

Influences on child fruit and vegetable intake: sociodemographic, parental and child factors in a longitudinal cohort study

Louise R Jones¹, Colin D Steer², Imogen S Rogers³ and Pauline M Emmett^{2,*}

¹Department of Social Medicine, University of Bristol, Bristol, UK: ²Department of Community Based Medicine, University of Bristol, Barley House, Oakfield Grove, Bristol BS8 2BN, UK: ³School of Pharmacy and Biomolecular Sciences, University of Brighton, Brighton, UK

Submitted 10 December 2008: Accepted 22 December 2009: First published online 3 March 2010

Abstract

Objective: To examine the sociodemographic, parental and child factors that predict fruit and vegetable consumption in 7-year-old children.

Design: Diet was assessed using three 1 d unweighed food diaries. The child's daily fruit and vegetable consumption was calculated by summing the weight of each type of fruit, fruit juice and vegetable consumed. The various other factors measured were assessed by a questionnaire at different time points.

Setting: The Avon Longitudinal Study of Parents and Children (ALSPAC).

Subjects: A total of 7285 children aged 7 years residing in the south-west of England during 1999–2000.

Results: Median daily fruit and vegetable consumption (201 g) was below the recommendations for this age group (320 g). Girls ate more fruit and vegetables per unit energy (30.3 g/MJ) than boys (26.7 g/MJ; $P < 0.001$). The predictors of fruit and vegetable consumption were mostly similar. Fruit and vegetable consumption was associated with maternal consumption, maternal education status and parental rules about serving fruit/vegetables every day, food expenditure per person and whether the child was choosy about food. Vegetable consumption was also associated with the other characteristics of the child, such as whether the child enjoyed food and whether the child tried a variety of foods.

Conclusions: Children are not eating recommended amounts of fruit and vegetables, particularly boys. Consumption of fruit and vegetables appears to be influenced by parental rules about daily consumption and parental consumption and by the child's choosiness. Parent's actions could influence this. These findings may prove useful for those planning healthy eating campaigns for children.

Keywords
Fruit and vegetables
Parents
Children
ALSPAC
Food records
Choosiness

It is evident that as part of a healthy diet, individuals should consume an adequate amount of fruit and vegetables as these may confer protection against certain cancers^(1,2), obesity⁽³⁾ and CVD⁽⁴⁾. The current guideline in the United Kingdom is to eat five portions daily⁽⁵⁾; however, the consumption is still substantially below this recommendation. In the National Diet and Nutrition Survey (NDNS) of adults aged 19–64 years in 2004, only 13% of men and 15% of women met this recommendation⁽⁶⁾. Failure to meet this recommendation is apparent in all age groups including primary-school children⁽⁷⁾. Evidence shows that a diet rich in fruit and vegetables during childhood has many beneficial effects on health outcomes throughout childhood and in adulthood⁽⁸⁾; for example, children who eat more fruit and vegetables have a lower blood pressure and a lower risk of stroke^(9,10). Studies have also shown that dietary habits

and preferences for foods established in childhood track through to adulthood⁽¹¹⁾. Therefore, it is important to understand factors that influence childhood consumption in order to implement long-term changes in the population's consumption of fruit and vegetables.

One of the most influential determinants of a child's consumption of fruit and vegetables is their parents. Parents make decisions about the types of foods that are offered to their child based on their own attitudes and beliefs about food. Consequently, a child's food choice is mostly limited to the range of foods provided by his/her parents and the availability of fruit and vegetables in the home is likely to be an antecedent to consumption. Children whose parents eat plenty of fruit and vegetables and who attempt to provide a home environment where fruit and vegetables are part of the regular diet have been reported to eat more of these foods than other children^(12–14).

*Corresponding author: Email p.m.emmett@bristol.ac.uk

Studies in adults have shown a strong consistent relationship between socio-economic status (SES) and fruit and vegetable consumption. Thompson *et al.*⁽¹⁵⁾ reported that low fruit and vegetable consumers were more likely to rent rather than own their property, to be unemployed and to have no access to a car. There is also a relationship between SES and children's consumption of fruit and vegetables⁽¹⁵⁾. In addition to parental SES, the child's own characteristics may influence their fruit and vegetable consumption. A child who exhibits food neophobia or choosiness may have lower consumption of fruit and vegetables. Galloway *et al.*⁽¹⁶⁾ stated that 'Food neophobia is an unwillingness to eat novel foods, whereas pickiness (choosiness) is an unwillingness to eat familiar foods', and they reported that 7-year-old girls with food neophobia and/or pickiness ate fewer vegetables.

Few large population-based prospective studies have been able to describe the independent longitudinal determinants of fruit and vegetable consumption in contemporary populations of children. Therefore, using the wealth of data collected in Avon Longitudinal Study of Parents and Children (ALSPAC), this report will examine the strength of the independent associations of a range of social and behavioural factors on fruit and vegetable consumption in a cohort of boys and girls growing up in South-west England.

Methods

Subjects

The present study formed part of the ALSPAC, a geographically based prospective cohort study investigating the factors influencing health, growth and development of children^(17,18). All pregnant women residing in a defined area of the county of Avon, UK, with an expected date of delivery between April 1991 and December 1992, were eligible to join the study. A total of 14 541 women were enrolled in the study. In comparison with the 1991 National Census data, for mothers with children under 1 year residing in Avon, the ALSPAC population was broadly similar. However, there were fewer single-parent families, fewer families living in rented accommodation and fewer not owning a car. In addition, there was a smaller proportion of mothers from ethnic minorities. Ethics approval for the study was obtained from the ALSPAC Law and Ethics Committee and the Local Research Ethics committees.

Assessment of fruit and vegetable consumption

Child's consumption of fruit and vegetables

The diet records were collected during 1999–2000. When the children were 7 years old, they were invited to attend a clinic. Before this visit, three 1 d diet diaries and a short questionnaire with detailed instructions were sent to the parent or main carer. They were asked to record everything the child ate and drank, using household measures, in these structured diaries. The parents chose which days

to record; however, we asked them to include two weekdays and one weekend day (not necessarily consecutive). The family brought the completed diaries to the clinic where they were collected by the clinic staff, and retained for coding at a later date. The dietary methodology used has been described in greater detail elsewhere^(19,20).

The diaries were coded by trained nutritionists using the computer programme DIDO (Diet in, Data out), which is designed for the direct entry of dietary records. The amount of the various types of fruit, fruit juice and vegetables consumed was calculated from the portion sizes described in the diary. If parents did not describe the portion size eaten by the child, an age-specific portion size was assigned based on the data collected from the NDNS. All the weights of various foods recorded at each age in NDNS were used to produce average portion weights for these foods for children at various ages⁽²¹⁾. Fruit and vegetables can be hidden in composite dishes such as stews or fruit-based desserts. Failure to include composite dishes when calculating total fruit and vegetable intake could result in an underestimate of consumption and misclassification of individuals⁽²²⁾. In the present study, a proportion of composite dishes according to the recipe of that dish was counted towards total fruit and vegetable consumption.

The child's daily fruit and vegetable consumption was calculated by summing the weight of each type of fruit, fruit juice and vegetable consumed. On the basis of the 'five a day' guidelines, only one portion of fruit juice (150 ml) and baked beans and legumes (65 g) was included and all potatoes were excluded. Fruit juice is lacking in fibre and is more cariogenic than fruit; and baked beans and legumes, unlike other vegetables, are rich in protein and fibre and provide little vitamins A, C and E⁽²³⁾.

The UK government provides no specific recommendation for fruit and vegetable consumption for children, but recommends that adults eat at least five portions per day⁽⁵⁾. Using the Estimated Average Requirement (EAR) of energy for healthy adults aged 19–50 years⁽²⁴⁾, the 'five a day' recommendation equates to the consumption of approximately 45 g of fruit and vegetables per MJ of energy consumption. This amount can be used to set the fruit and vegetable consumption of the children into context by calculating the actual amount eaten per MJ by the children. Thus, using the mean energy consumption (7.1 MJ)⁽²⁰⁾, these children should consume, on average, 320 g/d; therefore, an average portion for a child of 7 years would weigh 65 g.

Mother's consumption of fruit and vegetables

The mothers completed an FFQ about their own diet when the children were 47 months old. The FFQ was used to generate a weekly consumption of fruits, fruit juice and vegetables for each woman. There were thirteen questions about the frequency of consumption of various types of fruit and vegetables. The weekly portions eaten

assigned to each of the frequency options ticked in the questionnaire were 'never or rarely' = 0, 'once in 2 weeks' = 0.5, 'one to three times a week' = 2, 'four to seven times a week' = 5.5 and 'more than once a day' = 10. The total consumption of fruit and vegetables was calculated by summing all the portions. Only one portion of fruit juice and baked beans was counted per day. On the basis of these consumptions, mothers were categorised into tertiles of consumption (low, medium and high) for both fruit and vegetables.

Provision in the home

Parents were asked on a questionnaire, when the children were 65 months old, 'Do you have any rules that you try to follow when feeding the family? The statements were 'Proper cooked meal every day', 'Fresh fruit every day' and 'Vegetables or salad every day'. The responses were 'yes' or 'no'.

Child's eating characteristics

On the same questionnaire, parents were asked about their child's eating characteristics. The following statements were given: 'He/she likes to try different foods', 'He/she enjoys food' and 'He/she is choosy about food', with the options 'yes most of the time', 'yes sometimes' and 'no not at all'. As the numbers who replied 'no not at all' for 'he/she enjoys food' were very low, this option was combined with 'yes, sometimes' for analysis.

Demographic factors

Information on the highest maternal educational level was obtained from a questionnaire completed during pregnancy. Highest maternal educational qualification was used to assign mothers to one of the three categories: low (none, CSE and vocational), medium (O level) and high (A level or degree). CSE and O levels were written examinations usually taken at the age of 16 years. They have been superseded in the United Kingdom by GCSE examinations. A levels are written examinations usually taken at 18 years of age.

Information on family income was obtained from a questionnaire completed when the children were 4 years old. The mothers were asked 'How much is the family income each week?' and offered the choice of one of the four categories: (i) less than £200, (ii) £200–£299, (iii) £300–£399 and (iv) £400 or more. Subsequently, they were asked 'How much do you spend on food for the whole family each week?' They were given six categories that we have combined into three: (i) less than £40, (ii) £40–£59 and (iii) £60 or more. Using the data on the number of persons living in the household, the amount of money spent on food per person was calculated. There were four categories: ≤£9.99, £10–14.99, £15–19.99 and £20 or more.

Statistical analysis

A child's vegetable and fruit consumption (adjusted for energy g/MJ) was not normally distributed. The deviations from the normality reflected a truncation of this

distribution at the lower end; and for fruit consumption, there was also an excess of zero intakes. These features could not be corrected by transformation. Despite this, linear regression was used to analyse these outcomes. Valid results were anticipated for this large sample due to the Central Limit Theorem. The robustness of this technique was explored by repeating the analyses using ordinal regression with outcomes categorised as zero intake plus three equal groups.

Univariable analyses assessed the relationship between demographic, parental rules and child's eating characteristics as the independent variables. Interactions of gender with these variables were also investigated. Multivariable analyses were then performed to identify any independent associations. All variables that were associated in the univariable stage at 5% significance level were initially included in the model. This model was then reduced by eliminating factor, which did not show a relationship when adjusted for other factors. This procedure allowed more data to be used and, in the presence of collinearity between predictors, provided a better understanding of the factors explaining vegetable and fruit consumption. All analyses were adjusted for gender. Statistical analyses were carried out using the Statistical Package for the Social Sciences statistical software package version 12.0.1 (SPSS Inc., Chicago, IL, USA) or STATA version 9.2 (Stata Corp., College Station, TX, USA) as appropriate.

Results

A total of 8290 children attended the 7-year clinic out of which 7282 provided completed diaries (88% of those who attended). Diaries were received by post for three more children who did not attend the clinic, so the total number of diaries was 7285. A total of 6086 mothers had completed the FFQ (83.5%). There was no difference according to mother's education status between those who provided a diary and those who did not; however, there were some differences between the groups in family income (lowest income group = 13.4% *v.* 17.4% and highest income group = 23.9% *v.* 17.5%, $P < 0.001$), and weekly expenditure on food (lowest expenditure group = 11.8% *v.* 14.3% and highest expenditure group = 38.5% *v.* 28.3%, $P < 0.001$). Those who did not complete the diary were also much more likely not to have answered these questions (35% *v.* 20%).

Children's fruit and vegetable consumption

The reported intakes of fruit and vegetables by children were low. The median intake of fruit and vegetables was 201 g/d (127 g fruit, 71 g vegetables), the range was 0–1251 g/d. On average, children were consuming 2.0 portions of fruit and 1.1 portions of vegetables daily, based on a 65 g portion. Girls had a higher median daily consumption than boys; the difference between boys'

Table 1 Reported fruit and vegetable consumption in a cohort of 7-year-old children by sex: median weight, absolute and energy-adjusted and proportion of consumers/non-consumers

	Boys (n 3699)	Girls (n 3586)	P value
Fruit and vegetable consumption (g)	193.7	208.6	0.003
Fruit consumption (g)	123.3	133.3	0.003
Vegetable consumption (g)	70.5	72.0	0.138
Energy (MJ)	7.4	6.8	<0.001
Fruit and vegetable consumption (g/MJ)	26.6	30.3	<0.001
Fruit consumption (g/MJ)	16.8	19.1	<0.001
Vegetable consumption (g/MJ)	9.7	10.6	<0.001
Achieved the target (320 g/d; %)	19.7	21.0	0.150
Ate no fruit or vegetable (%)	1.0	0.9	0.639
Ate no fruit (%)	13.4	10.7	<0.001
Ate no vegetable (%)	3.0	1.3	0.367

Median weights were compared using the Mann–Whitney rank test. Proportions were compared using the Pearson χ^2 test based on the 2×2 table of frequencies.

and girls' consumption is shown in Table 1. Girls consumed more fruit and vegetables (30.3 g/MJ) per unit of energy than boys (26.7 g/MJ; $P < 0.001$).

Mothers' fruit and vegetable consumption

Mothers consumed more portions of fruit and vegetables daily than their children; however, intakes were still low. Mothers consumed on average 3.9 portions of fruit and vegetables per day. Unlike their children, the mothers ate more vegetables (2.5 portions/d) than fruits (1.4 portions/d). Median fruit intake was 0.5 portions/d for the lowest tertile and 2.5 portions/d for the highest tertile. Median vegetable intake was 1.4 portions/d for the lowest tertile and 3.7 portions/d for the highest tertile. A quarter of the mothers reached the target of at least five portions of fruit and vegetables daily; seventy-six and twenty-nine mothers reported no fruit and vegetable intakes, respectively, and one reported eating neither.

Univariate analyses

All factors described above showed an association with the energy-adjusted intakes of both fruit and vegetables for children (results not shown). There was little evidence of any difference between boys and girls in association with these variables (results not shown). The only suggested difference was with respect to family income on the child's vegetable consumption ($P = 0.040$) and maternal fruit consumption on the child's fruit consumption ($P = 0.043$). Boys tended to consume more vegetables as income increased, whereas girls' consumption remained the same. In contrast, the highest consumption of fruits by girls was in the medium maternal consumption group (a difference of 4.0 g/MJ than 2.4 g/MJ overall). Therefore, girls and boys were combined for the rest of the analysis.

Demographic factors

Mothers who had higher educational achievements, had children who ate more fruit and vegetables ($P < 0.001$). Although similar in statistical terms, maternal education status had a greater impact on fruit intake in numerical

terms. Children whose mothers had the highest educational achievements ate on average 8.1 g/MJ (57.7 g) more fruit than children whose mothers had the lowest, for vegetable intake the difference between the two groups was only 1.7 g/MJ (12.2 g). Family income, expenditure on food and expenditure on food per person in the household were strongly related to the child's consumption of fruit and vegetables ($P < 0.001$). These three variables had a greater impact on fruit intake than vegetable intake. Fruit intake was 5.6–6.4 g/MJ (40.0–45.6 g) higher for the children whose parents earned the most and spent the most on food. The difference for vegetable intake was 1.1–1.3 g/MJ (7.7–9.0 g).

Maternal consumption

The number of portions of fruit and vegetables that the mother consumed was positively associated with both fruit and vegetable consumption ($P < 0.001$). The children whose mothers were in the highest tertile for fruit consumption ate on average 9.4 g/MJ (66.5 g) more fruit than the children whose mothers were in the lowest tertile, for vegetable consumption this was 2.7 g/MJ (18.9 g).

Provision in the home

Parents who followed rules about providing a cooked meal every day and serving fruit and vegetables daily had children with greater intakes of fruit and vegetables ($P < 0.001$). The parental rules had a greater impact on fruit consumption. Children whose parents served fruit every day consumed on average 9.8 g/MJ (69.7 g) more fruit than children whose parents did not, the difference for vegetable consumption was 2.8 g/MJ (20.1 g).

Child's eating characteristics

All three eating behaviour characteristics measured were positively associated with fruit and vegetable consumption ($P < 0.001$). The characteristic that had the greatest effect on intake was whether or not the child was choosy about food. Children who were most choosy about food ate 3.4 g/MJ (25.5 g) and 4.3 g/MJ (30.2 g) fruit and vegetables, respectively.

Table 2 Multivariable linear regression of factors that affect children's fruit consumption at 7 years of age: full model includes all variables investigated; reduced model includes only those showing independent associations after backwards elimination

	<i>n</i>	Full model (<i>n</i> 4932, $R^2 = 0.14$)				Reduced model (<i>n</i> 5259, $R^2 = 0.14$)			
		Mean*	B†	95% CI	<i>P</i> value	Mean*	B†	95% CI	<i>P</i> value
Maternal fruit consumption									
Low tertile	1602	15.0	0.00		<0.001	15.2	0.00		<0.001
Middle tertile	1686	19.9	2.70	1.69, 3.71		19.9	2.57	1.60, 3.54	
High tertile	1644	24.7	6.41	5.36, 7.46		24.6	6.28	5.27, 7.29	
Fresh fruit rule									
No	899	11.8	0.00		<0.001	11.7	0.00		<0.001
Yes	4033	21.7	6.90	5.81, 7.99		21.7	7.22	6.18, 8.27	
Maternal education									
Low	907	14.5	0.00		<0.001	14.7	0.00		<0.001
Medium	1754	18.4	3.02	1.85, 4.19		18.5	2.95	1.84, 4.06	
High	2271	23.2	5.55	4.35, 6.76		23.2	5.69	4.59, 6.79	
Family Income									
<£200	818	17.1	0.00		0.278				
£200–299	1303	17.8	−1.10	−2.44, 0.25					
£300–399	1212	20.1	−0.51	−1.93, 0.90					
£400+	1599	22.9	−0.16	−1.63, 1.30					
Expenditure on food									
<£40	703	16.1	0.00		0.269				
£40–59	1838	18.8	0.59	−1.07, 2.25					
£60+	2391	21.9	1.56	−0.48, 3.61					
Food expenditure/person									
<£10	678	15.6	0.00		0.090	15.8	0.00		<0.001
£10–14.99	1725	19.0	1.38	−0.28, 3.04		19.1	1.58	0.33, 2.83	
£15–19.99	933	20.3	1.42	−0.56, 3.40		20.2	2.06	0.66, 3.45	
£20+	1596	22.5	2.58	0.43, 4.72		22.4	3.67	2.38, 4.95	
Child's variety in food									
No, not at all	1296	18.3	0.00		0.779				
Sometimes	2435	20.1	−0.22	−1.37, 0.93					
Most of the time	1201	21.1	0.13	−1.30, 1.55					
Child's choosiness									
Choosy most of the time	777	17.1	0.00		0.003	17.4	0.00		<0.001
Sometimes	2013	19.6	1.84	0.50, 3.18		19.8	1.82	0.67, 2.97	
Not choosy	2142	21.2	2.73	1.18, 4.27		21.0	2.77	1.62, 3.91	
Child's enjoyment of food									
Never/sometimes	1753	18.3	0.00		0.231				
Most of the time	3179	20.8	0.59	−0.38, 1.56					

*Unadjusted mean intake (g/MJ) of fruit for each variable category.

†B is the adjusted difference (with 95% CI) in fruit intake (g/MJ) from the reference category, which is constrained to be zero.

Multivariate analyses of fruit intake

The multivariate analyses of fruit intake are shown in Table 2. All variables were related to fruit consumption univariably, and were therefore included in the multivariate analysis (full model). Children's fruit consumption was predicted by a variety of factors. There remained a strong association with maternal consumption and parental rules about serving fresh fruit daily. There was a persistent association with expenditure on food per person in the household, but family income and total expenditure on food no longer predicted the intake. How choosy the child was about food remained important, but the child's enjoyment of food and willingness to try different foods were no longer associated. The variable, in the reduced model, which made the biggest impact on consumption was the parental rule about serving fresh fruit daily. Children whose parents implemented this rule ate 7.22 g/MJ (51.3 g) more fruit than children whose parents did not.

Multivariate analyses of vegetable intake

Table 3 shows the multivariate analyses of vegetable intake. As for fruit, all variables were related to vegetable consumption univariably, and were therefore included in the multivariate analysis (full model). The variables that predicted vegetable consumption were mostly similar to those for fruit consumption. Family income and total expenditure on food were not independently associated with vegetable intake. However, all three eating characteristics of the child were associated with intake. In the reduced model, the variable that made the biggest impact on consumption was how choosy the child was about food. Children who were not choosy about food ate 2.57 g/MJ (18.2 g) more vegetables than children who were very choosy about food.

Sensitivity analyses

To investigate the robustness of linear regression to non-normality in the child's fruit and vegetable consumption,

Table 3 Multivariable linear regression of factors that affect children's vegetable consumption at the age of 7 years: full model includes all variables investigated; reduced model includes only those showing independent associations after backwards elimination

	<i>n</i>	Full model (<i>n</i> 4911, <i>R</i> ² = 0.09)				Reduced model (<i>n</i> 5208, <i>R</i> ² = 0.09)			
		Mean*	B†	95 % CI	<i>P</i> value	Mean*	B†	95 % CI	<i>P</i> value
Maternal vegetable consumption									
Low tertile	1587	9.6	0.00		<0.001	9.7	0.00		<0.001
Middle tertile	1658	11.3	1.07	0.59, 1.54		11.3	1.01	0.55, 1.47	
High tertile	1666	12.3	1.72	1.23, 2.20		12.3	1.66	1.19, 2.14	
Cooked meal rule									
No	749	10.0	0.00		0.311				
Yes	4162	11.3	0.28	-0.27, 0.83					
Vegetable/salad rule									
No	1246	9.0	0.00		<0.001	9.0	0.00		<0.001
Yes	3665	11.8	1.70	1.22, 2.17		11.8	1.72	1.28, 2.17	
Maternal education									
Low	905	10.0	0.00		<0.001	10.0	0.00		<0.001
Medium	1743	10.7	0.59	0.04, 1.14		10.7	0.57	0.04, 1.09	
High	2263	11.9	1.18	0.61, 1.74		11.9	1.20	0.68, 1.72	
Family income									
<£200	818	10.6	0.00		0.109				
£200–299	1286	10.9	0.04	-0.59, 0.67					
£300–399	1208	10.8	-0.46	-1.13, 0.20					
£400+	1599	11.9	0.15	-0.54, 0.83					
Expenditure on food									
<£40	702	10.3	0.00		0.483				
£40–59	1826	11.0	0.09	-0.68, 0.87					
£60+	2383	11.4	-0.31	-1.26, 0.65					
Food expenditure/person									
<£10	672	10.2	0.00		0.119	10.3	0.00		0.046
£10–14.99	1720	11.0	0.027	-0.50, 1.05		10.9	0.10	-0.49, 0.69	
£15–19.99	928	11.5	0.089	-0.04, 1.82		11.5	0.64	-0.02, 1.30	
£20+	1591	11.5	1.03	0.02, 2.03		11.4	0.58	-0.03, 1.18	
Child's variety of food									
Never	1290	9.1	0.00		<0.001	9.1	0.00		<0.001
Sometimes	2427	11.4	0.66	0.12, 1.20		11.4	0.77	0.24, 1.29	
Most of the time	1194	12.7	1.39	0.72, 2.06		12.8	1.53	0.88, 1.18	
Child's choosiness									
Choosy most of the time	775	8.2	0.00		<0.001	8.3	0.00		<0.001
Sometimes	2006	10.9	1.84	1.22, 2.47		10.8	1.64	1.03, 2.24	
Not choosy	2130	12.4	2.73	2.01, 3.45		12.4	2.57	1.87, 3.27	
Child's enjoyment of food									
Never/sometimes	1747	9.8	0.00		0.107	9.8	0.00		0.031
Most of the time	3164	11.8	0.37	-0.08, 0.83		11.9	0.49	0.04, 0.93	

*Unadjusted mean intake (g/MJ) of vegetable for each variable category.

†B is the adjusted difference (with 95 % CI) in vegetable intake (g/MJ) from the reference category, which is constrained to be zero.

the multivariate analyses were repeated using ordinal regression. These results confirmed the conclusions obtained from the linear regression (results not shown). The analyses were also repeated using only children with a full 3 d of diet recorded (*n* 6028; 83%). Very similar results were obtained to those using all children.

Discussion

The results of this survey show that these 7-year-old children and their mothers were not meeting the recommendation for fruit and vegetable intake, with vegetable consumption being particularly low for the children. Parental rules to serve fruit and/or vegetables every day were associated with higher intakes of both fruit and vegetables, but child choosiness was associated with lower intakes. Despite highly publicised campaigns,

intake is still very low and children would need to increase their consumption considerably to meet the current recommendations. This level of consumption is in line with findings from other studies conducted on British children and adults^(6,7,25).

The demographic factors associated with greater fruit and vegetable consumption were maternal education status and expenditure on food per person in the household. A relationship between maternal education status and fruit and vegetable consumption has been shown before⁽²⁶⁾; however, some studies have shown an association with fruit only^(14,27) and others with vegetables only⁽²⁸⁾. Studies have shown that eating a healthier diet can be more expensive, with the price of fruit and vegetables reported to be the main contributors to the extra cost^(29,30). Mothers who are less educated and possibly have a lower income may buy less fruit and vegetables. This is partly confirmed by the finding of a

positive relationship between fruit and vegetable consumption and expenditure on food per person in the household. There was no association with family income and weekly expenditure on food, but there were limitations with the information on income and expenditure on food in the present study. The range of categories available for income and expenditure on food was limited. The top category for weekly income was £400 or more, but almost one-third of the families fell into this category. This was even more of a problem for expenditure on food, the top category was £60 or more, nearly half of the families fell into this group. The categories were not sensitive enough to distinguish further between the families with very high incomes.

Maternal consumption was strongly predictive of both fruit and vegetable consumption, although the difference in the amount eaten between the lowest and highest groups was greater for fruit than for vegetables. Other studies have reported that parental consumption is a strong determinant of both fruit and vegetable consumption^(28,31). However, the study by Gibson *et al.*⁽¹⁴⁾ reported no relationship between mothers and children for vegetable consumption. There are various reasons why maternal consumption may influence their child's consumption. The child's preference may be due to watching their parents eat these foods. One study observed that toddlers tried the same foods as their mothers rather than those eaten by strangers⁽³²⁾. It may be because these foods are available at home, as other studies have shown that this has a positive impact on children's consumption⁽³¹⁾. Parents can control what their children eat in the home environment by the type of foods that they make accessible and available to their children. We have shown here that if parents made a rule about serving fruit and/or vegetables every day, their child had a higher consumption of these foods. This factor remained in the multivariate analyses for both fruit and vegetables. Having the rule increased fruit intake by approximately 40% and vegetable intake by 17%. Making rules for providing fruit and vegetables every day is a simple message that can be conveyed to parents. The European Prospective Investigation into Cancer and Nutrition (EPIC) has shown that how often fruit and vegetables are eaten is a more important determinant than portion size in distinguishing between high and low consumption of fruit and vegetables. The EPIC study showed that low consumers ate fruit and vegetables less often than did high consumers, but there was only a slight difference in portion sizes⁽³³⁾.

Our findings show that boys ate less fruit and vegetables than girls; this has been shown in other studies of children and adults^(7,34). In studies of adolescents and adults, it has been postulated that women eat more fruit and vegetables because they have better knowledge of nutrition⁽³⁵⁾ and are more concerned about eating a healthy diet⁽³⁶⁾. It does not seem reasonable to think that

this would account for the variation in intake between boys and girls among this age group. At this age, parents mostly control children's diet, and would be unlikely to differentiate in provision of fruit and vegetables by sex. Further work is needed to examine this finding.

The child's own eating characteristics had a strong influence on consumption particularly of vegetables. The child's willingness to try a variety of foods was independently associated only with vegetable consumption. The children who exhibited possible food neophobia ate fewer vegetables than children who enjoyed a varied diet. Other studies have reported that food neophobia was related to both fruit and vegetable consumption^(28,37). Another study identified that both neophobia and pickiness were associated with vegetable intake⁽¹⁶⁾. In the present study, the child's choosiness was associated with both vegetable and fruit consumption; however, the largest independent association with the predictive variables for vegetable intake was how choosy the child was about food.

The data in the present study were collected from the 3 d unweighed recordings of foods and drinks consumed by the children and completed by the parents. Some inaccuracies due to methodology could have been introduced. There may have been some inaccuracies with the estimation of portions sizes; this would be more of an issue for vegetables than fruit. Parents were asked to record consumption using household measures; there may be discrepancies between a tablespoon and a deserts spoon, for example. If parents did not describe the portion size eaten by the child, portion sizes were used for some foods including vegetables, which were informed by a study using weights of foods recorded in NDNS; therefore, these food portions are likely to be reasonably well assessed⁽²¹⁾. Not all parents provided all 3 d of recording, but the reanalysis using only complete 3 d records did not change the results.

Under-reporting of energy consumption has been recognised as a major bias that can affect dietary surveys⁽³⁸⁾. People may well under-report their consumption of high-energy 'unhealthy' foods, but may also over-report their consumption of healthier items such as fruit and vegetables⁽³⁹⁾. This means that we may have over-estimated some children's consumption. Parents may have reported what they considered more socially acceptable answers for some of the questions, particularly about rules of provision of fruit and vegetables to their child. The questionnaires and records were completed at different times during the life of the child; this may mean that some of the variables had changed and were not applicable at the time of the diet record. However, all these biases would have militated against the study showing an association.

The present study confirms that children, especially boys, are not eating enough fruit and vegetables. The study also shows that many factors affect the consump-

tion of fruit and vegetables. Fruit and vegetable consumption was strongly related to the mother's own consumption and SES. Families with simple rules about serving fruit and vegetables have higher consumption; therefore, campaigns that advocate adoption of such rules maybe worth developing and evaluating. Our results are very much in line with findings from the recent systematic review carried out by Pearson *et al.*⁽⁴⁰⁾ and add to the evidence about the importance of parents and the family as targets for change. More work is specifically needed on how to increase the vegetable intake. Although the factors evaluated had an effect on intake, they did not increase vegetable intake as much as fruit intake and the child's eating characteristics had a greater effect.

Acknowledgements

The authors are extremely grateful to all the families who took part in the present study, the midwives for their help in recruiting them and the whole ALSPAC team, which includes interviewers, computer and laboratory technicians, clerical workers, research scientists, volunteers, managers, receptionists and nurses. The present work was supported by the European Commission, Quality of Life and Management of Living Resources Programme (Contract number QLGI-CT-2000-01643) and World Cancer Research Fund. The UK Medical Research Council, the Wellcome Trust and the University of Bristol provide core support for ALSPAC. This publication is the work of the authors and Pauline Emmett will serve as guarantor for the contents of the present paper. L.J. supervised the data entry and wrote the draft manuscript, C.S. provided the statistical input, I.R. and P.E. designed the study and all authors commented on the manuscript. There were no conflicts of interest.

References

- Block G, Patterson B & Subar A (1992) Fruit, vegetables, and cancer prevention: a review of the epidemiological evidence. *Nutr Cancer* **18**, 1–29.
- Potter JD & Steinmetz KA (1996) Vegetables, fruit and cancer prevention: a review. *J Am Diet Assoc* **96**, 1027–1039.
- McCrary MA, Fuss PJ, McCallum JE *et al.* (1999) Dietary variety within food groups: association with energy intake and body fatness in adult men and women. *Am J Clin Nutr* **69**, 440–447.
- Ness AR & Powles JW (1997) Fruit and vegetables, and cardiovascular disease: a review. *Int J Epidemiol* **26**, 1–13.
- Department of Health (1994) *Eat well! An action plan from the Nutrition Task Force to Achieve the Health of the Nation Targets on Diet and Nutrition*. London: The Department of Health; available at <http://www.eatwell.gov.uk/healthydiet>
- Henderson L, Gregory J & Swan G (2002) *The National Diet and Nutrition Survey: Adults Aged 19 to 64 Years. Types and Quantities of Foods Consumed*. London: HMSO.
- Gregory J & Lowe S (2000) *National Diet and Nutrition Survey: Young People Aged 4 to 18 Years. vol. 1.: Report of the Diet and Nutrition Survey*. London: The Stationery Office.
- Maynard M, Gunnell D, Emmett P *et al.* (2003) Fruit, vegetables, and antioxidants in childhood and risk of adult cancer: the Boyd Orr cohort. *J Epidemiol Community Health* **57**, 218–225.
- Moore LL, Singer MR, Bradlee MR *et al.* (2005) Intake of fruits, vegetables, and dairy products in early childhood and subsequent blood pressure change. *Epidemiology* **16**, 4–11.
- Ness AR, Maynard M, Frankel S *et al.* (2005) Diet in childhood and adult cardiovascular and all cause mortality: the Boyd Orr cohort. *Heart* **91**, 894–898.
- Kelder SH, Perry CL, Klepp KI *et al.* (1994) Longitudinal tracking of adolescent smoking, physical activity, and food choice behaviours. *Am J Public Health* **84**, 1121–1126.
- Kratt P, Reynolds K & Shewchuk R (2000) The role of availability as a moderator of family fruit and vegetable consumption. *Health Educ Behav* **27**, 471–482.
- Cullen KW, Baranowski T, Rittenberry L *et al.* (2000) Socioenvironmental influences on children's fruit, juice and vegetable consumption as reported by parents: reliability and validity of measures. *Public Health Nutr* **3**, 345–356.
- Gibson EL, Wardle J & Watts CJ (1998) Fruit and vegetable consumption, nutritional knowledge and beliefs in mothers and children. *Appetite* **31**, 205–208.
- Thompson RL, Margetts BM, Speller VM *et al.* (1993) The Health Education Authority's health and lifestyle survey 1993: who are the low fruit and vegetable consumers? *J Epidemiol Community Health* **53**, 294–299.
- Galloway AT, Lee Y & Birch LL (2003) Predictors and consequences of food neophobia and pickiness in young girls. *J Am Diet Assoc* **103**, 692–698.
- Golding J, Pembrey M, Jones R *et al.* (2001) ALSPAC – The Avon Longitudinal Study of parents and children I. Study methodology. *Paediatr Perinat Epidemiol* **15**, 74–87.
- ALSPAC website. <http://www.bristol.ac.uk/alspac/>.
- Emmett PM, Rogers IS, Symes C *et al.* (2002) Food and nutrient intakes of a population sample of 3-year-old children in the South West of England in 1996. *Public Health Nutr* **5**, 55–64.
- Glynn L, Emmett P, Rogers I *et al.* (2005) Food and nutrient intakes of a population sample of 7-year-old children in the South-West of England in 1999/2000 – what difference does gender make? *J Hum Nutr Diet* **18**, 7–19.
- Wrieden WL, Longbottom PJ, Adamson AJ *et al.* (2008) Estimation of typical food portion sizes for children of different ages in Great Britain. *Br J Nutr* **99**, 1344–1353.
- O'Brien MM, Kiely M, Galvin M *et al.* (2003) The importance of composite foods for estimates of vegetable and fruit intakes. *Public Health Nutr* **6**, 711–726.
- Williams C (1995) Healthy eating – clarifying advice about fruit and vegetables. *BMJ* **310**, 1453–1455.
- Department of Health (1991) *Dietary Reference Values for Food Energy and Nutrients for the United Kingdom*. London: HMSO.
- Prescott-Clarke P & Primatesta P (1998) *Health Survey for England: The Health of Young People 1995–1997*. London: HMSO.
- Timperio K, Ball K, Roberts R *et al.* (2008) Children's fruit and vegetable intake: associations with the neighbourhood food environment. *Prev Med* **46**, 331–335.
- Laitinen S, Rasanen L, Viikari J *et al.* (1995) Diet of Finnish children in relation to the family's socio-economic status. *Scand J Soc Med* **23**, 88–94.
- Cooke LJ, Wardle J, Gibson EL *et al.* (2004) Demographic, familial and trait predictors of fruit and vegetable consumption by pre-school children. *Public Health Nutr* **7**, 295–302.
- Mooney C (1990) Cost and availability of healthy food choices in a London health district. *J Hum Nutr* **3**, 111–120.
- Cade J, Upmeyer H, Calvert C *et al.* (1999) Cost of a health diet: analysis from the UK Women's Cohort Study. *Public Health Nutr* **2**, 505–512.

31. Cullen KW, Baranowski T, Owens E *et al.* (2003) Availability, accessibility and preferences for fruit, 100% fruit juice and vegetables influence children's dietary behavior. *Health Educ Behav* **30**, 615–626.
32. Harper LV & Sanders KM (1975) The effect of adult's eating on young children's acceptance of unfamiliar foods. *J Exp Child Psychol* **20**, 206–214.
33. Ashfield-Watt PAL, Welch AA, Day NE *et al.* (2003) Is 'five-a-day' an effective way of increasing fruit and vegetable intakes? *Public Health Nutr* **7**, 257–261.
34. Fraser GE, Welch A & Luben R (2000) The effect of age, sex, and education on food consumption of a middle-aged English cohort – EPIC in East Anglia. *Prev Med* **30**, 26–34.
35. Baker AH & Wardle J (2003) Sex differences in fruit and vegetable intake in older adults. *Appetite* **40**, 269–275.
36. Fagerli RA & Wandel M (1999) Gender differences in opinions and practices with regard to a 'healthy diet'. *Appetite* **32**, 171–190.
37. Cooke L, Carnell S & Wardle J (2006) Food neophobia and mealtime food consumption in 4–5 year old children. *Int J Behav Nutr Phys Activ* **3**, 14.
38. Bingham S, Welch A, Cassidy A *et al.* (1991) The use of 24 h urine nitrogen to detect bias in the reported habitual food intake of individuals assessed from weighted dietary records. *Proc Nutr Soc* **50**, 32A.
39. Domel SB, Baranowski T, Davis H *et al.* (1994) Fruit and vegetable food frequencies by 4th and 5th grade students – validity and reliability. *J Am Coll Nutr* **13**, 33–39.
40. Pearson N, Biddle SJH & Gorely T (2008) Family correlates of fruit and vegetable consumption in children and adolescents: a systematic review. *Public Health Nutr* **12**, 267–283.