

Does nutrition education in primary schools make a difference to children's fruit and vegetable consumption?

Joan Kathleen Ransley^{1,*}, Elizabeth Faye Taylor², Yara Radwan³, Meaghan Sarah Kitchen¹, Darren Charles Greenwood⁴ and Janet Elizabeth Cade¹

¹Nutritional Epidemiology Group, Centre for Epidemiology and Biostatistics, Worsley Building, University of Leeds, Leeds LS2 9JT, UK; ²Cancer Epidemiology Group, University of Leeds/Northern & Yorkshire Cancer Registry & Information Service, Leeds, UK; ³Human Nutrition Unit, University of Sheffield, Sheffield UK;

⁴Biostatistics Unit, Centre for Epidemiology and Biostatistics, University of Leeds, Leeds, UK

Submitted 7 August 2009; Accepted 20 January 2010; First published online 26 March 2010

Abstract

Objective: To explore whether initiatives to promote fruit and vegetables in primary schools are associated with changes in children's diet.

Design: Cross-sectional dietary survey. Main outcome measures were intakes of fruit, vegetables and key nutrients; and a score for initiatives promoting fruit and vegetables in school.

Setting: One hundred and twenty-nine English primary schools.

Subjects: Year 2 children (aged 6–7 years, *n* 2530).

Results: In schools running a gardening club, children ate more vegetables, 120 (95% CI 111, 129) g/d, compared with those that did not, 99.3 (95% CI 89.9, 109) g/d; and where parents were actively involved in school initiatives to promote fruit and vegetables, children's intake of vegetables was higher, 117 (95% CI 107, 128) g/d, compared with those where parents were not involved, 105 (95% CI 96.2, 114) g/d. In schools that achieved a high total score (derived from five key types of initiatives to promote fruit and vegetables in school) children ate more vegetables, 123 (95% CI 114, 132) g/d, compared with those that did not, 97.7 (95% CI 88.7, 107) g/d.

Conclusions: Gardening, parental involvement and other activities promoting fruit and vegetables to children in school may be associated with increased intake of vegetables but not fruit. These effects were independent of deprivation status and ethnicity.

Keywords
School
Children
Diet
Fruit
Vegetables

As an integral part of the Five A Day campaign, the School Fruit and Vegetable Scheme (SFVS) is currently the largest national initiative to promote fruit and vegetables to children in England. Introduced into primary schools between 2002 and 2004, the scheme makes available one piece of fruit or a vegetable to children each school day for the first three years of school. The UK is not alone in introducing initiatives to promote children's intake of fruit and vegetables^(1–3).

Several evaluations of the SFVS have shown an increased intake of fruit rather than vegetables while children participate in the scheme, but children's intake falls when they are no longer eligible^(4–6). In schools without the SFVS children's intake of fruit and vegetables falls as they progress from Reception (age 4–5 years) through to Year 2 (age 6–7 years)⁽⁷⁾. To maintain and improve existing intakes of fruit and vegetables from Reception to Year 2 and beyond, it seems important for schools to extend initiatives to promote fruit and

vegetables over and above the provision of free school fruit in Key Stage One (4–8 years).

Many English primary schools have embraced this idea and found opportunities for children to learn more about fruit and vegetables through lessons in the formal curriculum and extracurricular activities. For example, the National Curriculum enables children to learn about fruit and vegetables in Science, Design and Technology, and Personal, Social, Health Education and Citizenship. Geography, English and Art also provide some educational opportunities for children to learn about fruit and vegetables⁽⁸⁾.

Outside the formal curriculum children can learn about fruit and vegetables through growing and cooking activities. The Royal Horticultural Society, for example, has spearheaded a national campaign called 'Grow It, Cook It, Eat It'. This campaign encourages schools to set up growing activities in school which lead to cooking and eating opportunities for participating children⁽⁹⁾. The School Food Trust is also running a £20 million 'Lets Get

*Corresponding author: Email j.k.ransley@leeds.ac.uk

Cooking' campaign to help children learn relevant cooking and food preparation skills⁽¹⁰⁾.

Research has shown that practical activities such as cooking and gardening facilitate behaviour change in children^(11,12). Practical activities undertaken with peers and staff in school may help young children to overcome some of their natural fear of new food, known as food neophobia⁽¹³⁾. This may occur through modelling of appropriate eating behaviour, repeated exposure to foods, providing encouraging and supportive environments for eating, and practical activities which help children become more familiar with foods^(14–16).

New school food standards have been introduced to improve the nutritional quality of food served at school. Provision has been made to increase the amount of fruit and vegetables in school lunches and place restrictions on the provision of foods with low nutritional value, such as chips, confectionery and soft drinks^(10,17). These standards are compulsory; however, children are still at liberty to bring a packed lunch which does not conform to the new standards. A recent intervention to improve the food and nutritional value of children's lunch boxes found that only 19% of children met the food-based guidelines for vegetables and 54% for fruit⁽¹⁸⁾. The content and nutritional value of what children eat outside school is the responsibility of parents and other adult carers. There is some evidence that when children eat more fruit at school they eat less at home⁽⁷⁾.

The National Healthy Schools Programme also addresses the promotion of fruit and vegetables as part of a healthy diet. This voluntary scheme sets targets for schools to achieve in four areas including Healthy Eating and leads to National Healthy School Status⁽¹⁹⁾.

Schools are at liberty, in consultation with their governing bodies, to write and implement a policy on food in their school, which many have done. Some schools include parents in their initiatives to improve school food through correspondence with them and by involving them in activities such as cooking and growing. These arrangements for educating children about fruit and vegetables and their value in a healthy diet vary across English schools. Apart from the impact of the SFVS on the diet of young children, little is known about whether these initiatives have an effect on children's intake of fruit and vegetables and the nutritional composition of their diets.

Therefore the aim of the present research was to explore whether children's intake of fruit and vegetables is related to school initiatives to promote fruit and vegetables.

Methods

Sampling methods

The sample was drawn from maintained schools containing pupils in Years 2 to 4 with a minimum year group size of fifteen pupils. Independent schools, special schools, schools

without all three years, and small schools with less than fifteen pupils per year group were excluded. The National Foundation for Educational Research (NFER) was responsible for recruiting schools and collecting data. Schools that had or were participating in other NFER projects were excluded.

A random national sample was stratified by ethnicity, deprivation, educational achievement, and region of England. Power calculations suggested that a sample of 2200 children would give approximately 90% power to detect a difference of 0.33 portions of fruit per day based on a comparison of mean fruit intake in schools with a high proportion of children eligible for free school meals *v.* those with a low eligible proportion. Results from our initial evaluation of the SFVS found a 68% response from pupils completing the CADET food diary⁽⁴⁾. To allow for this loss to follow-up, 130 schools would be recruited with an estimated total of 3250 children available.

One hundred and twenty-nine schools accepted to take part in the study. A letter was sent to parents or guardians of children in Year 2, two weeks in advance of the data collection, giving information about the study and providing the opportunity for children to be withdrawn from the study. Ethical approval was granted by the University of Leeds Research Ethics Committee.

Dietary assessment

The Child and Diet Evaluation Tool (CADET) was used to estimate the children's mean intake of foods and nutrients. CADET was designed as a simple dietary assessment tool and records a child's dietary intake over 24 h. The validation study compared CADET with a 24 h semi-weighed food diary obtained from the same children for the same day and showed close association with the usual diet⁽²⁰⁾. CADET was completed by NFER trained administrators during the school day, and sent home to be completed by parents and returned the following morning with the child.

Children with a total energy intake of less than 2092 kJ/d (500 kcal/d) or more than 14 644 kJ/d (3500 kcal/d) were excluded from the study, as were those for whom the parental part of the CADET was left blank. This resulted in a final sample size of 2530 children.

Initiatives to promote fruit and vegetables

A questionnaire was developed by researchers at the University of Leeds to measure the initiatives schools use to promote fruit and vegetables to pupils in Year 2 and across the school. The questionnaire investigated what is taught about fruit and vegetables in the formal curriculum; the amount of time spent learning about fruit and vegetables; school activities and resources for growing and cooking food; school catering; and the involvement of parents in promoting fruit and vegetables to children. The questionnaire was administered to all Year 2 teachers to complete.

A scoring system was developed to rate the extent to which schools engaged in the activities outlined above.

A maximum score of 7 was awarded for each of five sections depending on the extent to which activities were undertaken. A maximum score of 35 could be awarded. The median of the scores was considered to be the cut-off point for schools falling into 'high' and 'low' scores.

Statistical analysis

A multivariable regression analysis using multilevel modelling techniques was conducted using the software MLwiN v2.10 (Centre for Multilevel Modelling, University of Bristol, Bristol, UK) to investigate the effect of initiatives to promote fruit and vegetable consumption on children's intake of these foods⁽²¹⁾. A two-level random intercepts model was used to allow for the dependency inherent in pupil observations nested within the same school to be taken into account.

Analyses were adjusted for ethnicity and deprivation. The interaction between ethnicity and deprivation was assessed by the likelihood ratio test and included in the model for foods where this was statistically significant ($P < 0.05$).

Results

Basic characteristics

We recruited 2709 children from 129 schools, a response rate of 72% to CADET. After 179 exclusions for mis-

reporting on CADET, a final sample size of 2530 children was achieved. The mean age of the children was 7 years (1290 girls and 1240 boys). English was spoken as an additional language by 10% of the sample. Seventeen per cent of children received free school meals and 54% ate a packed lunch. Thirty-five per cent of children had a member of the family educated to degree level or higher. Of the 130 participating schools, 100 returned the school questionnaire.

Table 1 shows the mean intake of foods and nutrients according to gender. The amount of vegetables eaten by boys exceeded that eaten by girls by 14 g/d; however, girls ate 38 g more fruit daily than boys. The combined daily intake of fruit and vegetables for all children was 309 g, equivalent to almost four 80 g portions daily but less than the Five A Day recommendation. Boys and girls consumed similar amounts of pulses, beans and seeds, about 20 g daily; while boys on average ate 8 g more dried fruit daily than girls. Children ate almost the same weight of chocolate, confectionery (sweets, toffees, mints, etc.) and savoury snacks each day (77 g) as they did vegetables (90 g).

Milk consumption was low for this age group, only 233 g/d (just over a quarter of a pint), as other drinks such as fruit juice, carbonated drinks and squashes featured highly in the diet. In both boys and girls the consumption of carbonated drinks and squash exceeded that of milk; however, these

Table 1 Mean intake of foods and nutrients in Year 2 children (aged 6–7 years, n 2530) from 129 English primary schools

	Girls		Boys		All children	
	Estimate (MLM)	95% CI	Estimate (MLM)	95% CI	Estimate (MLM)	95% CI
Vegetables (not pulses, beans or seeds) (g/d)	83.1	76.5, 89.8	96	89.3, 103	89.5	83.6, 95.4
Total vegetables (g/d)	104	97.0, 111	118	111, 125	111	105, 117
Pulses, beans, seeds (g/d)	20.7	17.4, 24.0	22.0	18.7, 25.3	21.3	18.5, 24.1
Total fruit (g/d)	217	206, 228	179	169, 191	198	189, 208
Fruit (not dried) (g/d)	216	205, 227	177	166, 188	196	187, 206
Dried fruit (g/d)	16.1	14.5, 17.6	23.7	22.3, 25.1	20.2	19.1, 21.3
Confectionery (sweets, toffees, mints, etc.) (g/d)	26.3	25.4, 27.2	25.4	24.4, 26.3	25.9	25.2, 26.6
Chocolate bars (Mars, Galaxy, etc.) (g/d)	23.7	22.8, 24.6	24.4	23.5, 25.2	24.1	23.4, 24.7
Crisps, savoury snacks (g/d)	26.3	25.6, 26.9	24.9	24.2, 25.5	25.6	25.1, 26.1
Nuts (g/d)	26.9	25.5, 28.2	26.2	24.4, 28.1	26.6	25.5, 27.7
Milk or milky drinks (g/d)	230	221, 239	237	228, 246	233	227, 240
Fizzy pop, squash, fruit drinks (g/d)	353	336, 370	372	355, 389	362	349, 376
Fruit juice (pure) (g/d)	216	206, 226	219	209, 229	217	210, 225
Energy (kJ/d)	6574	6452, 6696	7014	6892, 7136	6793	6689, 6897
Energy (kcal/d)	1561	1532, 1590	1666	1637, 1695	1613	1588, 1638
Protein (g/d)	53.1	52.0, 54.3	56.6	55.4, 57.7	54.8	53.9, 55.8
Carbohydrate (g/d)	224	220, 228	239	235, 243	231	228, 235
Fibre (g/d)	11.7	11.4, 12.0	12.3	12.0, 12.5	12.0	11.7, 12.2
Fat (g/d)	56.6	55.2, 58.0	60.5	59.1, 61.8	58.5	57.4, 59.7
% energy derived from fat	32.4	32.0, 32.7	32.4	32.0, 32.7	32.4	32.1, 32.7
Total sugars (g/d)	122	119, 125	126	123, 129	124	121, 126
Fe (mg/d)*	8.5	8.3, 8.7	9.2	9.0, 9.4	8.8	8.7, 9.0
Ca (mg/d)*	651	634, 668	716	698, 734	682	669, 696
K (mg/d)*	2167	2116, 2218	2237	2185, 2291	2202	2159, 2245
Na (mg/d)*	1905	1864, 1946	2080	2031, 2129	1990	1952, 2030
Folate (μ g/d)*	178	174, 183	189	184, 194	184	180, 187
Carotene (μ g/d)*	1447	1309, 1599	1594	1442, 1762	1518	1384, 1664
Vitamin A (μ g RE/d)*	216	208, 225	236	227, 246	226	219, 234
Vitamin C (mg/d)*	84.4	80.4, 88.7	78.6	74.8, 82.5	81.5	78.0, 85.0

MLM, multilevel model; RE, retinol equivalents.

*Log transformed and back transformed to estimate, treated as ratio instead.

children were obtaining enough calcium from their diet to meet the Reference Nutrient Intake (RNI) of 550 mg/d.

Reported daily energy intake for boys and girls was 1255 kJ (300 kcal) and 753 kJ (180 kcal), respectively, below the Estimated Average Requirement for this age group. Vitamin A intake was about half the RNI of 500 µg/d. Vitamin C intake was more than twice the RNI for this age group and intake of folate was also well above the RNI for this age group of 150 µg/d. Iron intake was adequate and protein intake (55 g) was almost twice the RNI of 28 g/d. Percentage energy derived from fat was low and consequently the percentage of energy derived from carbohydrate was slightly higher than guidelines recommend. There are no dietary guidelines for fibre intake in children; however, an intake of 12 g/d appears low. Sodium intake was high at double the recommended intake for children of this age.

Table 2 explores differences in food intake and initiatives to promote cooking, gardening and improve catering at school. There were no significant differences in children's intake of foods according to whether schools had a high or low score for cooking activities, although there were higher intakes of fruit (excluding dried fruit) in schools which had a high score.

In schools that achieved a high score for gardening, children ate significantly more vegetables, but there were no other significant differences in children's food intakes for a high score compared with a low score.

Where schools achieved a high score for improving catering, intake of pulses, beans and seeds was significantly higher, 24 (95 % CI 20, 29) g/d, compared with low-scoring schools, 17 (95 % CI 12, 22) g/d. A borderline non-significant but lower intake of sweets, toffees and mints was found in high-scoring schools compared with low-scoring schools.

Table 3 shows further effects associated with school initiatives to promote fruit and vegetables to children. Schools with a high score for lessons teaching children about fruit and vegetables were not associated with children's food intake apart from a slightly reduced intake of savoury snacks. This was borderline non-significant.

In schools where parents had been informed about its guidance on food and involved in meetings to promote fruit and vegetables (high scoring schools), children ate significantly more vegetables (not pulses, beans or seeds) compared with schools with a low score.

A high total score for promoting fruit and vegetables was associated with a significant increase, with children eating 25 g more vegetables daily. Children in these high-scoring schools also ate more pulses, nuts and seeds and less chocolate products, although the differences were borderline non-significant.

Table 4 confirms the independent effect associated with total score on children's intake of food by taking into account the effect of ethnicity and social deprivation. These results also show that children from schools with a high total score ate 25 g more vegetables daily than children

Table 2 The effect of cooking, gardening and school catering on food intake in Year 2 children (aged 6–7 years, *n* 2530) from 129 English primary schools

	Cooking score				Gardening score				Catering score			
	High score		Low score		High score		Low score		High score		Low score	
	Estimate (MLM)	95 % CI	Estimate (MLM)	95 % CI	P value	Estimate (MLM)	95 % CI	P value	Estimate (MLM)	95 % CI	Estimate (MLM)	95 % CI
Vegetables (not pulses, beans or seeds) (g/d)	89.0	78.8, 99.3	88.0	79.4, 96.6	0.876	97.0	88.0, 106	0.007	86.8	78.3, 95.3	90.9	80.4, 101
Total vegetables (g/d)	113	102, 123	108	99.0, 117	0.524	120	111, 129	0.002	111	103, 120	108	96.7, 119
Pulses, beans, seeds (g/d)	23.3	18.2, 28.3	20.1	15.8, 24.4	0.347	22.9	18.3, 27.5	0.344	24.4	20.2, 28.5	16.8	11.8, 21.9
Total fruit (g/d)	205	186, 222	193	179, 208	0.312	200	184, 216	0.738	197	183, 212	199	182, 217
Fruit (not dried) (g/d)	203	186, 220	191	177, 206	0.31	198	182, 214	0.735	195	181, 210	197	180, 215
Dried fruit (g/d)	19.4	17.4, 21.4	21.3	19.4, 23.1	0.174	21.5	19.5, 23.4	0.119	19.5	17.8, 21.3	21.6	19.5, 23.6
Confectionery (sweets, toffees, mints, etc.) (g/d)	25.4	24.4, 26.5	25.8	24.9, 26.7	0.598	26.1	25.2, 27.1	0.164	25.1	24.2, 26.0	26.4	25.4, 27.5
Chocolate bars (Mars, Galaxy, etc.) (g/d)	23.7	22.6, 24.7	24.4	23.5, 25.3	0.305	24.1	23.1, 25.0	0.968	23.9	23.0, 24.8	24.3	23.3, 25.4
Crisps, savoury snacks (g/d)	25.1	24.3, 26.0	25.5	24.8, 26.2	0.459	25.0	24.3, 25.8	0.192	25.5	24.8, 26.3	25.1	24.3, 25.9
Nuts (g/d)	26.0	23.9, 28.1	27.3	25.6, 29.1	0.332	27.2	25.4, 29.0	0.492	26.2	24.2, 28.1	27.4	25.6, 29.2
Milk or milky drinks (g/d)	228	218, 239	234	225, 243	0.412	238	228, 247	0.066	229	220, 237	236	225, 247
Fizzy pop, squash, fruit drinks (g/d)	363	340, 387	356	336, 376	0.645	367	346, 388	0.319	362	343, 382	355	331, 378
Fruit juice (pure) (g/d)	216	204, 228	211	201, 222	0.563	213	202, 224	0.977	213	203, 223	213	201, 226

MLM, multilevel model.

Table 3 The effect of lessons, parents and combined initiatives to promote fruit and vegetables in school on food intake in Year 2 children (aged 6–7 years, *n* 2530) from 129 English primary schools

	Lesson score						Parental involvement						Total score					
	High score			Low score			High score			Low score			High score			Low score		
	Estimate (MLM)			Estimate (MLM)			Estimate (MLM)			Estimate (MLM)			Estimate (MLM)			Estimate (MLM)		
	95 % CI	95 % CI	P value	95 % CI	95 % CI	P value	95 % CI	95 % CI	P value	95 % CI	95 % CI	P value	95 % CI	95 % CI	P value	95 % CI	95 % CI	P value
Vegetables (not pulses, beans or seeds) (g/d)	88.2	78.2, 98.0	88.6	79.8, 97.5	0.941	98.1	88.0, 108	82.0	73.7, 90.2	0.015	98.5	89.3, 108	79.1	70.3, 87.8	0.003			
Total vegetables (g/d)	112	101, 122	108	99.1, 118	0.626	117	107, 128	105	96.2, 114	0.078	123	114, 132	97.7	88.7, 107	0.000			
Pulses, beans, seeds (g/d)	23.5	18.6, 28.4	19.7	15.3, 24.1	0.255	19.2	14.0, 24.4	22.8	18.6, 27.1	0.285	24.4	19.7, 29.0	18.6	14.1, 23.1	0.082			
Total fruit (g/d)	196	180, 213	200	185, 215	0.771	209	191, 226	191	177, 205	0.129	198	181, 214	199	183, 214	0.908			
Fruit (not dried) (g/d)	194	177, 211	198	183, 213	0.743	206	189, 224	189	175, 204	0.143	196	180, 212	197	181, 212	0.915			
Dried fruit (g/d)	20.9	18.9, 22.9	20.0	18.1, 21.8	0.489	21.8	19.8, 23.8	19.3	17.5, 21.1	0.070	20.6	18.6, 22.5	20.2	18.3, 22.1	0.814			
Confectionery (sweets, toffees, mints, etc.) (g/d)	26.0	25.0, 27.0	25.4	24.5, 26.3	0.369	25.9	24.8, 27.0	25.5	24.6, 26.4	0.592	25.8	24.8, 26.8	25.5	24.6, 26.5	0.708			
Chocolate bars (Mars, Galaxy, etc.) (g/d)	23.8	22.7, 24.8	24.3	23.4, 25.3	0.432	24.2	23.2, 25.3	24.0	23.1, 24.9	0.758	23.5	22.5, 24.4	24.7	23.8, 25.7	0.069			
Crisps, savoury snacks (g/d)	25.9	25.1, 26.7	24.9	24.2, 25.6	0.053	25.5	24.6, 26.3	25.3	24.6, 26.0	0.799	25.0	24.2, 25.8	25.6	24.9, 26.4	0.283			
Nuts (g/d)	27.9	25.8, 29.9	26.1	24.3, 27.8	0.178	27.7	25.7, 29.6	26.1	24.4, 27.9	0.269	27.4	25.5, 29.3	26.3	24.4, 28.2	0.417			
Milk or milky drinks (g/d)	225	214, 235	236	228, 245	0.091	233	222, 244	231	222, 240	0.728	230	220, 240	233	224, 243	0.595			
Fizzy pop, squash, fruit drinks (g/d)	351	328, 374	365	345, 385	0.374	349	325, 373	366	346, 385	0.297	358	336, 380	360	339, 381	0.932			
Fruit juice (pure) (g/d)	215	203, 228	212	201, 222	0.630	213	201, 225	213	203, 224	0.991	214	202, 225	213	202, 224	0.889			

MLM, multilevel model.

from schools with a low score. These children also ate significantly more pulses, beans and seeds.

Discussion

The present results provide an overview of food and nutrient intake of a large sample of English children at the end of their third year of school (School Year 2).

Intake of fruit and vegetables in this group was almost four portions per day, which appears to be an improvement on the findings of earlier studies; however it is lower than the Five A Day recommended for current and future health. This finding is similar to the baseline intakes of children in an earlier evaluation of the SFVS⁽⁴⁾.

It is evident that foods other than fruit and vegetables have a prominent position in the diet of children. Sweets, confectionery and savoury snacks were eaten in almost the same amounts as vegetables, and more fizzy drinks and squash were consumed than milk.

From a nutritional point of view, however, calcium levels met recommended intakes and iron levels were adequate. Sodium levels were high as has been shown in many dietary surveys of children^(4,22). Large regular intakes of savoury snacks contribute to these high intakes of sodium. Vitamin A levels were low and may result from a poor intake of vegetables in some children. It is interesting to note that intake of folate was adequate and intake of vitamin C was high. Good sources of these vitamins in children's diets are likely to be fortified breakfast cereals and fruit juice, respectively.

With regard to macronutrient intake, energy intake was low. This may be due to under-reporting foods consumed as a result of items being missed or assumed portion sizes which are too small for this age of child; however protein intake was more than adequate. Fibre intakes appeared low and the figures obtained are in line with a diet which is low in fruit and vegetables. The fibre intake of children in the current survey is on a par with that of the adult population. However, it should be noted there are currently no absolute recommendations for intake of fibre for this age group of children.

Schools across England vary in the number and type of initiatives they undertake to educate about and promote fruit and vegetables to children. The present study has provided some evidence to show that, in schools where gardening activities take place, children consume significantly more vegetables and pulses than in schools where gardening and growing activities are limited. This may provide some evidence to support the importance of practical activities in encouraging children to consume vegetables, as has been shown elsewhere⁽²³⁾; however, further work is required to confirm this.

Likewise, in schools where there was a high degree of parent involvement in promoting fruit and vegetables to children, more vegetables were eaten. Because of the

Table 4 Independent* effect of initiatives to promote fruit and vegetables in schools, controlling for social class and ethnicity, in Year 2 children (aged 6–7 years, *n* 2530) from 129 English primary schools

	Difference between schools	95 % CI	<i>P</i> value for significance of parameter on food group
Reference category: Good total score			
Vegetables (not pulses, beans or seeds) (g/d)	–18.0	–30.1, –5.9	0.004
Total vegetables (g/d)	–25.1	–37.9, –12.3	0.000
Pulses, beans, seeds (g/d)	–6.7	–12.8, –0.7	0.029
Total fruit (g/d)	3.0	–19.3, 25.4	0.791
Fruit (not dried) (g/d)	3.0	–19.3, 25.3	0.789
Dried fruit (g/d)	0.1	–2.7, 2.8	0.956
Confectionery (sweets, toffees, mints, etc.) (g/d)	–0.5	–1.9, 0.9	0.490
Chocolate bars (Mars, Galaxy, etc.) (g/d)	0.9	–0.5, 2.3	0.224
Crisps, savoury snacks (g/d)	0.6	–0.5, 1.7	0.291
Nuts (g/d)	–1.7	–4.6, 1.3	0.267
Milk or milky drinks (g/d)	6.0	–8.9, 21.0	0.429
Fizzy pop, squash, fruit drinks (g/d)	–3.2	–35.2, 28.9	0.846
Fruit juice (pure) (g/d)	–1.0	–17.3, 15.3	0.904

*Linear regression of the total score on the foods listed was adjusted for ethnicity and deprivation. The interaction between ethnicity and deprivation was assessed by the likelihood ratio test and included in the model for foods where this was statistically significant ($P < 0.05$).

nature of the current cross-sectional analysis it is not possible to deduce a causal relationship, but these results suggest there may be some association that needs to be tested further. Parents are vitally important to the acceptance by children of new fruit and vegetables in their diet. This is because of the importance of adults modelling appropriate eating behaviour and creating a positive environment to support and encourage children's intake of these foods^(13,24–26).

The number of lessons spent on promoting fruit and vegetables was not associated with consumption of fruit and vegetables. Perhaps lessons do not include the best behaviour change techniques such as modelling, repeated exposure and practical experience with fruit and vegetables^(17,27). Lessons may not include such an approach and may explain why efforts in this area are not associated with a higher intake of fruit and vegetables. It is therefore important to augment knowledge about fruit and vegetables with other approaches to encourage consumption of these foods.

Combining the five individual scores to produce a global score to reflect initiatives schools made to educate children about fruit and vegetables produced one notable finding regarding higher intakes of vegetables in schools with a high score. One might ask why this did not hold true for fruit. Perhaps because all schools now participate in the SFVS, which largely supplies fruit to children, intake of fruit cannot be improved upon. It has reached its upper threshold, leaving more scope for increasing vegetable intake. Certainly, the children were eating on average about 88 g more fruit than vegetables daily, equivalent to a portion of fruit.

Do the results differ in more deprived schools? The results reported in Table 4 provide some encouragement that efforts to promote fruit and vegetables to children have an effect regardless of the deprivation status of the area and the ethnic mix of the school.

The present study was a large, national, cross-sectional study of children's diet; however there are limitations. Cross-sectional studies can only suggest associations between variables and do not provide robust evidence of causality. Little work has been undertaken to evaluate the impact of educational interventions on children's intake of fruit and vegetables. Measuring exactly how and what is being taught in different parts of the formal curriculum relies on teacher recall and is therefore subject to error. Promotion of fruit and vegetables in the informal curriculum through activities such as cooking and gardening is also limited by reliance on teachers to record this involvement. However, we believe the questionnaire used to do this provided a reasonable record of the activities schools engaged in to promote fruit and vegetables to pupils.

CADET has been used in several large studies to estimate children's intake of food and nutrients. It has the limitations of a 24 h record of food intake; however the sample size for the study is large and should compensate for this.

This is, we believe, the first time an attempt has been made to explore the relationship between initiatives schools themselves are taking to promote fruit and vegetables to children and their association with diet. Our findings show some encouraging results for schools that involve parents and promote fruit and vegetables through extracurricular activities such as gardening, but further work is needed to confirm these findings.

Acknowledgements

This work was supported by the National Prevention Research Initiative (NPRI), Medical Research Council Grant number G050129. The authors state that there are no conflicts of interest. The contribution of each author to the research was as follows: J.K.R. was the project manager and drafted the paper; E.F.T. conducted the statistical

analysis; Y.R. designed the scoring system for school-based initiatives to promote fruit and vegetables, and undertook preliminary analysis; M.S.K. was the research assistant, liaised with schools and performed data collection; D.C.G. was the senior statistician and adviser; J.E.C. was the principal investigator for the project.

References

1. Parmer SM, Salisbury-Glennon J, Shannon D *et al.* (2009) School gardens: an experiential learning approach for a nutrition education program to increase fruit and vegetable knowledge, preference, and consumption among second-grade students. *J Nutr Educ Behav* **41**, 212–217.
2. He M, Beynon C, Bouck MS *et al.* (2009) Impact evaluation of the Northern fruit and vegetable pilot programme – a cluster-randomised controlled trial. *Public Health Nutr* **12**, 2199–2208.
3. Tak NI, Velde SJ & Brug J (2009) Long-term effects of the Dutch Schoolgruitem Project – promoting fruit and vegetable consumption among primary-school children. *Public Health Nutr* **12**, 1213–1223.
4. Ransley JK, Greenwood DC, Cade JE *et al.* (2007) Does the school fruit and vegetable scheme improve children's diet? A non-randomised controlled trial. *J Epidemiol Community Health* **61**, 699–703.
5. Wells L & Nelson M (2005) The National School Fruit Scheme produces short term but not long term increases in fruit consumption in primary school children. *Br J Nutr* **93**, 537–542.
6. Fogarty AW, Antoniak M, Venn AJ *et al.* (2007) Does participation in a population-based dietary intervention scheme have a lasting impact on fruit intake in young children? *Int J Epidemiol* **36**, 1080–1085.
7. Schagen S, Ransley J, Blenkinsop S *et al.* (2005) *Evaluation of the School Fruit and Vegetable Pilot Scheme. Final Report*. London: Evaluation and Research Team Big Lottery Fund.
8. Qualifications and Curriculum Authority (2008) National Curriculum. <http://curriculum.qca.org.uk/key-stages-1-and-2/index.aspx> (accessed November 2008).
9. Royal Horticultural Society (2008) RHS Campaign for Gardening. <http://www.rhs.org.uk/SCHOOLGARDENING/default.aspx> (accessed November 2008).
10. School Food Trust (2008) Let's Get Cooking. <http://www.letsgetcooking.org.uk/Home> (accessed November 2008).
11. Thomas J, Sutcliffe K, Harden A *et al.* (2003) *Children and Healthy Eating: A Systematic Review of Barriers and Facilitators*. London: EPPI-Centre, Social Science Research Unit, Institute of Education, University of London.
12. British Nutrition Foundation (2004) *A Critical Review of the Psychosocial Basis of Food Choice and Identification of Tools to Effect Positive Food Choice: A Summary*. London: British Nutrition Foundation.
13. Birch LL (1999) Development of food preferences. *Annu Rev Nutr* **19**, 41–62.
14. Birch LL & Marlin DW (1982) I don't like it; I never tried it: effects of exposure on two-year-old children's food preferences. *Appetite* **3**, 353–360.
15. Wardle J, Herrera M, Cooke L *et al.* (2003) Modifying children's food preferences: the effects of exposure and reward on acceptance of an unfamiliar vegetable. *Eur J Clin Nutr* **57**, 341–348.
16. Wardle J, Cook LJ, Gibson EL *et al.* (2002) Increasing children's acceptance of vegetables: a randomized trial of parent-led exposure. *Appetite* **40**, 155–162.
17. School Food Trust (2010) School Meal Standards. http://www.schoolfoodtrust.org.uk/doc_item.asp?DocId=8cDocCatId=9 (accessed March 2010).
18. Evans CE, Greenwood DC, Thomas JD *et al.* (2010) An intervention to improve children's school lunch box meals. *J Epidemiol Community Health* (Publication ahead of print version).
19. Department of Children Schools and Families, Department of Health (2008) Healthy Schools. <http://www.healthy-schools.gov.uk/About.aspx> (accessed November 2008).
20. Cade JE, Frear L & Greenwood DC (2006) Assessment of diet in young children with an emphasis on fruit and vegetable intake: using CADET – Child and Diet Evaluation Tool. *Public Health Nutr* **9**, 501–508.
21. Rashbash J, Steele F, Browne WJ *et al.* (2009) *A User's Guide to MLwiN, Version 2.0*. London: Institute of Education.
22. Gregory J, Lowe S & Bates C (2001) *National Diet and Nutrition Survey: Young People Aged 4 to 18 Years*. vol. 1: *Report of the Diet and Nutrition Survey*. London: Office of National Statistics.
23. Morris JL & Zidenberg-Cherr S (2002) Garden-enhanced nutrition curriculum improves fourth-grade school children's knowledge of nutrition and preferences for some vegetables. *J Am Diet Assoc* **102**, 91–93.
24. Johnson SL & Birch LL (1994) Parents' and children's adiposity and eating style. *Pediatrics* **94**, 653–661.
25. Brown R & Ogden J (2004) Children's eating attitudes and behaviour: a study of the modelling and control theories of parental influence. *Health Educ Res* **19**, 261–271.
26. Birch LL & Fisher JO (1998) Development of eating behaviors among children and adolescents. *Pediatrics* **101**, 539–549.
27. Contendo I, Contendo I, Bronner YL *et al.* (1995) The effectiveness of nutrition education and implications for nutrition education policy, programs, and research: a review of research. *Nutr Educ* **27**, 277–418.