +24.49

*$P<0.05$; **$P<0.01$.

Table 6 Pooled differences in skimmed and full-fat milk consumption (g/day) between individuals with the highest and the lowest educational/occupational levels in four European dietary surveys 1985–1995 (95% confidence intervals)

	Education				*Occupation*			
	Men		*Women*		*Men*		*Women*	
	Pooled estimates	*Q statistic (df, P)*	*Pooled estimates*	*Q statistic (df, P)*	*Pooled estimates*	*Q statistic(df, P)*	*Pooled estimates*	*Q statistic (df, P)*
Skimmed milk								
All studies (n_1=4/n_2=3)	+20.44 (−28.70 to +69.58)	16.3 (3; <0.01)	+14.03 (−33.09 to +61.15)	20.9 (3, <0.01)	+32.89 (+15.68 to +50.10)	0.4 (2, 0.82)	+35.04 (+9.09 to +61.00)	3.6 (2, 0.16)
Fullfat milk								
All studies (n_1=4/n_2=3)	−30.70 (−69.74 to +8.33)	20.5 (3, <0.01)	−11.74 (−48.89 to +20.41)	16.1 (3, <0.01)	−17.72 (−43.93 to +8.50)	9.5 (2, 0.01)	−17.65 (−33.08 to −2.22)	0.9 (2, 0.64)

A negative difference means a higher consumption by those in the lower socioeconomic level.
n_1: number of studies by educational level; n_2: number of studies by occupational level.

Our findings about a higher consumption of cheese in the higher social class are consistent with previous studies (Popkin *et al*, 1989; Erkkilä *et al*, 1999; Borrell *et al*, 2000). We also observed a positive association between a higher level of education and a greater consumption of milk. However, the association between occupational level and milk intake was negative both for men and women.

Some dietary guidelines recommend replacing full-fat milk with low-fat or skimmed milk. In many countries, skimmed milk is mainly consumed by the higher socioeconomic groups whereas the lower groups consume full-fat milk. Unfortunately, our data did not allow us to perform further analyses, although some differences found in our meta-analysis point toward a higher consumption of skimmed milk among people belonging to higher occupational levels. We also have to take into account the magnitude of the effect found in the comparison between the higher and the lower occupational levels according to skimmed milk consumption. Both men and women belonging to the higher occupational level exceed the skimmed milk consumption in more than 30 g/day as compared with the lower one.

Possibly, class differences may explain differences in food choice. Subjects in a higher social class or better educated people have different attitudes toward health and healthy foods perhaps because highly educated people have a better knowledge about a healthy diet than subjects in a lower social class or less educated subjects. Roos *et al* found a higher consumption of vegetables, fruits and cheese and a lower consumption of milk, butter, and bread among higher socioeconomic levels (Roos *et al*, 1996). It has been shown that educated people eat more salads and less meat and fats. Some studies have suggested that the upper social groups tend to consume more low-fat milk and cheese and less full-cream milk than lower social groups (Smith & Baghurst, 1992; James *et al*, 1997). These differences can perhaps be explained by the fact that higher social groups are more interested, self-conscious, and responsible about their health.

Another explanatory factor is the status of different foods. 'Modern' foods are those whose consumption is increasing (Roos *et al*, 2001). Higher-class people distinguish themselves by choosing modern foods while lower-class people adhere more to traditional foods (Smith & Baghurst, 1992). Obviously, under-reporting is another factor that has to be taken into account. Those belonging to the lower social classes may under-report their intake due to their lower education, whereas those belonging to higher classes may do it in order to respond to what social images expect from them (Roos *et al*, 2001). However, it is difficult to accept that this general principle may also be applied to dairy products. Messages about health effects emphasizing low-fat products may be involved in this fact.

Osteoporosis is one of the major public health problems in developed countries (European Commission, 1998; National Institutes of Health, 2000). Moreover, although dietary calcium intake plays an important role in bone metabolism, consumption of this micronutrient is below recommended levels in many of these countries (European Commission, 1998). Calcium deficiency resulting from inadequate intake or poor intestinal absorption is related with reduced bone mass. In fact, an association between low levels of calcium intake and osteoporosis has been repeatedly reported (Dawson-Hughes, 1998; Bendich, 2001; Gennari, 2001). In addition, calcium may decrease the risk of hypertension (Ascherio *et al*, 1996), coronary artery disease (Ness *et al*, 2001), and stroke (Iso *et al*, 1999). Likewise, recently, an inverse association between frequency of dairy intake and development of obesity, abnormal glucose homeostasis, elevated blood pressure, dyslipidemia, and the overall insulin-resistance syndrome has been observed (Pereira *et al*, 2002).

An important concern is social desirability bias. People belonging to higher socioeconomic classes would be more likely to be compliant with the messages promoting dairy intake to reduce the risk of osteoporosis or several chronic diseases so that they might over-estimate their cheese consumption. However, we do not suspect that over-reporting may have biased our results. Instead, it seems more logical that subjects from a higher social class would be more likely to under-report their cheese consumption than to over-estimate it. A high consumption of dairy products has been considered as a component of an unhealthy diet because of the widespread message promoting a low-fat diet together with the known high-fat content of cheese products. Higher classes would avoid dairy products to follow the health policy recommendations (Schrauwen & Westerterp, 2000). Although the cheese benefits have been suggested, these are still very little known. On the other hand, we do think that part of the substantially greater effect size observed regarding skimmed milk may be explained by the social desirability bias and selective over-reporting among higher social classes.

Finally, we have to consider the cost of food and the available budget to buy food products. Cheese is generally an expensive product. This is another likely explanation of our findings.

A potential limitation of our study is the heterogeneity between studies. Substantial heterogeneity existed in the initial pooled estimates except for differences in cheese intake among women according to occupational levels. The stratification reduced the heterogeneity but only for cheese intake. Heterogeneity continued after stratifying on several factors when the difference in milk consumption was analyzed.

The response rate in each survey showed a positive association with the effect size. The difference in means across educational and/or occupational levels decreased when the response rate was less than 70%. An adequate design with a high response rate seems to minimize the bias in the estimation of the observed differences in consumption.

Likewise, we found that the difference in means decreased when the consumption of cheese or milk was adjusted for total energy intake. Adjustment for energy intake can be considered as an indicator of quality of the study. When the total amount of consumed food is considered, the differences in cheese and milk consumption were lower across educational and occupational levels. In many countries, people—especially men—belonging to the lower occupational and educational groups have a higher energy consumption and therefore eat more. Unfortunately, we did not have the individual information from each participant in order to get energy-adjusted figure in the use of cheese and milk. This procedure might have diminished the differences between men and women as far as low occupational levels are considered.

The meta-regression analysis was consistent with the existence of the inverse relationship between the year of the study and the size of the effect. The apparent trends of a lower effect size when the study was conducted after 1990 may suggest that behaviors regarding healthy diet are changing rapidly among individuals belonging to lower social classes. For example, milk and dairy products have been considered expensive products for years in many European countries. Nevertheless, such differences are currently waning, for example, the statistically significant differences in milk consumption between socioeconomic and educational levels found in Spain in 1983 disappeared in 1993 (Arija *et al*, 1996). Changes in food habits take place first in higher social classes because their consumption is related to what is socially perceived as 'modern'—though it is not always correlated with what is recommended in dietary patterns ('modernity hypothesis')—whereas the change in lower social classes takes place later because they consume more traditional foods and their change has to do with the imitation of what higher classes do (Prätälä *et al*, in press). In conclusion, we can infer that social differences are not a stable factor but a factor changing in time. Nevertheless, although the trends are changing, socioeconomic differences in cheese and milk intake remain among European countries.

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