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Is maternal education level associated with diet in 10-year-old children?

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Abstract

Objective: To examine the associations between maternal education level and diet in 10-year-old children.
Design: Three-day diet diaries (child completed with parental help) were collected. Height and weight were measured in research clinics. Maternal education level was derived from a questionnaire completed during pregnancy and classified into low, medium or high. One-way ANOVA was undertaken to compare maternal education groups for nutrient intakes and the Kruskal–Wallis test used for food consumption.
Setting: Avon Longitudinal Study of Parents and Children (ALSPAC), Bristol, UK.
Subjects: Children (*n* 7474) who provided dietary data at age 10 years.
Results: A large proportion (60 %) of the sample was classified as plausible reporters, with under-reporting accounting for 36 %. No clear differences were found for intakes of energy or macronutrients between maternal education groups for plausible reporters. However, there were marked differences in micronutrient intakes especially for vitamin C, retinol equivalents and folate, highlighting lower diet quality with lower maternal education level. Intakes of fruit and vegetables showed a positive gradient with increasing maternal education (57 % *v.* 79 % consumed fresh fruit in low and high educational groups, respectively). A trend towards higher intake in the lower educated group was shown for less healthy foods (meat pies $P < 0{\cdot}001$; sausages, burgers and kebabs $P < 0{\cdot}001$).
Conclusions: The quality of children's diet at 10 years was related to maternal education level. Lower maternal education was associated with less healthy food choices that could be detrimental to health. Further research is needed to establish if these associations can be explained by other socio-economic factors.

Keywords
Food groups
Misreporting
Fruit and vegetables
ALSPAC

Diet is important in the health and development of children, and can impact on later health outcomes[1]. The early adoption of healthy lifestyle behaviours can reduce the risk of disease[2,3] and have implications for the child's behaviour and school performance[4,5]. Establishing and maintaining healthy eating habits is important because habits formed in early life are likely to continue into adulthood[2,4], therefore it is very important to understand influences on children's diets. It has been suggested that maternal education may play a key role in the quality of children's diets[6,7].

Parents, especially mothers, help children learn and develop both eating habits and food choices[8]; this may act through their personal preferences[9,10], attitudes to food[11] and their knowledge and understanding of the benefits of a healthy diet[9,12]. However, children can exercise their own control independent of their parents; it has been observed that children varied the foods they consumed depending on whether or not they were being observed by their parents[13].

Several studies have examined the relationship between maternal education and diet in infants and children. Higher maternal educational status was associated with longer duration of breast-feeding, improved physical growth, higher intakes of micronutrients, fruits and vegetables, and lower intake of soft drinks[6,7,14–16]. A relatively small

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study (n 133) showed maternal education to be a strong determinant for better nutritional intake in primary-school children aged 7–10 years[14]. Studies have found similar links between educational status and diet in adults; a meta-analysis of studies from seven European countries reported a less healthy dietary pattern in the least educated groups[17], while among Chinese Americans intakes of grains, fruits and vegetables rose with education and income[18].

Despite the evidence from these studies, limited research is available examining the extent to which maternal education level is associated with dietary intake in older children. Therefore, the aim of the present study was to use data from a well-characterised cohort of children followed from birth to establish whether the educational background of the mother is associated with dietary habits in 10-year-old children.

Methods

Subjects

Subjects were children participating in the Avon Longitudinal Study of Parents and Children (ALSPAC), an ongoing longitudinal cohort study designed to investigate the health and development of children. The study design has been described in more detail elsewhere[19] (see also http://www.bristol.ac.uk/alspac/). Briefly, pregnant women were eligible if they had an expected delivery date between April 1991 and December 1992 and were resident in the former Avon Health Authority in South West England. This established a cohort of 14 541 resulting in 13 988 children (alive at 12 months) with 548 new subjects recruited at age 7 years (total children 14 536). The primary source of data collected was via parental self-completion questionnaires. At recruitment the ALSPAC cohort was compared with the 1991 National Census data for mothers with infants aged <1 year resident in the area; they were similar except for a slight shortfall in those living in rented accommodation, single-parent families and ethnic minorities. Ethical approval for the study was obtained from the ALSPAC Law and Ethics Committee and the Local Research Ethic Committees.

Dietary assessment

Dietary data were collected between February 2002 and October 2003, when each child (mean age 10·6 years) and their main carer were invited to attend a research clinic. Prior to the visit, the children were asked to record in a structured diary (using household measures) all food and drink consumed over three individual days, two weekdays and one weekend day (self-selected and not necessarily consecutive), with the help of their carer. A full description of the food and drink consumed was requested with a description of any leftovers. They were asked to bring completed diaries to the clinic, where they were interviewed by a nutrition fieldworker to expand the description; for example, gaining further information on portion size, cooking methods and any food/drink missed out. If no diaries had been brought to the clinic, the fieldworker conducted a 24 h recall during which the child was asked about everything consumed on the previous day. A short questionnaire was also included, asking about the use of vitamin supplements, types of spread normally used on bread and other details of foods commonly eaten, to aid coding.

The completed diaries were coded by the same nutrition fieldworker using the computer program DIDO (Diet In, Data Out) originally developed by MRC Human Nutrition Research Unit and shown to improve speed and accuracy of dietary coding[20]. This program is designed for direct entry of dietary data and generates a food code and an associated weight for each item of food and drink recorded, and was extended to cover all foods eaten by the subjects. An advantage of this program is that new food codes can be added and portion sizes adjusted depending on the age group being assessed. When information on portion size was missing from the diary, average portion sizes for similar aged children were obtained from an analysis of weighed dietary intake from the National Diet and Nutrition Survey (NDNS) for 4- to 18-year-olds[21,22]. These portions were the same for both sexes.

The databank used for nutrient analysis included the fifth edition of McCance and Widdowson's food tables[23] and supplements[24–31]. Additional up-to-date nutrient information was obtained from the NDNS database and manufacturers' information. The coded diaries were checked against the originals by a different nutrition fieldworker and any errors identified were corrected. Diaries that produced very high or low estimates for key nutrients were rechecked.

An in-house nutrient analysis program was used to generate the nutrients for each food the child ate. The average daily nutrient intakes and amount of various food groups were calculated. Nutrient intakes from vitamin supplements were not included in this analysis. Non-milk extrinsic sugars (NMES) were calculated based on the definition in the UK Dietary Reference Values (DRV)[32]. Na intake did not include salt added at the table and vegetables were coded as cooked without added salt; therefore it covered non-discretionary salt only.

Maternal education and child anthropometry

Highest maternal education level was derived from a questionnaire completed at 32 weeks of pregnancy, with answers grouped according to UK standards as follows: CSE or less (Certificate of Secondary Education; national school exams at age 16 years); vocational qualifications; O Levels (national school exams at 16 years, higher than CSE); A Levels (national school exams at 18 years); or degree. For the present analysis maternal education level was grouped as low (none, CSE or vocational), medium (O Levels) or high (A Level or degree). More up-to-date information about maternal education was not available.

At the clinic, the child's height was measured to the last complete millimetre using a Harpenden stadiometer and his/her weight was measured to the nearest 50 g using a Tanita Body Fat Analyser (model TBF 305). BMI was calculated using the standard equation: BMI = weight (kg)/[height (m)]^2. Overweight and obesity were defined using age- and sex-specific cut-off points identified by Cole *et al.*[33] using 1990 reference centiles, with underweight defined as in Cole *et al.*[34].

Statistical methods

Nutrient intakes were checked visually for normality and those with skewed distributions were transformed to the natural logarithm prior to analysis to improve the normality of distributions. Energy adjustment was completed on all nutrients using the regression residual method recommended by Willett and Stampfer[35]. Weights of foods eaten per unit energy (MJ) were calculated. To compare intakes between maternal education groups, one-way ANOVA was conducted for nutrient intakes with linear regression performed to establish *P* values for trend, and a Kruskal–Wallis test was used for food intakes because these data could not be normalised. All statistical analyses were performed using the SPSS for Windows statistical software package version 15 (SPSS Inc., Chicago, IL, USA).

Misreporting

Studies have shown that misreporting of energy intake (EI) can affect dietary surveys[36]; furthermore if EI is underestimated it is probable that intakes of other nutrients are also underestimated[37]. Misreporting of EI tends to be biased towards under-reporting and is more common in obese individuals[38]. It was important, therefore, to establish the degree to which misreporting occurred in the current sample. This was determined using an individualised method (which allows for moderate activity levels), by calculating the ratio of reported EI to estimated energy requirement (EER)[39]. EER was calculated for each child based on his/her body weight, using separate equations for boys and girls, with an increment added for energy used in growth[40]. The validity of reported energy intake was assessed by comparing the calculated EER with EI: any EI less than 78·45 % or above 121·55 % of EER was classified as under-reporting or over-reporting, respectively. A logistic regression analysis was conducted to establish if BMI status and maternal education had an independent effect on misreporting status.

Energy and nutrient intakes – comparisons with national data and reference intakes

The dietary intakes of the current sample were compared with similar data obtained from NDNS[21]. The latter survey of dietary habits and nutritional status studied a cross-sectional sample of British children aged 4–18 years. Comparable data consisted of 7 d weighed food diaries collected in 1997 from 256 boys and 226 girls aged 7–10 years. Comparisons were made between the NDNS and the present study for the whole sample and the plausible reporters separately.

UK DRV[32] were used to assess the adequacy of the recorded diets for most nutrients. At present, there is no official DRV for NSP (a measure of fibre intake); however, in adults the DRV is 18 g and intakes in children should be comparatively less due to smaller body sizes. NSP intakes have been calculated previously for 7-year-olds in ALSPAC[41], and the same method was used for the 10-year-olds. Na is an essential nutrient but should not be taken in excess; the DRV is a Reference Nutrient Intake (RNI) set at 1200 mg/d[32]. Salt levels for children should be lower than for adults, with children aged 7–10 years consuming no more than 5 g (1966 mg Na) daily[41,42].

Results

Response rates

A total of 11 868 children were eligible to attend the clinic for assessment at 10 years (mean age 10·6 years) and 7563 attended (63·7 %). Dietary diaries were available for 7474 (98·8 % of attendees); of these seventeen provided 4 d of intake (24 h recall + 3 d), 5753 provided 3 d, 694 provided 2 d and 1010 provided 1 d only (usually a 24 h recall); all were included in the analysis. Table 1 illustrates characteristics of the children who did or did not attend the clinic and the anthropometric measures of attendees by sex. Girls were on average taller and heavier than boys. Of the mothers, 22 % were classified as low educational status, 35 % as medium and 43 % as high. This showed a bias towards higher education compared with the non-attendees ($P < 0·001$).

Energy requirements and misreporting of energy intake

Not all the sample could be classified by misreporting status owing to incomplete data, but classification was possible in 7433 (98·3 %). The proportion of under-reporters was similar in both sexes at about 36 %. Compared with the NDNS where the level of under-reporting increased substantially in the older age groups, from 27 % in 7- to 10-year-olds to 50 % in 11- to 14-year-olds[21], ALSPAC had an intermediate prevalence of under-reporting but all of the children were at the maximum end of the 7–10-year age range. Over-reporters were identified, but numbers were small (3–4 % in ALSPAC *v.* 1–2 % in NDNS). This meant that about 60 % of the ALSPAC sample was considered to be plausibly reporting. Table 2 compares the weight status and maternal education level of the misreporting groups. The under-reporters were much more likely than the other two groups to be overweight or obese. Misreporting occurred more often in the lowest education group and least in the highest group. Logistic regression analysis showed that misreporting was independently associated with child BMI status but not

Table 1 Characteristics of children who attended the research clinic at 10 years, Avon Longitudinal Study of Parents and Children

	Attended clinic				Did not attend clinic	
	Boys (*n* 3735)		Girls (*n* 3828)			
	Mean or *n*	SD or %	Mean or *n*	SD or %	*n*	%
Diet diaries obtained	3703		3771			
Age (years)	10·6	0·3	10·6	0·3		
Height (cm)	143·9	6·4	144·2	7·0		
Weight (kg)	37·6	8·2	38·6	8·9		
Maternal education level						
Low	752	20·3	748	19·8	2226	39·4
Medium	1217	32·9	1207	32·0	1881	33·3
High	1427	38·5	1477	39·2	1493	27·4
Missing	307	8·3	339	9·0	56	1·0

Data are expressed as mean and standard deviation for continuous variables or *n* and % for categorical variables.

Table 2 Reporting of dietary energy intake* by weight status, maternal education level and sex: 10-year-old children, Avon Longitudinal Study of Parents and Children

	Under-reporting (%)	Plausible reporting (%)	Over-reporting (%)	*P* value (logistic regression)
BMI				<0·001/<0·001†
Missing (*n* 44)	29·5	59·1	11·4	
Underweight (*n* 75)	8·0	76·0	16·0	
Healthy weight (*n* 5707)	27·9	67·8	4·3	
Overweight (*n* 1263)	64·1	35·7	0·4	
Obese (*n* 344)	82·3	17·7	–	
Maternal education level				0·823/0·053‡
Missing (*n* 642)	42·7	52·6	4·7	
Low (*n* 1497)	39·7	55·6	4·7	
Medium (*n* 2410)	35·6	61·1	3·3	
High (*n* 2884)	34·0	63·1	2·9	
Sex				
Boys (*n* 3685)	36·4	59·5	4·1	
Girls (*n* 3748)	36·4	60·5	3·1	

*Overall prevalence of under-reporting, plausible reporting and over-reporting in the sample was 36·2 %, 59·7 % and 3·6%, respectively.
†*P* value in boys/girls for the difference in under-reporting prevalence by BMI group adjusting for the effect of maternal education level.
‡*P* value in boys/girls for the difference in under-reporting prevalence by maternal education group adjusting for the effect of BMI.

Table 3 Weight status by maternal education level: 10-year-old children, Avon Longitudinal Study of Parents and Children

	Maternal education level				
	Low (%)	Medium (%)	High (%)	Missing (%)	*P* value (χ^2 test)
BMI					<0·001
Underweight (*n* 48)	21·2	31·5	38·9	8·9	
Healthy weight (*n* 2854)	19·0	32·5	40·7	7·8	
Overweight (*n* 632)	22·4	32·2	33·9	11·6	
Obese (*n* 173)	30·3	31·1	27·5	11·3	

maternal education. Table 3 shows the weight status of the children by maternal education group; an excess of children in the low education group were classified as obese. The prevalence of underweight was similar across all maternal education groups, but more underweight girls had mothers of high education.

Food and nutrients according to misreporting status

By definition there were major differences in mean energy and nutrient intakes between the misreporting status groups (data not shown). Table 4 shows the overall mean food intakes in the under-reporters compared with plausible reporters; there were too few over-reporters to allow a separate comparison. There were differences in recorded intakes in both sexes of biscuits, cakes, puddings, rice and pasta, whole milk, chocolate, sweets and sweet spreads such that the under-reporters recorded substantially lower intakes (all $P < 0{\cdot}001$). Intakes of meat and meat products and fish were not different between the groups. No differences were seen between under-reporters and plausible reporters for vegetables in either sex, but there were differences for cooked vegetables in girls ($P = 0001$) and for fruit and fruit juice for boys only ($P < 0{\cdot}001$).

Table 4 Overall mean food intakes and percentage of consumers by under-reporting and plausibly reporting and sex, and significance of the difference comparing under-reporters and plausible reporters in boys and girls separately using the Kruskal–Wallis test: 10-year-old children, Avon Longitudinal Study of Parents and Children

	Under-reporters				Plausible reporters				*P* value (under-reporters *v.* plausible reporters)	
	Boys (*n* 1341)		Girls (*n* 1365)		Boys (*n* 2194)		Girls (*n* 2268)			
Food Item	Intake (g)	% of consumers	Intake (g)	% of consumers	Intake (g)	% of consumers	Intake (g)	% of consumers	Boys (*n* 3535)	Girls (*n* 3633)
Cereal products										
High-fibre breakfast cereals	15·2	47	10·1	39	17·7	50	13·6	48	0·731	<0·001
Other breakfast cereals	12·7	49	9·1	43	15·4	53	11·5	50	0·951	0·038
White bread	57·4	82	50·9	84	67·3	87	62·0	89	0·005	0·068
Brown & wholemeal bread	11·0	22	8·8	21	13·1	25	10·6	24	0·321	0·064
Other bread	3·9	12	4·9	16	5·8	17	5·9	18	<0·001	0·175
Biscuits	16·1	68	13·1	68	23·1	79	20·2	80	<0·001	<0·001
Buns, cakes & pastries	19·3	53	18·5	56	31·0	69	31·1	71	<0·001	<0·001
Puddings	36·5	59	31·4	54	50·0	68	46·8	69	<0·001	<0·001
Rice & pasta	75·7	75	72·8	79	80·1	78	77·1	79	<0·001	<0·001
Meat & meat products										
Meat	42·0	72	38·2	71	46·6	75	42·3	72	0·089	0·023
Meat pies & pasties	6·8	15	5·8	15	8·8	18	7·7	17	0·022	0·344
Sausages, burgers & kebabs	15·4	45	12·5	41	18·1	49	13·3	42	0·656	0·131
Breaded chicken or turkey	9·8	26	9·4	27	10·3	26	10·5	28	0·753	0·553
Chicken & turkey dishes	23·1	51	20·1	48	26·0	54	24·0	53	0·777	0·549
Other meat & meat dishes	3·0	16	2·7	14	3·6	19	2·9	16	0·028	0·149
Fish										
Coated white fish	7·1	18	6·2	18	8·1	20	6·4	18	0·346	0·259
Other fish	2·3	7	1·5	5	1·8	5	2·0	6	0·041	0·265
Oily fish	4·2	14	5·2	18	4·3	14	5·2	19	0·996	0·740
Vegetables										
Baked beans	21·2	33	16·0	30	24·2	37	19·0	32	0·129	0·622
Raw vegetables	13·3	35	18·2	46	15·5	41	20·8	52	0·041	0·177
Cooked vegetables	42·4	71	42·9	73	51·8	79	51·4	80	0·169	0·001
Legumes	1·2	4	0·9	4	0·9	4	1·1	4	0·972	0·351
Fruit										
Fresh fruit	51·4	58	60·9	68	66·4	70	73·5	77	<0·001	0·455
Canned fruit	1·9	6	2·2	9	3·0	7	3·7	10	0·032	0·002
Fruit juice	94·9	47	95·4	52	131·9	57	123·6	60	<0·001	0·009
Nuts	1·4	11	1·0	11	1·8	14	1·6	16	0·047	<0·001
Potatoes										
Fried/roast potatoes or chips	58·1	74	55·2	76	66·9	81	59·2	77	0·085	<0·001
Other potatoes	30·7	44	29·6	49	35·0	50	34·8	53	0·267	0·813
Dairy products										
Whole milk	49·5	26	32·1	23	96·6	37	64·6	32	<0·001	<0·001
Semi-skimmed milk	130·0	63	93·6	60	156·3	61	133·5	62	0·038	0·022
Skimmed milk	8·1	7	6·9	5	5·3	4	6·4	5	<0·001	0·648
Soya milk	0·4	0·4	0·8	0·4	1·3	1	0·8	1	0·140	0·713
Goat's/sheep's milk	1·0	0·4	0·2	0·1	0·5	0·2	0·5	0·2	0·431	0·622
Other milk/cream	1·2	11	0·9	12	1·9	16	1·9	17	0·001	<0·001
Yoghurt/fromage frais	29·3	39	27·1	39	35·2	45	34·0	47	0·127	0·011
Eggs	8·8	25	8·2	29	9·6	28	9·0	30	0·491	0·711
Cheese	10·0	47	9·8	51	13·3	54	13·6	60	0·006	0·005

Table 4 *Continued*

	Under-reporters				Plausible reporters				*P* value (under-reporters *v.* plausible reporters)	
	Boys (*n* 1341)		Girls (*n* 1365)		Boys (*n* 2194)		Girls (*n* 2268)			
Food Item	Intake (g)	% of consumers	Intake (g)	% of consumers	Intake (g)	% of consumers	Intake (g)	% of consumers	Boys (*n* 3535)	Girls (*n* 3633)
Fats										
Butter	1·9	17	2·1	20	3·1	22	2·9	24	<0·001	0·022
Spreads	8·3	67	8·0	71	10·4	74	9·5	74	0·227	0·129
Miscellaneous										
Chocolate confectionery	13·0	60	12·8	64	21·5	77	20·2	78	<0·001	<0·001
Sugar confectionery	5·7	38	5·9	45	9·3	52	8·9	55	<0·001	<0·001
Sugar preserves & sweet spreads	7·8	66	6·4	63	11·0	74	9·5	73	<0·001	<0·001
Crisps & savoury snacks	16·3	72	16·1	76	20·7	81	19·9	83	0·545	0·329
Drinks										
Sweetened drinks (total volume, ml)	126·6	52	103·9	54	179·2	63	152·7	60	<0·001	<0·001
Diet drinks (total volume, ml)	280·6	70	246·4	72	266·6	69	239·5	70	0·144	0·153

Nutrient intakes according to maternal education level

Table 5 examines energy-adjusted mean nutrient intakes according to maternal educational level in plausible reporters only. There were no clear differences between education groups for macronutrients, except in sugars where total sugars showed a gradient. There was no association between maternal education and NMES, but those from high education groups consumed more intrinsic sugars (contained within fruit and vegetables). We observed marked differences in micronutrient intakes, especially for vitamin C, carotene and retinol equivalents, such that as maternal education fell the amount of nutrient decreased by 23 %, 15 % and 12 % respectively. Folate, Mg and riboflavin were 7 % higher in the high *v.* low education group and Ca, Fe and vitamin B_{12} showed a similar small gradient; Na levels were highest in the low education group and fell with education level (all $P < 0·001$).

Food group intakes according to maternal education level

Table 6 illustrates energy-adjusted mean intakes of food items for the plausible reporters only according to maternal education level. All types of fruit and vegetables (except baked beans) had a small gradient towards the highest education group, particularly fresh fruit ($P < 0·001$) and fruit juice ($P < 0·001$). Consumption was fairly similar for meat and poultry; however, meat products such as meat pies ($P < 0·001$) and sausages, burgers and kebabs ($P < 0·001$) showed a positive trend towards the lower education group. Intakes of oily fish in particular showed an educational gradient ($P < 0·001$). White bread fell with education level ($P = 0·046$), as brown and wholemeal bread rose ($P < 0·001$), however over 80 % of children consumed white bread. A similar pattern was observed for milk; intake of whole milk fell with education level ($P = 0·001$), while that of semi-skimmed milk increased ($P < 0·001$). Sugar confectionery decreased from low to high education groups ($P = 0·006$), and chocolate confectionery was highest in the middle education group ($P < 0·001$). Intakes of sugar confectionery, chocolate confectionery and savoury snacks were high in all education groups. Consumption of biscuits fell with maternal education ($P = 0·002$); however, that of buns, cakes and pastries rose ($P < 0·001$). Diet soft drinks were consumed in greater amounts than sugar-sweetened ones and showed a positive trend towards the lowest education group ($P < 0·001$).

Nutrient intakes and comparisons with national data

Comparisons of energy and nutrient intakes by sex for the whole ALSPAC sample with NDNS children aged 7–10 years and for plausible reporters in ALSPAC separately (Supplementary Table 1) showed that intakes of

Table 5 Energy and energy-adjusted nutrient mean intakes, and their 95 % confidence intervals, for plausible reporters only by maternal education level, using ANOVA to compare diets and linear regression to obtain *P* for trend: 10-year-old children, Avon Longitudinal Study of Parents and Children

	Maternal education level						
	Low (*n* 832)		Medium (*n* 1472)		High (*n* 1820)		
Nutrient	Mean	95 % CI	Mean	95 % CI	Mean	95 % CI	*P* for trend
Energy (MJ)	8·39	8·31, 8·48	8·40	8·34, 8·46	8·38	8·32, 8·43	0·716
Protein (g)	59·8	59·0, 60·6	60·1	59·6, 60·6	61·2‡	60·7, 61·7	<0·001
Fat (g)	75·7‡	75·0, 76·4	74·5	74·0, 75·0	73·4	72·9, 73·8	<0·001
Saturated fat (g)	29·1‡	28·6, 29·5	28·5	28·2, 28·8	28·3	28·0, 28·6	0·003
Monounsaturated fat (g)	25·7‡	25·4, 26·0	25·1	24·9, 25·3	24·4	24·2, 24·6	<0·001
Polyunsaturated fat (g)	12·2‡	12·0, 12·5	12·1	11·9, 12·3	11·8	11·6, 12·0	0·002
Carbohydrate (g)	243	241, 244	246	245, 247	247‡	246, 248	<0·001
Total sugars (g)	107	105, 109	111	110, 113	114‡	112, 115	<0·001
NMES (g)	83	81, 85	85	84, 84	85	84, 86	0·103
Starch (g)	131	130, 133	129	128, 131	129	128, 130	0·014
NSP (g)	10·8	10·6, 11·0	11·0	10·8, 11·1	11·5‡	11·5, 11·8	<0·001
Carotene (μg)	1616	1520, 1716	1722	1650, 1795	1863‡	1795, 1931	<0·001
Retinol (μg)	280	269, 292	289	282, 297	304‡	297, 311	<0·001
Retinol equivalents (μg)*†	563	542, 585	588	574, 603	628‡	615, 642	<0·001
Thiamin (mg)†	1·33	1·30, 1·36	1·37	1·35, 1·40	1·43‡	1·40, 1·45	<0·001
Riboflavin (mg)	1·41	1·38, 1·45	1·44	1·42, 1·47	1·52‡	1·49, 1·54	<0·001
Niacin equivalents (mg)*	28·0	27·6, 28·5	28·5	28·2, 28·8	29·3‡	29·0, 29·5	<0·001
Vitamin B_6 (mg)	1·79	1·76, 1·83	1·82	1·80, 1·85	1·84‡	1·82, 1·86	0·028
Vitamin B_{12} (mg)†	3·11	3·01, 3·21	3·10	3·03, 3·18	3·31‡	3·25, 3·39	<0·001
Folate (μg)	195	191, 199	200	197, 203	211‡	208, 214	<0·001
Vitamin C (mg)†	67·3	64·0, 70·8	74·0	71·3, 76·7	88·0‡	85·3, 90·6	<0·001
Vitamin D (μg)†	2·35	2·27, 2·42	2·43	2·37, 2·48	2·50‡	2·45, 2·56	0·001
Na (mg)	2559‡	2523, 2596	2547	2521, 2574	2486	2463, 2508	<0·001
Ca (mg)	721	706, 736	739	728, 750	759‡	749, 769	<0·001
Mg (mg)	201	198, 203	204	203, 206	214‡	212, 215	<0·001
K (mg)	2356	2325, 2387	2357	2334, 2381	2393‡	2372, 2414	0·024
Fe (mg)	8·5	8·3, 8·6	8·5	8·4, 8·6	8·9‡	8·9, 9·0	<0·001
Zn (mg)	6·46	6·35, 6·58	6·42	6·34, 6·50	6·69‡	6·61, 6·76	<0·001
Cu (mg)	0·78	0·77, 0·79	0·80	0·79, 0·81	0·83‡	0·82, 0·84	<0·001
Se (μg)	54·3	53·1, 55·5	54·5	53·7, 55·4	56·9‡	56·2, 57·7	<0·001
Iodine (μg)†	111	108, 113	114	112, 116	116‡	115, 118	<0·001

NMES, non-milk extrinsic sugars.
*Retinol equivalents = carotene/6 + retinol; niacin equivalents = niacin+tryptophan/60.
†Transformed to the natural logarithm, geometric mean and confidence intervals.
‡Direction of trend for maternal education groups ($P < 0·01$).

energy and most nutrients were slightly higher in ALSPAC than in NDNS for both sexes, but this was likely to be explained by the higher average age in the ALSPAC sample. Exceptions to this were observed for vitamin B_{12}, vitamin C, vitamin D, Fe and iodine in both sexes; also vitamin B_6 in girls. Energy intake and intakes of most nutrients were higher in boys than girls in both studies. Compared with DRV there was no evidence of inadequacy for any nutrient (mean intakes of all vitamins and minerals exceeded the RNI), except NSP; however, intakes of saturated fat, NMES and Na (non-discretionary) were substantially higher than recommended.

Discussion

In this large prospective study of diet in 10-year-old children we found a social gradient in diet quality, such that as maternal education increased diet quality improved. This was particularly true of the types of foods eaten.

Girls were taller and heavier than the boys which is typical at this age[1]; however, boys had higher intakes of energy and macronutrients and similar levels of under-reporting. It is likely that the higher energy intake in boys was due to higher activity levels since objective physical activity data, obtained from ALSPAC at age 11 years, have shown that boys were more active than girls and spent more time in moderate-to-vigorous physical activity[43]. In the present sample, more children with mothers in the lowest education group were classified as obese, while those classified as underweight or healthy weight were more likely to have mothers in the highest education group.

We used the method of Torun to estimate levels of misreporting of dietary intakes; this allows sex and body weight to be considered but includes only a standard increment for moderate physical activity. Levels of under-reporting were high (36 %) and over-reporting low (4 %); therefore to assess differences in foods recorded we looked at under-reporters compared with plausible reporters. Under-reporters consistently recorded substantially less

Table 6 Energy-adjusted overall mean intakes and their standard error, and percentage of consumers of food items, for plausible reporters only by maternal education level, using the Kruskal–Wallis test to compare diets: 10-year-old children, Avon Longitudinal Study of Parents and Children

	Maternal education level									
	Low (*n* 832)			Medium (*n* 1472)			High (*n* 1820)			
	Intake (g/MJ)			Intake (g/MJ)			Intake (g/MJ)			*P* value (Kruskal–Wallis test)
Food item	Mean	SE	% of consumers	Mean	SE	% of consumers	Mean	SE	% of consumers	
Cereal products										
High-fibre breakfast cereals	1·79	0·11	45·3	1·69	0·07	47·6	2·14*	0·08	49·3	<0·001
Other breakfast cereals	1·59	0·07	50·0	1·65	0·06	52·5	1·56	0·05	50·4	0·493
White bread	7·88	0·20	86·8	7·90	0·14	88·8	7·42	0·12	87·9	0·046
Brown & wholemeal bread	1·09	0·09	18·5	1·21	0·08	21·1	1·72*	0·08	30·1	<0·001
Other bread	0·45	0·05	13·1	0·63	0·05	15·9	0·87*	0·05	21·4	<0·001
Biscuits	2·79*	0·09	78·8	2·74	0·07	79·9	2·41	0·05	79·6	0·002
Buns, cakes & pastries	3·10	0·12	62·3	3·51	0·10	68·5	4·09*	0·09	74·3	<0·001
Puddings	5·69	0·22	65·6	5·85	0·16	69·2	5·70	0·14	69·8	0·677
Rice & pasta	8·87	0·32	76·1	8·84	0·23	76·6	10·13*	0·22	81·4	<0·001
Meat & meat products										
Meat	5·40	0·21	73·1	5·23	0·15	73·2	5·36	0·14	74·1	0·396
Meat pies & pasties	1·28*	0·11	20·9	1·06	0·07	19·5	0·76	0·05	14·7	<0·001
Sausages, burgers & kebabs	2·25*	0·12	49·5	1·92	0·08	46·6	1·61	0·06	41·9	<0·001
Breaded chicken or turkey	1·30	0·10	27·3	1·44*	0·07	30·8	1·07	0·06	24·6	<0·001
Chicken & turkey dishes	3·01	0·16	51·1	3·02	0·11	54·6	2·92	0·09	53·4	0·478
Other meat and meat dishes	0·43	0·05	16·6	0·38	0·03	16·4	0·37	0·03	18·3	0·960
Fish										
Coated white fish	0·91	0·08	20·0	0·86	0·06	19·1	0·87	0·05	18·4	0·677
Other fish	0·14	0·03	3·5	0·18	0·03	4·3	0·30*	0·04	7·4	<0·001
Oily fish	0·39	0·06	10·6	0·43	0·04	13·7	0·76*	0·04	22.3	<0·001
Vegetables										
Baked beans	2·98*	0·19	39·3	2·65	0·13	34·3	2·33	0·11	32·9	0·004
Raw vegetables	1·55	0·11	35·9	1·85	0·09	40·8	2·84*	0·10	56·0	<0·001
Cooked vegetables	5·84	0·22	73·6	6·17	0·16	78·0	6·52*	0·14	82·7	<0·001
Legumes	0·07	0·03	1·9	0·10	0·02	3·0	0·17*	0·02	5·5	<0·001
Fruit										
Fresh fruit	6·05	0·28	59·9	7·82	0·24	71·1	9·94*	0·21	81·7	<0·001
Canned fruit	0·30	0·05	7·0	0·42	0·05	8·4	0·39	0·04	9·1	0·190
Fruit juice	11·58	0·60	47·1	13·70	0·47	54·9	18·52*	0·49	66·8	<0·001
Nuts	0·12	0·02	9·5	0·15	0·02	12·2	0·28*	0·02	19·8	<0·001
Potatoes										
Fried/roast potatoes or chips	9·33*	0·24	84·9	8·02	0·17	82·5	6·36	0·14	73·2	<0·001
Other potatoes	4·00	0·20	47·2	4·12	0·14	51·1	4·41	0·13	53·9	0·024
Dairy products										
Whole milk	10·37*	0·63	37·4	9·70	0·46	35·7	8·53	0·39	30·7	0·001
Semi-skimmed milk	15·75	0·73	57·6	16·58	0·53	60·1	18·35*	0·50	64·8	<0·001
Skimmed milk	0·72	0·16	4·2	0·78	0·12	4·7	0·62	0·09	4·7	0·848
Soya milk	0·11	0·06	0·4	0·04	0·02	0·3	0·18	0·05	0·1	0·023
Goat's/sheep's milk	0·08	0·08	0·1	0·02	0·02	0·1	0·09	0·04	0·4	0·122
Other milk/cream	0·19	0·03	14·2	0·21	0·02	16·2	0·25	0·02	18·4	0·019
Yoghurt/fromage frais	3·60	0·21	38·9	4·26	0·16	47·4	4·27*	0·14	48·6	<0·001
Eggs	0·97	0·07	26·6	1·03	0·06	26·5	1·20*	0·05	31·8	0·001
Cheese	1·40	0·07	49·5	1·54	0·06	55·4	1·76*	0·05	61·4	<0·001

Table 6 *Continued*

	Maternal education level									
	Low (*n* 832)			Medium (*n* 1472)			High (*n* 1820)			
	Intake (g/MJ)			Intake (g/MJ)			Intake (g/MJ)			
Food item	Mean	SE	% of consumers	Mean	SE	% of consumers	Mean	SE	% of consumers	*P* value (Kruskal–Wallis test)
Fats										
Butter	0·26	0·03	15·7	0·27	0·02	18·7	0·47*	0·02	30·0	<0·001
Spreads	1·24	0·04	76·2	1·30*	0·03	79·7	1·06	0·03	68·4	<0·001
Miscellaneous										
Chocolate confectionery	2·64*	0·10	74·9	2·61	0·07	80·7	2·27	0·05	76·3	<0·001
Sugar confectionery	1·14*	0·06	52·2	1·18	0·05	56·1	0·98	0·04	52·7	0·006
Sugar preserves & sweet spreads	1·14	0·05	72·7	1·17	0·04	71·2	1·29*	0·03	76·4	<0·001
Crisps & savoury snacks	2·88*	0·07	84·5	2·61	0·05	86·5	2·11	0·04	78·0	<0·001
Drinks										
Sweetened drinks (total volume, ml)	179·27	8·29	62·3	162·14	5·83	61·8	163·61	5·11	63·9	0·376
Diet drinks (total volume, ml)	295·16*	10·87	76·0	290·88	8·10	76·4	205·96	6·11	61·0	<0·001

*Direction of trend for maternal education groups ($P < 0·01$).

fat/sugar-containing foods such as biscuits, cakes, puddings, chocolates and sweets but very similar levels of meat and meat products. Other studies have shown similar relationships with fatty/sugary foods and with meat products[37,44]. Perhaps it was less easy to forget to record meats usually eaten as part of a meal than biscuits or sweets often eaten as snacks, or it could be that the snack foods which have a reputation as being unhealthy were selectively omitted by the under-reporters.

Comparisons made between the intakes in these children and nutrient recommendations showed that nutrient intakes were adequate; however, fat and saturated fat intakes were much higher than the recommended levels, both exceeding the recommendation by more than 10 %. Eating a high-fat diet has been associated with heart disease and cancer risk[45]. Average NSP intake was much lower than current health guidelines recommend and the mean intake of NMES was much higher, almost double the recommended maximum.

In assessing the relationship between child diet and maternal education only those reporting plausible energy intakes were used, this was in order to avoid bias from differential under-reporting. Furthermore we found that there was no independent association between misreporting status and maternal education. There was no evidence of a gradient in energy intake between maternal education groups and differences in macronutrient intakes were small. However, total sugars intake increased with education while NMES intake was similar, suggesting that the higher education group consumed more intrinsic sugars. This was probably explained by their higher consumption of fruit.

Substantial differences were seen in types of food and drinks consumed between maternal education groups. Intakes of fruit, fruit juice, raw vegetables and nuts were more than a third higher in the highest education group compared with the lowest. This probably explained their higher vitamin C intake. A diet rich in fruit and vegetables is thought to be beneficial to health[46] and a recent review of studies in adults has shown that fruit and vegetable consumption was higher in those with better education[47]. Previous studies in adolescents found a relationship between educational level of the household and raw vegetable intake[48], and low intakes of fruit and high intakes of sweetened beverages were found in children from households of low educational attainment[49]. In the present study, sweetened drinks intake was similar across the education groups, but diet drinks intake was considerably higher in the low maternal education group. In line with the higher NSP intake in the highest education group, high-fibre breakfast cereals and brown and wholemeal bread were more likely to be consumed by them. A balanced diet should include a sufficient amount of fibre to promote long-term health[45].

In contrast, a trend towards higher intakes of less healthy foods was shown in the lowest education group.

Intakes of various types of processed meat were 15–40 % higher in the low compared with the high education group. Intakes of both chocolate confectionery and savoury snacks were 10–25 % higher in the lowest education group; however, there was little difference in consumption levels for sugar confectionery and all these foods were consumed by large numbers of children in all groups. Other studies have shown that consumption of snack foods was more prominent in children with low *v.* higher educated mothers and that the converse is true with regard to eating fruit and vegetables[15,50]. Furthermore, consumption of savoury snacks will add to the high non-discretionary Na intakes found in the current sample, which fell slightly with increased maternal education status. High Na/salt intakes are associated with increased risk of hypertension and strokes in later life[43].

Differences in diet quality according to maternal education level were evident in the present study. Various studies in adults have shown that those with a high educational status tend to consume a better-quality diet[51,52]. Inequality in family background has been shown to impact on children's diets; for example, a study of 2149 American girls aged 9–10 years found on average that those whose parents had a higher educational status had a healthier diet[53].

There are several limitations to the present study. It was conducted in one geographical area of England and so may not be applicable throughout the UK; however, the cohort was reasonably representative of the UK population at recruitment and we have shown that the dietary intakes in the study were comparable with those of a nationally representative cross-sectional sample, NDNS. Under-reporting of energy intake occurred in approximately 36 % of subjects in the current sample; again this was comparable with NDNS. The assessment to classify plausibility of intake was limited because objective physical activity was not measured at 10 years, thus necessitating the assumption of a moderate physical activity level for everyone. This is likely to have led to bias[54]. However, the misreporting level was fairly reasonable which may in part be due to parents helping their 10-year-olds to complete the diet diaries and the fact that children were interviewed with their diaries to fill in any gaps. The interviewers obtained 24 h recalls of the diet from the previous day if no diary was produced, thus maximizing the number of participants. A maximum of 3 d of diet recording was obtained from most children in the present study, whereas 7 d of recording is likely to provide a more reliable estimate of intake. We considered that asking for more recording days would put unnecessary pressure on the children and their parents, which could have impacted adversely on response rates. One of the main strengths of the study is its large sample size and high participation rate. However those from higher educational groups were more likely to attend the 10-year clinic and provide dietary data and the comparisons between education groups were limited to plausible reporters of energy, thus reducing the number of subjects further. This will have had an impact on the results such that the observed social gradients were likely to appear smaller than in reality, as the less educated who stayed in the study may be different in ways that make their diet better than those who dropped out.

In conclusion, we have shown that maternal education level is related to differences in children's diet at 10 years. Lower maternal education level is associated with less healthy food choices that could have a detrimental effect on later health outcomes. Further research is needed to establish whether these associations are explained by related socio-economic factors such as family income and parental occupation or are independent of these factors. Little is known about the mechanisms that underlie the differences in eating behaviours according to maternal educational status, although some important clues have been obtained by qualitative methods[54]. For example, women of lower educational attainment perceived themselves to have a lack of control over food choice for their families compared with better educated women[55].

Further work should assess how socio-economic indicators relate to food choice. Clarifying associations between educational level, socio-economic status and nutrition may help in the development of interventions to improve diet quality, especially in the poorly educated, thus helping to reduce health inequalities.

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