Public Health Nutrition: 10(1), 24–33 DOI: 10.1017/S1368980007193940

Impact of parental education and income inequality on children's food intake

Stefanie Sausenthaler[1], Iris Kompauer[1,2], Andreas Mielck[3], Michael Borte[4,5], Olf Herbarth[6,7], Beate Schaaf[8], Andrea von Berg[8] and Joachim Heinrich[1,*],for the LISA Study Group†

[1]GSF – National Research Centre for Environment and Health, Institute of Epidemiology, Ingolstaedter Landstrasse 1, D-85764 Neuherberg, Germany: [2]Ludwig-Maximilians-University of Munich, Institute of Medical Data Management, Biometrics and Epidemiology, Munich, Germany: [3]GSF – National Research Centre for Environment and Health, Institute of Health Economics and Health Care Management, Neuherberg, Germany: [4]University of Leipzig, Department of Pediatrics, Leipzig, Germany: [5]Municipal Hospital 'St. Georg' Leipzig, Children's Hospital, Leipzig, Germany: [6]UFZ – Centre for Environmental Research, Department of Human Exposure Research and Epidemiology, Leipzig, Germany: [7]University of Leipzig, Faculty of Medicine, Environmental Hygiene and Environmental Medicine, Leipzig, Germany: [8]Marien-Hospital Wesel, Department of Pediatrics, Wesel, Germany

Submitted 1 August 2005: Accepted 31 January 2006

Abstract

Objective: To analyse the association between socio-economic indicators and diet among 2-year-old children, by assessing the independent contribution of parental education and equivalent income to food intake.

Design: The analysis was based on data from a prospective birth cohort study. Information on diet was obtained using a semi-quantitative food-frequency questionnaire. Low and high intake of food was defined according to the lowest and the highest quintile of food consumption frequency, respectively.

Setting: Four German cities (Munich, Leipzig, Wesel, Bad Honnef), 1999–2001.

Subjects: Subjects were 2637 children at the age of 2 years, whose parents completed questionnaires gathering information on lifestyle factors, including parental socio-economic status, household consumption frequencies and children's diet.

Results: Both low parental education and low equivalent income were associated with a low intake of fresh fruit, cooked vegetables and olive oil, and a high intake of canned vegetables or fruit, margarine, mayonnaise and processed salad dressing in children. Children with a low intake of milk and cream, and a high intake of hardened vegetable fat, more likely had parents with lower education. Low butter intake was associated with low equivalent income only.

Conclusions: These findings may be helpful for future intervention programmes with more targeted policies aiming at an improvement of children's diets.

Keywords
Socio-economic status
Parental education
Equivalent income
Diet
Children

Socio-economic differences in diet have been reported in all age groups. Previous studies conducted in developed countries, focusing on children[1], adults[2–7] or elderly people[8], have demonstrated associations particularly between fruit, vegetable, meat and fat consumption, on one hand, and different socio-economic indicators, on the other. These former findings generally supported the presumption that people from higher socio-economic classes have higher intakes of healthy foods, such as fruit and vegetables, and at the same time lower intakes of foods related to dietary habits supposed to be less healthy, such as meat and fat.

Various measures of socio-economic position have been applied to investigate their association with food and nutrient intake, including education, occupation and income. The majority of these studies were performed using only one single variable as an indicator of socio-economic status or using more socio-economic determinants, but failing to assess the independent contribution of each indicator. Two previous investigations demonstrated that education, occupation and income may affect food consumption in different ways due to different underlying social processes and thus do not serve as adequate proxies for one another[9,10]. Therefore, they highlighted the need for multiple indicator approaches coupled with simultaneous adjustment, so that the independent associations with food intake can be seen. The potential independence of

† Members of and institutions affiliated with the LISA Study Group are listed in the Appendix.

**Corresponding author:* Email joachim.heinrich@gsf.de

socio-economic indicators was also confirmed by results of a large survey carried out in Germany that showed relatively weak correlations between income and education and between income and occupation, respectively[11].

Studies in children examining the relationship between socio-economic status and intake of single food items are in general scarce. As far as we know, they also have never used multiple indicator approaches. Thus, our aim in the present study was to determine whether there are differences by parental education and income in food intake among 2-year-old children and whether or not the influence of both socio-economic indicators is independent.

Methods

Subjects

We analysed data from the LISA Study on 'Influences of lifestyle-related factors on the immune system and the development of allergies in childhood'. The design and objective of this prospective birth cohort study have been described in detail elsewhere[12]. In brief, 3097 newborns were initially recruited between November 1997 and January 1999 in the four German cities of Munich, Leipzig, Wesel and Bad Honnef. Data on lifestyle factors, including socio-economic status and diet, were collected by repeated parental-completed questionnaires at regular time intervals during the first two years (6, 12, 18 and 24 months of child's age).

The analysis presented in this paper is based on 2664 subjects who participated in the follow-up after 2 years (86% of the baseline population) between 1999 and 2001. From those, we excluded children without information about parental education ($n = 27$). Equivalent income could not be calculated in 281 cases (10.7%), but subjects were not excluded from the analysis. Thus, the final study population consisted of 2637 children.

The local ethics committees approved the study protocol, and informed consent was obtained from the parents.

Dietary assessment

Data on dietary intake were gathered by means of a semi-quantitative food-frequency questionnaire. In terms of fruit and vegetable consumption, parents estimated the child's habitual intake during the last six months using a 7-point scale comprising the following categories: several times a day, (almost) daily, several times a week, about once a week, two to three times a month, once in a month or less, (almost) never. Information on milk consumption was derived from the questions 'Does your child drink milk?' and 'If yes, how much?' The following categories were given: more than two cups per day, two cups per day, one cup per day, less than one cup per day, no milk. The intake of butter, margarine, vegetable oils, cream, mayonnaise and processed salad dressing was evaluated from questions on the use of these foods for meal preparation at home and was reported as: (almost) daily, several times a week, about once a week, two to three times a month, once a month or less, (almost) never.

Socio-economic status

Parental education was determined based on information about school education according to the German educational system, and was defined by the highest grade completed by either the mother or the father. Thus, children were assigned to the group of low (less than 10th grade), medium (10th grade) or high (more than 10th grade) level of parental education.

Net household income per month was reported on an 11-point scale ranging from less than 511 € to more than 3068 €. Because the income levels were originally reported in DM, their conversion into Euro generated these odd-numbered income limits. As this income measure does not account for the total number of household members and consequently does not reflect the actual amount that is available for each person, adjustment for family size and family composition was needed. The calculation of equivalent income according to the new OECD (Organisation for Economic Cooperation and Development) guidelines[13] was performed by dividing the net household income by an equivalence factor, which gives a weight of 1.0 to the first adult, 0.5 to all other adult persons and children above 14 years, and 0.3 to all children upto 14 years. As income was measured categorically, we took the mid-point of each income class to calculate the income level. For the lowest income level (less than 511 €) we calculated two-thirds of this limit, and for the highest income level (more than 3068 €) four-thirds, as done previously[14]. Finally, the new variable was collapsed into three groups each containing approximately an equal number of subjects. This resulted in the following groups of equivalent income: 160 €–913 € (low), 914 €–1339 € (medium), 1340 €–3146 € (high).

Statistical methods

Food frequency variables were transformed into dichotomous variables by first computing quintiles for each food item. Subsequently, the four upper quintiles (Q2–Q5) were pooled. If there were more than 20% of children in the lowest intake category, this procedure was not possible and the lower four quintiles (Q1–Q4) were summarised. Thus, we contrasted either low intake (Q1) (in terms of fresh fruit, salad and raw vegetables, cooked vegetables, milk, butter, sunflower oil, olive oil and cream) versus higher intake (Q2–Q5), or high intake (Q5) (in terms of canned vegetables or fruit, margarine, rape oil, safflower oil, hardened vegetable fat, mayonnaise, processed salad dressing and yoghurt for dressings) against lower intake (Q1–Q4). This kind of classification was carried out because it allowed comparing children with common food intake (about 80% of the study population) to children with uncommon food intake (about 20% of the study population).

Depending on the intake distribution of each food item, low intake (Q1) and high intake (Q5) each referred to

different consumption frequencies. Q1 is corresponding to food consumption not exceeding 'several times a week' (fresh fruit), 'two to three times a month' (salad and raw vegetables, cooked vegetables, cream), 'once in a month or less' (butter), '(almost) never' (sunflower oil, olive oil) or 'less than one cup per day' (milk). Concerning high intake, Q5 includes children who consumed foods at least '(almost) daily' (margarine), 'once a week' (canned vegetables or fruit, yoghurt for dressing), 'two to three times a month' (safflower oil, hardened vegetable fat, mayonnaise, processed salad dressing) or 'once in a month or less' (rape oil).

The relationship of food intake with parental education and equivalent income was first examined via contingency table analysis. In addition, the association between equivalent income and food intake was estimated for each group of parental education. For this specific analysis, low and medium levels of parental education were pooled, due to small numbers in the group of low parental education. The Cochran–Armitage test for trend was used to test for linear trends in food intake across categories of both parental education and equivalent income.

We further applied multiple logistic regression analyses to investigate the association of parental education and equivalent income with food intake. Odds ratios (OR) with corresponding 95% confidence intervals (CI) were computed for three different models. First, we examined the crude association of food intake with parental education and equivalent income. Then we calculated these effects adjusted for study area (Munich/Leipzig/Wesel and Bad Honnef), and finally we applied a model that simultaneously adjusted for study area and both socio-economic indicators. For each socio-economic variable the highest group (high parental education/high equivalent income) was used as reference category. An independent influence on food intake was presumed if at least in one group the effect estimate was statistically significant, and if the effect estimates showed the same direction across all categories of socio-economic status.

We additionally analysed the effect when maternal education was included in the model instead of parental education.

The correlation coefficient between parental education and equivalent income was 0.43. Thus, there should be no concern to include both variables in one model.

All computations were performed using the statistical analysis package SAS for Windows version 8.2 (SAS Institute, Cary, NC, USA). Two-sided P-values < 0.05 were considered statistically significant for all analyses.

Results

Characteristics of the study population

Among 2637 children included in the present analysis, equivalent income could not be calculated for 281 subjects (10.7%). No significant differences in mean maternal age at delivery (31.3 vs. 31.7 years; $P = 0.15$), living together with a partner (94.6 vs. 93.0%; $P = 0.26$), being a single parent (8.5 vs. 9.6%; $P = 0.54$), being married (81.8 vs. 85.3%; $P = 0.16$) and high level of parental education (67.8 vs. 67.6%; $P = 0.94$) could be observed between those who reported household income and those who did not. Those who answered the questions on household income had slightly fewer household members (3.7 vs. 3.8; $P = 0.005$) and were slightly less likely to have a childminder (92.5 vs. 96.1%; $P = 0.03$).

Table 1 shows the socio-economic characteristics of the study population according to study area. Altogether, 50.1 and 29.7% of all children lived in the urban areas of Munich (West Germany) and Leipzig (East Germany), respectively, while the rest lived in the more rural areas of Wesel and Bad Honnef (both West Germany). High levels of parental education were seen more often in the study area of Munich (79.4%) than in the areas of Leipzig (53.1%) and Wesel/Bad Honnef (60.7%). Similarly, high income was most prevalent in Munich (49.2%) in contrast to Leipzig (16.7%) and Wesel/Bad Honnef (23.7%).

Food intake also varied between East and West Germany, in particular between Leipzig and Munich. We observed statistically significant higher intakes of cream, butter, olive oil, safflower oil and hardened vegetable fat in Munich than in Leipzig (data not shown). Parents in Leipzig in turn more frequently indicated a high intake of

Table 1 Socio-economic characteristics of the study population according to study area

	Total ($N = 2637$)		Munich ($N = 1321$)		Leipzig ($N = 784$)		Wesel/Bad Honnef ($N = 532$)	
	n/*N*	%	*n*/*N*	%	*n*/*N*	%	*n*/*N*	%
Total			1321/2637	50.1	784/2637	29.7	532/2637	20.2
Parental education								
Low	120/2637	4.5	54/1321	4.1	21/784	2.7	45/532	8.5
Medium	729/2637	27.7	218/1321	16.5	347/784	44.2	164/532	30.8
High	1788/2637	67.8	1049/1321	79.4	416/784	53.1	323/532	60.7
Equivalent income*								
Low	751/2356	31.9	206/1183	17.4	375/701	53.5	170/472	36.0
Medium	794/2356	33.7	395/1183	33.4	209/701	29.8	190/472	40.3
High	811/2356	34.4	582/1183	49.2	117/701	16.7	112/472	23.7

*Low – 160 €–913 €; medium – 914 €–1339 €; high – 1340 €–3146 €.

fresh fruit, cooked vegetables, milk, canned vegetables or fruit, margarine and processed salad dressing.

Association between food intake and level of parental education

Table 2 shows the proportion of children in the intake categories of selected food items by level of parental education. We observed some significant linear trends: with increasing parental education, low intake of fresh fruit, cooked vegetables and butter decreased. The percentage of children with high intakes of margarine, mayonnaise and processed salad dressing also decreased with increasing parental education.

Education also seemed to have a great impact on olive oil consumption, as low intake was reported more than twice as often in the group of low or medium level of parental education than by highly educated parents. Further, significant parental educational differences were observed for the intake of cream, canned vegetables or fruit, safflower oil and hardened vegetable fat. According to the *P*-value for the trend test, these associations were indeed significant but the trend direction not that clear.

Association between food intake and equivalent income

Equivalent income also affected the consumption of many individual food items (Table 3). Subjects less likely reported low intakes of fresh fruit, cooked vegetables, cream, butter and olive oil, and high intakes of canned vegetables or fruit, margarine, mayonnaise and processed salad dressing, when equivalent income increased. High intake of safflower oil emerged to be more prevalent in medium- and high-income families than in low-income families.

Association of food intake and equivalent income according to level of parental education

Stratification of the association between food intake and equivalent income by level of parental education again showed some significant associations (Table 4).

While in the group of lower parental education the percentage of children with low intake of fresh fruit and cooked vegetables decreased with increasing equivalent income, no significant influence of equivalent income could be assessed in children of higher educated parents.

Irrespective of parental education, positive relationships emerged between equivalent income and intake of cream and olive oil, while the association with intake of canned vegetables or fruit, and margarine was negative. Each of these associations was similarly strong in both education groups, except for margarine, where the influence of income seemed to be substantially stronger in children of highly educated parents.

Some significant income differences in food intake were restricted to children with high parental education. In terms of low butter intake, a linear trend was shown to decrease with increasing equivalent income, whereas for the intake of sunflower oil an inverse association could be demonstrated. Moreover, children from the low-income group tended to consume more mayonnaise and processed salad dressing than did children in the high-income group.

Table 2 Consumption frequencies of selected food items according to level of parental education

				Level of parental education						
		Total ($N = 2637$)		Low ($N = 120$)		Medium ($N = 729$)		High ($N = 1788$)		
Variable	Intake category	*n*/*N*	%	*n*	%	*n*	%	*n*	%	*P*-value*
Low intake (Q1) vs. higher intake (Q2–Q5)†										
Fresh fruit	Low	551/2633	20.9	40	33.3	173	23.7	338	18.9	<0.001
Salad and raw vegetables	Low	548/2630	20.8	27	22.5	160	21.9	361	20.3	0.308
Cooked vegetables	Low	451/2626	17.2	35	29.2	139	19.2	277	15.6	<0.001
Milk	Low	396/2625	15.1	26	22.0	105	14.5	265	14.9	0.248
Cream	Low	509/2605	19.5	22	18.6	207	28.9	280	15.8	<0.001
Butter	Low	492/2609	18.9	33	28.2	166	23.0	293	16.5	<0.001
Olive oil	Low	588/2608	22.6	44	37.3	281	39.3	263	14.8	<0.001
Sunflower oil	Low	513/2586	19.8	18	15.7	136	19.1	359	20.4	0.195
High intake (Q5) vs. lower intake (Q1–Q4)†										
Canned vegetables or fruit	High	647/2617	24.7	33	27.5	245	33.9	369	20.8	<0.001
Margarine	High	539/2590	20.8	43	36.4	238	33.2	258	14.7	<0.001
Rape oil	High	133/2529	5.3	8	7.2	29	4.2	96	5.6	0.605
Safflower oil	High	492/2541	19.4	23	20.5	95	13.6	374	21.6	<0.001
Hardened vegetable fat	High	581/2549	22.8	32	28.1	190	27.1	359	30.7	<0.001
Mayonnaise	High	563/2590	21.7	54	47.0	179	25.1	330	18.7	<0.001
Processed salad dressing	High	455/2593	17.6	31	27.0	188	26.4	236	13.4	<0.001
Yoghurt for dressing	High	508/2589	19.6	25	21.9	120	16.9	363	20.5	0.231

* Cochran–Armitage trend test.
† Q1 – lowest quintile of consumption distribution; Q5 – highest quintile of consumption distribution.

Table 3 Consumption frequencies of selected food items according to equivalent income

				Equivalent income*						
		Total ($N = 2356$)		Low ($N = 751$)		Medium ($N = 794$)		High ($N = 811$)		
Variable	Intake category	*n*/*N*	%	*n*	%	*n*	%	*n*	%	*P*-value†
Low intake (Q1) vs. higher intake (Q2–Q5)‡										
Fresh fruit	Low	489/2353	20.8	178	23.7	176	22.2	135	16.7	<0.001
Salad and raw vegetables	Low	487/2350	20.7	166	22.1	155	19.6	166	20.5	0.445
Cooked vegetables	Low	403/2347	17.2	156	20.8	127	16.1	120	14.9	0.002
Milk	Low	355/2347	15.1	108	14.5	117	14.8	130	16.1	0.372
Cream	Low	458/2326	19.7	206	27.9	143	18.2	109	13.6	<0.001
Butter	Low	444/2330	19.1	173	23.4	159	20.1	112	14.0	<0.001
Olive oil	Low	507/2330	21.8	260	35.1	180	22.9	67	8.3	<0.001
Sunflower oil	Low	449/2310	19.4	139	18.1	141	18.1	175	21.9	0.056
High intake (Q5) vs. lower intake (Q1–Q4)‡										
Canned vegetables or fruit	High	581/2340	24.8	249	33.2	201	25.5	131	16.3	<0.001
Margarine	High	476/2316	20.6	230	31.2	171	21.8	75	9.4	<0.001
Rape oil	High	119/2262	5.3	31	4.4	42	5.4	46	5.9	0.177
Safflower oil	High	428/2274	18.8	102	14.3	159	20.4	167	21.4	<0.001
Hardened vegetable fat	High	508/2276	22.3	163	22.7	187	24.2	158	20.1	0.211
Mayonnaise	High	503/2314	21.7	185	25.3	185	23.6	133	16.7	<0.001
Processed salad dressing	High	408/2315	17.6	164	22.4	151	19.3	93	11.6	<0.001
Yoghurt for dressing	High	460/2310	19.9	139	19.1	161	20.6	160	20.1	0.642

* Low – 160 €–913 €; medium – 914 €–1339 €; high – 1340 €–3146 €.
† Cochran–Armitage trend test.
‡ Q1 – lowest quintile of consumption distribution; Q5 – highest quintile of consumption distribution.

Logistic regression analysis

The crude and adjusted OR calculated for the associations between food intake, on one hand, and level of parental education and equivalent income, on the other, are presented in Tables 5 and 6, respectively. Only the significant relationships are discussed here in more detail. Overall, most of the associations identified by contingency tables were confirmed in multivariate analysis.

Table 4 Consumption frequencies of selected food items according to level of parental education and equivalent income

				Lower parental education ($N = 758$)*							Higher parental education ($N = 1598$)						
				Equivalent income†							Equivalent income‡						
		Total ($N = 2356$)		Low		Medium		High			Low		Medium		High		
	Intake category	*n*/*N*	%	*n*	%	*n*	%	*n*	%	*P*-value§	*n*	%	*n*	%	*n*	%	*P*-value§
Low intake (Q1) vs. higher intake (Q2–Q5)¶																	
Fresh fruit	Low	489/2353	20.8	75	27.8	69	27.1	44	18.9	0.024	111	20.1	102	19.4	88	17.1	0.216
Salad and raw vegetables	Low	487/2350	20.7	56	20.7	66	25.9	48	20.6	0.975	105	19.0	113	21.5	99	19.3	0.904
Cooked vegetables	Low	403/2347	17.2	71	26.3	46	18.1	43	18.6	0.031	95	17.2	81	15.4	67	13.1	0.062
Milk	Low	355/2347	15.1	42	15.7	38	15.0	44	18.9	0.359	76	13.8	74	14.1	81	15.7	0.374
Cream	Low	458/2326	19.7	99	37.5	61	24.2	47	20.5	<0.001	116	21.1	73	14.1	62	12.1	<0.001
Butter	Low	444/2330	19.1	63	23.7	74	29.3	40	17.5	0.131	115	21.0	90	17.1	62	12.2	<0.001
Olive oil	Low	507/2330	21.8	126	47.7	94	37.6	62	27.2	<0.001	118	21.4	73	14.0	34	6.6	<0.001
Sunflower oil	Low	449/2310	19.4	45	17.0	51	20.6	38	16.9	0.975	98	18.0	93	18.1	124	24.3	0.011
High intake (Q5) vs. lower intake (Q1–Q4)¶																	
Canned vegetables or fruit	High	581/2340	24.8	104	38.7	88	34.7	59	25.5	0.002	143	25.9	106	20.3	81	15.8	<0.001
Margarine	High	476/2316	20.6	98	36.8	92	36.5	59	26.0	0.013	111	20.4	85	16.5	31	6.1	<0.001
Rape oil	High	119/2262	5.3	10	3.9	7	2.9	13	5.9	0.304	31	5.8	28	5.5	30	6.0	0.886
Safflower oil	High	428/2274	18.8	26	10.2	42	17.0	35	15.8	0.066	109	20.3	103	20.2	113	22.5	0.379
Hardened vegetable fat	High	508/2276	22.3	69	26.9	57	23.2	69	30.9	0.360	110	20.4	104	20.3	99	19.8	0.833
Mayonnaise	High	503/2314	21.7	74	28.1	79	31.6	56	25.0	0.484	119	21.8	87	16.8	88	17.2	0.050
Processed salad dressings	High	408/2315	17.6	79	30.0	57	22.9	58	25.8	0.257	88	16.1	76	14.6	50	9.8	0.003
Yoghurt for dressings	High	460/2310	19.9	45	17.4	45	18.1	37	16.6	0.834	120	21.9	114	22.0	99	19.3	0.313

* Lower – low and medium level of parental education.
† Low – 160 €–781 €; medium – 782 €–1034 €; high – 1035 €–3146 €.
‡ Low – 182 €–1065 €; medium – 1066 €–1562 €; high – 1563 €–3146 €.
§ Cochran–Armitage trend test.
¶ Q1 – lowest quintile of consumption distribution; Q5 – highest quintile of consumption distribution.

Table 5 Logistic regression results describing the association between food consumption and level of parental education

			Level of parental education		
			High ($N = 1788$)*	Medium ($N = 729$)	Low ($N = 120$)
Variable	Intake category		OR	OR (5% CI)	OR (5% CI)
Low intake (Q1) vs. higher intake (Q2–Q5)†					
Fresh fruit	Low	OR‡	1.00	1.33 (1.08–1.64)	2.14 (1.44–3.18)
		Adj. OR§		1.46 (1.18–1.82)	1.94 (1.30–2.91)
		Adj. OR¶		1.30 (1.02–1.65)	1.46 (0.93–2.29)
Salad and raw vegetables	Low	OR‡	1.00	1.11 (0.90–1.37)	1.14 (0.73–1.78)
		Adj. OR§		1.07 (0.86–1.33)	1.06 (0.68–1.66)
		Adj. OR¶		1.13 (0.88–1.43)	1.12 (0.69–1.82)
Cooked vegetables	Low	OR‡	1.00	1.29 (1.03–1.61)	2.24 (1.48–3.82)
		Adj. OR§		1.47 (1.16–1.87)	2.41 (1.59–3.67)
		Adj. OR¶		1.69 (1.07–1.80)	2.09 (1.32–3.32)
Milk	Low	OR‡	1.00	0.97 (0.76–1.24)	1.62 (1.03–2.55)
		Adj. OR§		1.08 (0.84–1.39)	1.60 (1.01–2.53)
		Adj. OR¶		1.24 (0.94–1.64)	1.73 (1.05–2.86)
Cream	Low	OR‡	1.00	2.16 (1.76–2.65)	1.22 (0.75–1.97)
		Adj. OR§		1.54 (1.23–1.93)	1.41 (0.85–2.34)
		Adj. OR¶		1.53 (1.19–1.96)	1.18 (0.67–2.08)
Butter	Low	OR‡	1.00	1.51 (1.22–1.87)	1.98 (1.30–3.02)
		Adj. OR§		1.33 (1.06–1.66)	1.66 (1.07–2.56)
		Adj. OR¶		1.16 (0.90–1.48)	1.53 (0.95–2.46)
Olive oil	Low	OR‡	1.00	3.72 (3.05–4.54)	3.42 (2.30–5.08)
		Adj. OR§		2.81 (2.28–3.46)	3.10 (2.04–4.71)
		Adj. OR¶		2.26 (1.79–2.86)	2.29 (1.44–3.64)
Sunflower oil	Low	OR‡	1.00	0.92 (0.74–1.15)	0.72 (0.43–1.21)
		Adj. OR§		0.92 (0.73–1.16)	0.77 (0.46–1.29)
		Adj. OR¶		0.97 (0.75–1.25)	0.87 (0.50–1.53)
High intake (Q5) vs. lower intake (Q1–Q4)†					
Canned vegetables or fruit	High	OR‡	1.00	1.95 (1.61–2.37)	1.44 (0.95–2.19)
		Adj. OR§		1.37 (1.12–1.68)	1.40 (0.91–2.16)
		Adj. OR¶		1.30 (1.03–1.63)	1.35 (0.85–2.16)
Margarine	High	OR‡	1.00	2.89 (2.36–3.55)	3.33 (2.24–4.95)
		Adj. OR§		2.12 (1.71–2.64)	2.86 (1.87–4.38)
		Adj. OR¶		1.78 (1.39–2.26)	2.58 (1.61–4.11)
Rape oil	High	OR‡	1.00	0.74 (0.48–1.13)	1.32 (0.62–2.78)
		Adj. OR§		0.69 (0.45–1.08)	1.36 (0.64–2.90)
		Adj. OR¶		0.72 (0.45–1.17)	0.83 (0.29–2.36)
Safflower oil	High	OR‡	1.00	0.67 (0.45–0.73)	0.94 (0.58–1.50)
		Adj. OR§		0.74 (0.57–0.95)	0.90 (0.56–1.45)
		Adj. OR¶		0.78 (0.59–1.04)	0.72 (0.41–1.27)
Hardened vegetable fat	High	OR‡	1.00	1.43 (1.17–1.75)	1.50 (0.98–2.29)
		Adj. OR§		1.55 (1.26–1.92)	1.44 (0.94–2.20)
		Adj. OR¶		1.50 (1.19–1.91)	1.57 (0.98–2.50)
Mayonnaise	High	OR‡	1.00	1.46 (1.19–1.80)	3.84 (2.62–5.65)
		Adj. OR§		1.46 (1.17–1.83)	3.15 (2.08–4.76)
		Adj. OR¶		1.36 (1.05–1.74)	3.04 (1.93–4.79)
Processed salad dressing	High	OR‡	1.00	2.32 (1.87–2.88)	2.39 (1.55–3.70)
		Adj. OR§		1.95 (1.56–2.44)	2.18 (1.40–3.38)
		Adj. OR¶		1.82 (1.42–2.33)	1.89 (1.16–3.09)
Yoghurt for dressing	High	OR‡	1.00	0.79 (0.63–0.99)	1.09 (0.69–1.72)
		Adj. OR§		0.78 (0.62–0.99)	0.96 (0.60–1.53)
		Adj. OR¶		0.73 (0.56–0.95)	0.89 (0.53–1.48)

OR – odds ratio; CI – confidence interval.
* Reference category.
† Q1 – lowest quintile of consumption distribution; Q5 – highest quintile of consumption distribution.
‡ Crude OR.
§ OR adjusted for study area.
¶ OR adjusted for study area and equivalent income.

Low intake of fresh fruit, cooked vegetables and butter, and at the same time high intake of margarine and mayonnaise, steadily increased with decreasing levels of parental education when considering unadjusted effects. The risk estimates for intake of cream, olive oil, canned vegetables or fruit, hardened vegetable fat and processed salad dressing differed significantly between levels of parental education, but without a clear linear relationship. In terms of milk consumption, it turned out that children with low parental education had significantly decreased intakes compared with children of highly educated parents.

Table 6 Logistic regression results describing the association between food consumption and equivalent income

			Equivalent income		
			High ($N = 811$)*	Medium ($N = 794$)	Low ($N = 751$)
Variable	Intake category		OR	OR (5% CI)	OR (5% CI)
Low intake (Q1) vs. higher intake (Q2–Q5)†					
Fresh fruit	Low	OR‡	1.00	1.43 (1.11–1.83)	1.55 (1.21–1.99)
		Adj. OR§		1.47 (1.14–1.90)	1.83 (1.40–2.39)
		Adj. OR¶		1.39 (1.07–1.80)	1.62 (1.22–2.16)
Salad and raw vegetables	Low	OR‡	1.00	0.94 (0.74–1.21)	1.10 (0.86–1.40)
		Adj. OR§		0.89 (0.70–1.15)	1.03 (0.79–1.33)
		Adj. OR¶		0.87 (0.68–1.13)	0.98 (0.74–1.29)
Cooked vegetables	Low	OR‡	1.00	1.10 (0.84–1.44)	1.50 (1.16–1.95)
		Adj. OR§		1.23 (0.93–1.62)	1.91 (1.44–2.54)
		Adj. OR¶		1.13 (0.85–1.50)	1.60 (1.18–2.17)
Milk	Low	OR‡	1.00	0.91 (0.69–1.19)	0.88 (0.67–1.17)
		Adj. OR§		0.94 (0.72–1.24)	1.00 (0.74–1.35)
		Adj. OR¶		0.89 (0.67–1.18)	0.88 (0.64–1.22)
Cream	Low	OR‡	1.00	1.41 (1.08–1.86)	2.46 (1.90–3.19)
		Adj. OR§		1.15 (0.87–1.54)	1.42 (1.06–1.89)
		Adj. OR¶		1.06 (0.79–1.42)	1.21 (0.89–1.65)
Butter	Low	OR‡	1.00	1.55 (1.19–2.02)	1.87 (1.44–2.44)
		Adj. OR§		1.32 (1.01–1.74)	1.52 (1.15–2.02)
		Adj. OR¶		1.26 (0.96–1.67)	1.39 (1.02–1.88)
Olive oil	Low	OR‡	1.00	3.27 (2.42–4.41)	5.96 (4.45–7.98)
		Adj. OR§		2.55 (1.87–3.48)	3.75 (2.76–5.11)
		Adj. OR¶		2.10 (1.53–2.88)	2.65 (1.91–3.67)
Sunflower oil	Low	OR‡	1.00	0.79 (0.62–1.01)	0.79 (0.61–1.01)
		Adj. OR§		0.79 (0.62–1.02)	0.77 (0.58–1.01)
		Adj. OR¶		0.80 (0.62–1.03)	0.78 (0.59–1.05)
High intake (Q5) vs. lower intake (Q1–Q4)†					
Canned vegetables or fruit	High	OR‡	1.00	1.76 (1.37–2.25)	2.56 (2.01–3.25)
		Adj. OR§		1.39 (1.08–1.80)	1.50 (1.15–1.95)
		Adj. OR¶		1.31 (1.01–1.71)	1.34 (1.01–1.77)
Margarine	High	OR‡	1.00	2.68 (2.00–3.59)	4.35 (3.28–5.79)
		Adj. OR§		2.00 (1.47–2.71)	2.58 (1.90–3.50)
		Adj. OR¶		1.71 (1.25–2.34)	1.93 (1.39–2.70)
Rape oil	High	OR‡	1.00	0.91 (0.59–1.41)	0.72 (0.45–1.15)
		Adj. OR§		0.87 (0.56–1.36)	0.63 (0.38–1.05)
		Adj. OR¶		0.93 (0.59–1.45)	0.71 (0.42–1.21)
Safflower oil	High	OR‡	1.00	0.94 (0.74–1.21)	0.61 (0.47–0.80)
		Adj. OR§		1.10 (0.86–1.42)	0.94 (0.70–1.26)
		Adj. OR¶		1.16 (0.90–1.50)	1.04 (0.76–1.42)
Hardened vegetable fat	High	OR‡	1.00	1.26 (0.99–1.61)	1.17 (0.91–1.50)
		Adj. OR§		1.30 (1.02–1.66)	1.30 (0.99–1.69)
		Adj. OR¶		1.19 (0.93–1.53)	1.09 (0.82–1.45)
Mayonnaise	High	OR‡	1.00	1.54 (1.20–1.98)	1.69 (1.32–2.17)
		Adj. OR§		1.37 (1.05–1.78)	1.68 (1.27–2.22)
		Adj. OR¶		1.24 (0.95–1.62)	1.35 (1.00–1.82)
Processed salad dressing	High	OR‡	1.00	1.82 (1.37–2.40)	2.20 (1.66–2.90)
		Adj. OR§		1.57 (1.18–2.09)	1.67 (1.24–2.25)
		Adj. OR¶		1.37 (1.02–1.83)	1.28 (0.93–1.77)
Yoghurt for dressing	High	OR‡	1.00	1.03 (0.81–1.32)	0.94 (0.73–1.21)
		Adj. OR§		0.98 (0.76–1.26)	0.92 (0.70–1.20)
		Adj. OR¶		1.04 (0.80–1.34)	1.02 (0.76–1.36)

OR – odds ratio; CI – confidence interval.
* Reference category; low – 160 €–913 €; medium – 914 €–1339 €; high – 1340 €–3146 €.
† Q1 – lowest quintile of consumption distribution; Q5 – highest quintile of consumption distribution.
‡ Crude OR.
§ OR adjusted for study area.
¶ OR adjusted for study area and equivalent income.

Study area was shown to have a weak influence on the consumption of fresh fruit, cooked vegetables, butter, mayonnaise and processed salad dressing, but a very strong one on the intake of cream, olive oil, canned vegetables and margarine, even though not consistent across all levels of parental education. Indeed, risk estimates diminished but remained statistically significant. Even after adjusting for equivalent income, the majority of risk estimates became only slightly smaller; the effects of parental education on butter intake attenuated to non-significance.

When analysing the influence of maternal education on food intake, trends across the levels of maternal education

were more stable compared with parental education. For foods such as fresh fruit, milk, cream, hardened vegetable fat and processed salad dressing, the OR increased and became partially significant. For other foods the effect estimates decreased slightly, but none of the associations changed their direction.

The adjusted effects of equivalent income showed that low intake of fresh fruit, cooked vegetables, butter and olive oil, and high intake of margarine, steadily increased with decreasing equivalent income. In terms of high intake of canned vegetables or fruit, mayonnaise and processed salad dressing, a slight tendency to rise across declining levels of equivalent income could also be detected, but the strength of associations was weak and hence the conclusion less clear.

Discussion

The results of the present study suggest that both parental education and equivalent income affect the intake of certain food items in 2-year-old children. As summarised in Fig. 1, the intake of fresh fruit, cooked vegetables, olive oil, canned vegetables or fruit, margarine, mayonnaise and processed salad dressing seemed to be influenced by parental education and equivalent income in a similar manner. Parental education turned out to be the only independent predictor for the intake of milk, cream and hardened vegetable fat, while an independent influence of equivalent income alone could be observed for butter intake.

In the past, a few studies have been conducted describing the relationship between socio-economic determinants and childhood nutrition. A study carried out in Germany, being part of the World Health Organization's cross-sectional survey HBSC (Health Behaviour in School-Aged Children), analysed this association in 11- to 15-year-old children[15]. They observed that the impact of social situation was particularly strong for healthy foods, such as raw vegetables, fruit and whole wheat bread. Apart from studies that applied principal components analysis[16,17] or determined the degree of compliance with dietary recommendations[18,19], other researchers have primarily paid attention to the socio-economic status of the mother, particularly maternal education. For example, in a Spanish study investigating the association between level of maternal education and food consumption in pre-school children, consumption of added sugars, fruit and fish increased with increasing maternal education, while snacking was more frequent with decreasing maternal education[20]. Among several demographic characteristics examined in a cross-sectional survey in 2–6-year-old children in England, high maternal education was positively associated with higher vegetable intake, but not with fruit intake[1]. A Belgian study demonstrated that differences in children's consumption of fruit and vegetables between levels of maternal education could be largely explained by the food intake of the mother[21].

Furthermore, socio-economic status has been defined according to the father's education level, his occupation and the family income[22]. In this way, a study carried out in Finland observed that children with higher socio-economic status consumed more fruit, low-fat milk and margarine, and less high-fat milk, butter, rye products and coffee, than did children in the lower socio-economic group. However, they did not investigate the independent influence of each single socio-economic indicator.

Before the implications of these findings are discussed, several limitations of our analysis need to be considered. First, fruit, salad, vegetable and milk intakes were reported specifically for children, whereas fats, oils, cream, mayonnaise and salad dressing used for meal preparation at home were assessed as consumption frequencies of the whole household. We cannot prove that household consumption frequencies are a valid surrogate for the food intake in 2-year-old children in general, but assume that even if children do not consume all meals prepared at home, it is unlikely that their own meal is prepared with

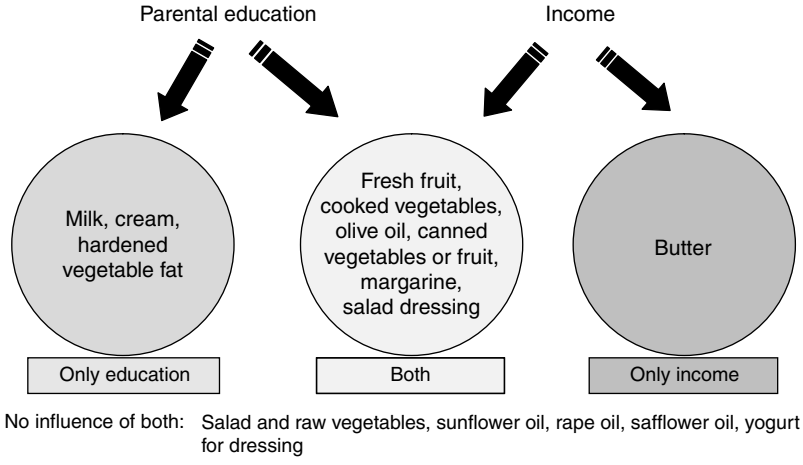

Fig. 1 Summary of the influence of parental education and equivalent income on food intake

other fats than the reported ones. As we analysed only qualitative food intake, we suggest that even if the surrogate variables are imprecise, they do not introduce any bias to our finding. Second, parents of participating children have reached a comparatively high level of education. In 2002, the Federal Statistical Office in Germany estimated that 31% of all adults aged between 20 and 39 years have completed more than 10th grade according to the German educational system[23]. Thus, in our study, more than twice as many subjects reached high levels of education compared with the total German population. Therefore, it is likely that we have under-represented children from lower social classes, even if we consider the urban over-representation of our study population. In this context, it also has to be taken into account that, although we proved a low correlation between parental education and income level ($r = 0.43$), both socio-economic variables are not independent. The income categories within the groups of lower and higher parental education have different lower and upper limits. Therefore, we cannot completely rule out that the impact of parental education on food intake is partly affected by income. Third, we investigated how often children consumed various food items, but did not consider portion sizes. As a result, children were assigned to different intake categories based on food consumption frequencies only, which might have led to some misclassification in outcome measurement. Fourth, the food frequency method is highly dependent on the participant's ability to recall usual consumption frequencies of specific foods during the last six months. Since recall ability has been shown to differ between socio-economic groups[24], we were unable to determine whether the same degree of validity was achieved in each socio-economic group. Some previous studies also considered the fact that overreporting of healthy foods mainly occurs among subjects with higher levels of education, as they have a greater knowledge about healthy diet and therefore might tend to overstate their true consumption[2,6]. This would introduce some bias. However, in our opinion it cannot completely explain the variation in food intake by level of parental education seen in our analysis. One further statistical problem is due to the use of the Cochran–Armitage test for trend when comparing the proportions of food intake among the groups of socio-economic status. This test is appropriate when a linear dose–response relationship is assumed, but is known to lack in power for other shapes[25]. Our assumption of a linear relationship between food intake and socio-economic status seems plausible to us. However, when comparing only three groups, the results of these tests for linear trends might be vague and should be interpreted cautiously.

The most notable strength of this study is its large sample size. Previous investigations with comparable study designs have mostly analysed data of fewer children than we did. More importantly, studies dealing with nutrition-related issues in early childhood are scarce, particularly those concerning the association between social determinants and diet. Some researchers have tried to determine the impact of maternal education on children's diet. As far as we know, the association between income level and intake of single food items in children has never been investigated. This indicates the need to assess the independent contribution of parental education and equivalent income on individual food intake in children.

The key findings of the present study highlight that the impact of socio-economic determinants on food intake exists even among very young children. Not all foods seem to be influenced by both parental education and income level. Thus, it would be profitable to further investigate the association between more foods consumed by children and socio-economic factors. This could help to develop more targeted programmes addressing the diet of children.

Acknowledgements

This work was supported by grants 01 EG 9732 and 01 EG 9705/2 from the Federal Ministry for Education, Science, Research and Technology.

References

1 Cooke LJ, Wardle J, Gibson EL, Sapochnik M, Sheiham A, Lawson M. Demographic, familial and trait predictors of fruit and vegetable consumption by pre-school children. *Public Health Nutrition* 2003; **7**: 295–302.
2 De Irala-Estevez J, Groth M, Johansson L, Oltersdorf U, Prattala R, Martinez-Gonzalez MA. A systematic review of socio-economic differences in food habits in Europe: consumption of fruit and vegetables. *European Journal of Clinical Nutrition* 2000; **54**: 706–14.
3 Giskes K, Turrell G, Patterson C, Newman B. Socioeconomic differences among Australian adults in consumption of fruit and vegetables and intakes of vitamins A, C and folate. *Journal of Human Nutrition and Dietetics* 2002; **15**: 375–85.
4 Agudo A, Pera G. Vegetable and fruit consumption associated with anthropometric, dietary and lifestyle factors in Spain. EPIC Group of Spain. European Prospective Investigation into Cancer and Nutrition. *Public Health Nutrition* 1999; **2**: 263–71.
5 Johansson L, Thelle DS, Solvoll K, Bjorneboe GE, Drevon CA. Healthy dietary habits in relation to social determinants and lifestyle factors. *British Journal of Nutrition* 1999; **81**: 211–20.
6 Hulshof KF, Brussaard JH, Kruizinga AG, Telman J, Lowik MRH. Socio-economic status, dietary intake and 10 y trends: the Dutch National Food Consumption Survey. *European Journal of Clinical Nutrition* 2003; **57**: 128–37.
7 Groth MV, Fagt S, Brondsted L. Social determinants of dietary habits in Denmark. *European Journal of Clinical Nutrition* 2001; **55**: 959–66.
8 Van Rossum CT, van de Mheen H, Witteman JC, Grobbee E, Mackenbach JP. Education and nutrient intake in Dutch elderly people. The Rotterdam Study. *European Journal of Clinical Nutrition* 2000; **54**: 159–65.
9 Turrell G, Hewitt B, Patterson C, Oldenburg B. Measuring socio-economic position in dietary research: is choice of

socio-economic indicator important? *Public Health Nutrition* 2003; **6**: 191–200.
10 Galobardes B, Morabia A, Bernstein MS. Diet and socio-economic position: does the use of different indicators matter? *International Journal of Epidemiology* 2001; **30**: 334–40.
11 Geyer S, Peter R. Income, occupational position, qualification and health inequalities – competing risks? (Comparing indicators of social status). *Journal of Epidemiology and Community Health* 2000; **54**: 299–305.
12 Heinrich J, Bolte G, Holscher B, Douwes J, Lehmann I, Fahlbusch B, *et al*.; LISA Study Group. Allergens and endotoxin on mothers' mattresses and total immunoglobulin E in cord blood of neonates. *European Respiratory Journal* 2002; **20**: 617–23.
13 Hauser R. Adequacy and poverty among the retired. Working Paper AWP 3.2. In: Organisation for Economic Cooperation and Development (OECD), ed. *Maintaining Prosperity in an Ageing Society*. Ageing Working Papers. Paris: OECD, 1998; 6.
14 Mackenbach JP, Martikainen P, Looman CW, Dalstra JA, Kunst AE, Lahelma E.; SEdHA Working Group. The shape of the relationship between income and self-assessed health: an international study. *International Journal of Epidemiology* 2005; **34**: 286–93.
15 Klocke A. The impact of poverty on nutrition behaviour in young Europeans. In: Kohler BM, Feichtinger E, Barlosius E, Dowler E, eds. *Poverty and Food in Welfare Societies*. Berlin: Sigma, 1997; 224–37.
16 Weber Cullen K, Baranowski T, Rittenberry L, Cosart C, Owens E, Hebert D, *et al*. Socioenvironmental influences on children's fruit, juice and vegetable consumption as reported by parents: reliability and validity of measures. *Public Health Nutrition* 2000; **3**: 345–56.
17 North K, Emmett P. Multivariate analysis of diet among three-year-old children and associations with socio-demographic characteristics. The Avon Longitudinal Study of Pregnancy and Childhood (ALSPAC) Study Team. *European Journal of Clinical Nutrition* 2000; **54**: 73–80.
18 Serra-Majem L, Ribas L, Perez-Rodrigo C, Garcia-Closas R, Pena-Quintana L, Aranceta J. Determinants of nutrient intake among children and adolescents: results from the enKid Study. *Annals of Nutrition & Metabolism* 2002; **46**(Suppl. 1): 31–8.
19 Watt RG, Dykes J, Sheiham A. Socio-economic determinants of selected dietary indicators in British pre-school children. *Public Health Nutrition* 2001; **4**: 1229–33.
20 Navia B, Ortega RM, Requejo AM, Perea JM, Lopez-Sobaler AM, Faci M. Influence of maternal education on food consumption and energy and nutrient intake in a group of pre-school children from Madrid. *International Journal for Vitamin and Nutrition Research* 2003; **73**: 439–45.
21 Vereecken CA, Keukelier E, Maes L. Influence of mother's educational level on food parenting practices and food habits of young children. *Appetite* 2004; **43**: 93–103.
22 Laitinen S, Rasanen L, Viikari J, Akerblom HK. Diet of Finnish children in relation to the family's socio-economic status. *Scandinavian Journal of Social Medicine* 1995; **23**: 88–94.
23 Federal Statistical Office in cooperation with the Social Science Research Centre, Berlin and the Centre for Survey Research and Methodology, Mannheim. *Data Report 2004. Figures and Facts on the Federal Republic of Germany*, 2nd ed. Publication Series Vol. 450. Bonn: Federal Centre for Political Education, 2004; 88.
24 Gallacher JE, Elwood PC, Hopkinson C, Rabbitt PM, Stollery BT, Sweetnam PM, *et al*. Cognitive function in the Caerphilly study: associations with age, social class, education and mood. *European Journal of Epidemiology* 1999; **15**: 161–9.
25 Neuhauser M, Hothorn LA. An exact Cochran–Armitage test for trend when dose–response shapes are *a priori* unknown. *Computational Statistics & Data Analysis* 1999; **30**: 403–12.

Appendix – LISA Study Group

GSF – National Research Center for Environment and Health, Institute of Epidemiology, Neuherberg (Wichmann HE, Heinrich J, Bolte G, Belcredi P, Jacob B, Schoetzau A, Mosetter M, Schindler J, Höhnke A); University of Leipzig, Department of Pediatrics (Borte M, Schulz R, Sierig G, Mirow K, Gebauer C, Schulze B, Hainich J), Institute of Clinical Immunology and Transfusion Medicine (Sack U, Emmrich F); Marien-Hospital Wesel, Department of Pediatrics (von Berg A, Schaaf B, Scholten C, Bollrath C); UFZ – Centre for Environmental Research Leipzig-Halle Ltd, Department of Human Exposure Research and Epidemiology (Herbarth O, Diez U, Lehmann I, Rehwagen M, Schlink U); Ludwig-Maximilians-University Munich, Dr von Haunersches Kinderspital, Division of Pediatric Infectious Diseases and Immunology (Weiss M, Albert M); Friedrich-Schiller-University Jena, Institute of Clinical Immunology (Fahlbusch B), Institute of Occupational, Social and Environmental Medicine (Bischof W, Koch A).