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The quality of midday meals eaten at school by adolescents; school lunches compared with packed lunches and their contribution to total energy and nutrient intakes

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Abstract

Objective: To compare food and nutrient intakes from midday meals provided by schools with those from packed lunches and to estimate the contribution from food eaten at midday to the total daily energy and nutrient intakes of teenagers.
Design: Dietary data were recorded in 4 d estimated diaries of which 2 d were school days. The school day data were analysed for total and midday energy and nutrient intakes. The latter were compared with the recommendations of the Caroline Walker Trust (CWT).
Setting: Cambridgeshire, UK, 2006.
Subjects: Teenagers (*n* 757) aged 14–15 years, from eighteen secondary schools, who reported food eaten at school.
Results: The contribution to total daily energy intake from all lunches eaten at school was 29 % (boys) and 28 % (girls). School meals provided greater quantities of protein, starch, carotene and folate but also more saturated fats and Na than packed lunches. Intakes of energy and several nutrients fell below the CWT recommendations for both types of lunch. School meals and packed lunches provided different types of foods; greater quantities of rice, pasta and vegetables in school meals; more yoghurt, cheese, fruit and juices but also more confectionery and soft drinks in packed lunches.
Conclusions: There has been concern that schoolchildren who are not opting for lunch provided by schools are compromising the overall quality of their diet, but the present study showed small differences in nutrient content between packed and school lunches. These data were collected in 2005–2007 before the government programme of improvements reached secondary schools.

Keywords
Midday meals
School lunches
Packed lunches
Adolescents

The provision and quality of meals served in schools in the UK have been topics for discussion for over 100 years. With the recognition that children who were malnourished could not benefit fully from their education, legislation in 1906 gave local authorities powers to provide meals for necessitous children. During World War II the school meals service became established for all children and from 1944 the provision of a midday meal became obligatory in all Local Education Authority schools. The aim was to provide a meal of the highest nutritional quality to counteract the possible nutritional deprivation at home due to poverty or mothers being at work and unable to prepare meals[1]. In 1965, school meals were required for the first time to comply with government standards devised by the Department of Education: each meal to provide 3682 kJ (880 kcal), 29 g protein and 32 g fat.

The requirement for Local Education Authorities to provide school meals or for those meals to reach a nutritional standard was dropped in 1980, which, together with the increase in children bringing packed lunches to school, led to the perception that children were eating midday meals at school of poorer nutritional value. As a result of increasing concern about the nutritional content of school dinners and the rising levels of childhood overweight and obesity in England, the Caroline Walker Trust (CWT)[2] published nutritional guidelines for school meals in 1992, based on the dietary reference values for the UK published in 1991. The Education and Employment Select Committee recommended that these quantified nutrient-based standards be introduced for school meals and should be monitored by the Office for Standards in Education, Children's Services and Skills (Ofsted) as part of its inspection remit. It was not until 2001 that the

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Department for Education and Skills (DfES) reintroduced statutory national nutritional standards for school lunches[3]. The standards were expressed in terms of food groups and in secondary schools at least two items from each group were to be available every day. These food groups were starchy foods such as bread, potatoes, rice or pasta, of which one must not be cooked in fat, vegetables and fruit, milk and dairy foods, meat, fish or alternative non-dairy source of protein. Red meat was to be served at least three times weekly and fish at least once weekly. These standards applied to hot and cold lunches but it was recommended that schools offered hot food, particularly in winter. The standards aimed at providing children with the opportunity to select healthy balanced meals at lunchtime. Responsibility for funding school meals and for meeting the guidelines rested with the schools' governing bodies. However, a survey of school lunches carried out in seventy-nine secondary schools in England in 2004 commissioned by the DfES and Food Standards Agency[4] revealed that the current nutritional standards had failed to encourage children in England to choose foods such as those described above. A high percentage of meals served failed to meet the CWT guidelines for school meals[2], particularly for Fe and Ca content[4]. In early 2005 television focused the attention of the nation, and subsequently the Prime Minister, on the food that was actually being served in schools. Thus public and government awareness provided the impetus to set up the School Meals Review Panel (SMRP) in 2005, with remit to advise upon a major revision of school meals with the intent to reduce fat and sugar consumption and increase fruit and vegetable intakes among children. The DfES set up the School Food Trust to take these recommendations forward[5]. The guidelines combined food-based and nutrient-based recommendations, using the CWT guidelines as a baseline. These standards became statutory in primary schools in England in 2008 and in secondary schools in 2009[6].

Recent reports on school meals have mainly covered primary schools[7,8] but attention should also be focused on adolescents who not only have more freedom to choose what they eat but also have increased requirements for some nutrients. The current paper presents data on meals eaten at school from a dietary survey in 2005–2007 of 757 teenagers, aged 14–15 years, across eighteen schools in the Cambridgeshire area. Total daily intake and lunchtime intakes of energy and selected nutrients on school days were analysed and a comparison made between packed lunches and meals provided by the school.

Methods

Participants

The ROOTS project is a longitudinal study that aims to identify the risk patterns and processes for psychopathology emerging during adolescence[9]; i.e. the 'roots' of mental illness in young people. The study recruited a broad range of young people across the counties of Cambridgeshire and Suffolk. Twenty-seven urban and rural schools were approached, eighteen of which agreed to participate in the study. Eligible students were those aged between 14 and 15 years. Overall, 1238 teenagers consented to take part in the study. Information was collected on a number of topics at entry into the study in 2005–2007 and included data from both parents and adolescents, using self-report questionnaires and semi-structured interviews. Using the ACORN score to categorise consenting participants in relation to socio-economic status it was found that 54 % fell in the category of 'wealthy achievers'[9]. The study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Cambridgeshire 2 Research Ethics Committee. Written informed consent was obtained from all participants and a parent.

Dietary assessment

Of the 927 participants recruited into the ROOTS study, 69 % of the boys and 76 % of the girls completed an estimated dietary record of all food and drinks consumed over a 4 d period during the school term, including two weekdays and two weekend days. The ROOTS diet diaries included a section for the participants to state where the food was obtained and where it was eaten. Participants were asked to give estimated portion sizes in terms of small, medium or large, household measures or as individual items. Diets were coded and analysed using an in-house dietary assessment system, DINO, based on McCance and Widdowson's *The Composition of Foods*[10]. In this analysis data from individual school days only were used. Intakes for school days of food groups, energy and selected nutrients, for daily totals and for lunchtime only, were analysed and a comparison made between those eating packed lunches and meals provided by the school. The diaries of participants who recorded nothing in the 'lunchtime' slot were further examined and it was found that some were consuming their packed lunch in the middle of the morning during the break period. These packed lunches were included in the analysis.

Data analysis

Means and 95 % confidence intervals for energy and selected nutrients were calculated for total daily intakes and for lunches eaten at school for boys and girls separately. Only those who had recorded food eaten at school at midday (n 757) were included. ANOVA was used to compare the intakes of energy and selected nutrients for the children who had consumed a school meal with those eating packed lunches. Data analysis was performed using the SPSS for Windows statistical software package version 14 (SPSS Inc., Chicago, IL, USA).

Results

Results are shown for 1265 participant-days for boys and girls who ate 584 school meals and 681 packed lunches over two weekdays at school. Children were not consistent, some eating a school meal on one day and a packed lunch on the other. For 148 (16%) of the boys and 139 (15%) of the girls who completed diet diaries, no lunch was recorded as eaten on any school day. Tables 1 and 2 present the mean intakes of energy and key nutrients from school lunches and packed lunches eaten by boys and girls, respectively. School meals eaten by boys provided significantly more protein, starch and folate but also significantly more Na and (borderline significantly) more saturated fats than packed lunches. School meals eaten by girls also provided significantly more Na and saturated fat but also more energy, carbohydrate and carotene than packed lunches, which provided significantly more Ca.

Tables 3 and 4 show the total daily intakes of energy and nutrients (mean, SD), and the percentage contribution (mean, SD) to total intake of meals eaten at school. Packed lunches contributed 27% (boys) and 25% (girls) to total daily energy intake whereas the contribution to total daily energy intake from school lunches was 29% for both boys and girls. The contribution to total daily nutrients from boys' packed lunches ranged from 16% for β-carotene to 28% for fat; the contribution from boys' school lunches varied from 21% for vitamin C to 31% for fat and Na. The contribution from girls' packed lunches to total daily nutrients ranged from 13% for β-carotene to 27% for fat and Ca, and that from girls' school lunches from 24% for vitamin C and total sugars to 33% for starch. Comparing the contribution to total intakes from

Table 1 Mean and median intakes of energy and nutrients from packed and school lunches eaten by 14–15-year-old boys, Cambridgeshire, UK, 2006

	Packed lunch (*n* 318)					School lunch (*n* 234)					
	Mean	Median	SD	P95	P5	Mean	Median	SD	P95	P5	*P* (ANOVA)*
Energy (MJ)	2·3	2·1	1·3	4·6	0·6	2·5	2·3	1·3	4·8	0·7	NS
Protein (g)	17·3	17·0	10·9	38·1	1·2	20·0	17·8	13·8	46·3	1·7	0·009
Fat (g)	23·6	21·1	16·8	58·2	0·6	24·7	22·4	17·0	57·0	0·5	NS
SFA (g)	7·9	6·1	7·1	21·8	0·2	9·0	6·9	6·8	21·7	0·1	0·07
Carbohydrate (g)	71·2	64·7	41·0	139·1	20·9	74·5	66·5	41·5	153·7	24·5	NS
Starch (g)	31·5	27·9	26·0	76·4	0·0	45·6	41·1	28·4	101·3	0·0	<0·001
Sugars (g)	29·3	25·7	24·7	77·3	2·5	27·4	23·5	25·8	69·9	1·8	NS
Total NSP (g)	3·6	3·2	2·4	8·4	0·7	3·3	2·9	2·5	7·9	0·0	NS
Na (mg)	634	473	563	1619	29	861	783	564	1895	39	<0·001
Ca (mg)	251	200	194	640	24	230	169	199	681	28	NS
Fe (mg)	2·4	2·3	1·5	4·7	0·4	2·6	2·3	1·7	5·8	0·3	NS
Carotene equiv. (μg)	262	46	894	815	0	352	99	780	1462	0	NS
Folate (μg)	47·7	42·7	34·1	117·1	4·3	54·9	43·4	42·2	140·9	6·4	0·028
Vitamin C (mg)	28·2	8·9	49·0	110·4	0·0	23·7	9·1	44·6	137·5	0·0	NS

P95, upper 5th percentile; P5, lower 5th percentile.
**P*, significance of the difference between the nutrient content of packed lunch *v.* school lunch.

Table 2 Mean and median intakes of energy and nutrients from packed and school lunches eaten by 14–15-year-old girls, Cambridgeshire, UK, 2006

	Packed lunch (*n* 363)					School lunch (*n* 350)					
	Mean	Median	SD	P95	P5	Mean	Median	SD	P95	P5	*P* (ANOVA)*
Energy (MJ)	1·8	1·6	1·0	3·8	0·5	2·0	1·8	1·1	4·0	0·5	0·026
Protein (g)	14·1	11·1	11·2	36·9	1·2	15·5	13·7	11·0	38·2	1·7	NS
Fat (g)	17·8	15·2	13·7	45·3	1·0	19·5	16·9	13·7	46·9	1·5	NS
SFA (g)	5·2	3·6	5·4	16·3	0·0	7·3	6·2	5·9	17·5	0·3	<0·001
Carbohydrate (g)	55·6	50·2	33·5	106·9	15·2	63·1	57·3	51·8	117·7	18·7	0·021
Starch (g)	20·5	17·4	19·2	55·1	0·0	39·9	35·7	23·8	81·2	4·0	<0·001
Total sugars (g)	22·9	17·5	22·7	55·7	1·4	20·8	16·2	18·3	57·0	1·2	NS
Total NSP (g)	3·1	2·6	2·4	7·1	0·3	3·2	2·7	2·2	7·5	0·7	NS
Na (mg)	396	261	399	1148	3	646	559	466	1544	40	<0·001
Ca (mg)	228	175	197	631	16	201	170	161	510	19	0·051
Fe (mg)	1·9	1·7	1·3	4·5	0·3	2·1	1·9	1·3	4·5	0·4	0·064
Carotene equiv. (μg)	196	26	675	578	0	400	87	1398	1902	0	0·016
Folate (μg)	44·2	36·6	36·3	112·1	3·9	49·1	38·5	42·4	128·0	4·7	NS
Vitamin C (mg)	17·8	5·9	34·6	81·2	0·0	20·4	6·7	38·1	92·7	0·0	NS

P95, upper 5th percentile; P5, lower 5th percentile.
**P*, significance of the difference between the nutrient content of packed lunch *v.* school lunch.

Table 3 Total daily intakes of energy and nutrients (mean, SD), and percentage contribution (mean, SD) to total intake, of school and packed lunches eaten by 14–15-year-old boys, Cambridgeshire, UK, 2006

	Boys eating packed lunch (*n* 318)				Boys eating school lunch (*n* 234)				
	Total daily intake		% contribution from lunch		Total daily intake		% contribution from lunch		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	*P**
Energy (MJ)	8·9	2·9	27	13	8·7	2·7	29	14	0·057
Protein (g)	72·3	26·2	25	15	73·0	26·4	28	17	0·028
Fat (g)	84·8	35·8	28	17	81·7	32·7	31	19	NS
SFA (g)	33·8	16·3	24	19	32·1	13·8	29	20	NS
Carbohydrate (g)	280·0	95·6	26	13	274·0	87·9	28	13	NS
Starch (g)	156·0	56·2	22	17	153·6	53·7	30	16	NS
Total sugars (g)	122·2	58·9	26	19	118·6	60·4	24	18	<0·001
Total NSP (g)	14·0	6·2	27	16	12·7	5·3	26	17	NS
Na (mg)	2844	1178	25	21	2823	1119	31	18	NS
Ca (mg)	1028	491	26	17	954	474	24	17	<0·001
Fe (mg)	11·8	4·6	22	13	11·7	4·8	23	13	NS
Carotene equiv. (μg)	1707	1989	16	23	1623	1778	25	27	NS
Folate (μg)	244	111	21	15	252	111	23	15	NS
Vitamin C (mg)	112·4	100·8	24	27	115·4	109·0	21	25	NS

**P*, significance of the difference between the percentage contribution of packed lunch *v.* school lunch.

Table 4 Total daily intakes of energy and nutrients (mean, SD), and percentage contribution (mean, SD) to total intake, of school and packed lunches eaten by 14–15-year-old girls, Cambridgeshire, UK, 2006

	Girls eating packed lunch (*n* 363)				Girls eating school lunch (*n* 350)				
	Total daily intake		% contribution from lunch		Total daily intake		% contribution from lunch		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	*P**
Energy (MJ)	7·2	2·4	25	13	7·2	2·7	29	14	0·002
Protein (g)	58·4	21·6	24	17	58·4	24·5	28	18	0·005
Fat (g)	67·4	29·8	27	17	68·4	31·0	30	20	0·017
SFA (g)	26·2	12·3	20	19	26·8	13·2	29	21	<0·001
Carbohydrate (g)	232·4	85·2	25	13	227·0	85·1	29	19	0·002
Starch (g)	127·6	50·6	18	16	126·6	48·2	33	19	<0·001
Total sugars (g)	102·5	51·6	23	17	98·4	53·4	24	20	NS
Total NSP (g)	12·0	5·4	26	16	11·5	5·7	31	19	<0·001
Na (mg)	2296	1002	19	18	2280	1356	30	19	<0·001
Ca (mg)	848	380	27	18	865	1400	27	18	NS
Fe (mg)	9·6	4·3	22	14	9·3	4·5	25	16	0·002
Carotene equiv. (μg)	1572	1758	13	21	1500	2074	26	29	<0·001
Folate (μg)	208	94	23	16	199	98	26	18	0·008
Vitamin C (mg)	100·4	90·7	18	23	86·3	77·5	24	29	0·001

**P*, significance of the difference between the percentage contribution of packed lunch *v.* school lunch.

packed and school lunches showed that, for girls, school lunches made a significantly greater contribution to the total intake of all nutrients except total sugars and Ca, whereas for boys only the contribution of protein was significantly greater from school lunches while the contribution of Ca and sugars was significantly greater from packed lunches.

Results for school meals were compared with the recommendations made by the CWT in relation to the Estimated Average Requirement (EAR) for energy and the Reference Nutrient Intake (RNI) for nutrients[2]. The provision of energy and several nutrients in school lunches and packed lunches eaten by both boys and girls fell below the recommendations for school meals. Table 5 shows the percentage of boys and girls eating school or packed lunches whose intakes fell below the CWT recommendation that the meal should provide not less than 30 % of the EAR, 30 % of the RNI for protein and 40 % of the RNI for vitamins and minerals. Also shown are the percentages who exceed the recommendation for intakes of fat, saturated fat and Na. In relation to the recommendations, 80 % of boys' school lunches did not provide sufficient energy, 87 % insufficient Fe, 82 % insufficient Ca and 76 % insufficient folate. Packed lunches eaten by boys were more inadequate in relation to these nutrients compared with school lunches, but fewer boys eating packed lunches exceeded the recommendations for saturated fat and Na intakes. The results for girls were similar but a greater proportion of girls than boys eating school lunches did not meet the recommendation for Fe and folate and girls' packed lunches were more likely than those of boys to be lacking in vitamin C.

Table 5 Compliance of school and packed lunches with the CWT guidelines, Cambridgeshire, UK, 2006

	Boys			Girls		
	% failing to meet CWT guidelines			% failing to meet CWT guidelines		
	Packed lunch (*n* 318)	School lunch (*n* 234)	CWT guideline	Packed lunch (*n* 363)	School lunch (*n* 350)	CWT guideline
Energy (MJ)	88	80	8·3	84	79	6·3
Protein (g)	49	46	16·6	59	49	13·5
Fat (g)	58	58	<36 % food energy	58	60	<36 % food energy
SFA (g)	49	60	<12 % food energy	39	59	<12 % food energy
Carbohydrate (g)	55	55	>49 % food energy	52	54	>49 % food energy
NSP (g)	83	82	5·6	87	85	4·6
Na (mg)	49	72	<2360 mg	34	60	<2360 mg
Ca (mg)	82	82	400 mg	77	83	320 mg
Fe (mg)	94	87	4·5 mg	99	99	5·9
Folate (μg)	86	76	80 μg	86	83	80 μg
Vitamin C (mg)	61	66	16 mg	75	68	16 mg

CWT, Caroline Walker Trust.

Table 6 Mean (SD) weight of food groups (including non-consumers) and percentage of consumers provided by 681 packed lunches and 584 school lunches eaten by 14–15-year-old boys and girls on school days, Cambridgeshire, UK, 2006

	Packed lunch			School lunch			
	Mean	SD	% consumers	Mean	SD	% consumers	*P**
Pasta, rice, pizza	9·2	41·0	6	36·9	80·0	22	<0·001
Bread	50·7	41·2	70	27·9	38·9	41	<0·001
Biscuits, cakes, puddings	14·4	31·8	31	20·5	38·8	33	0·003
Cheese, yoghurt	17·2	35·4	29	12·0	33·7	19	0·001
Meat†	21·5	39·5	41	30·6	59·9	37	0·002
Fish	3·8	17·1	5	8·7	31·6	9	<0·001
Vegetables‡	12·1	30·3	25	22·3	46·9	29	<0·001
Potatoes§	4·1	24·1	3	33·9	66·0	23	<0·001
Fruit	38·6	64·5	34	16·6	43·5	16	<0·001
Fruit juice	23·4	79·5	11	25	87·8	9	NS
Confectionery	6·6	20·7	17	3·8	16·0	10	0·010
Savoury snacks	7·7	14·1	26	3·2	9·3	12	<0·001
Soft drinks	85·2	183·0	24	54·5	134·7	17	0·001

**P*, significance of the difference between the mean weight of the food group provided by packed lunch *v.* school lunch.
†Meat includes meat dishes, processed meat and meat products.
‡Vegetables include baked beans and pulses.
§Potatoes include chips, but not crisps, and not potatoes as part of a dish containing meat or other vegetables.

Table 6 shows the mean (SD) intake and the percentage of consumers of the principal food groups provided by school lunches and packed lunches for all participants (boys and girls combined). Packed lunches provided significantly more bread, cheese and yoghurt, fruit, confectionery, savoury snacks and soft drinks, while school lunches provided significantly more cereals such as rice, pasta and pizza, meat, fish, vegetables, including pulses, and potatoes. Only 25 % of participants ate vegetables in packed lunches and 29 % in school lunches and the quantities consumed were 46 g and 77 g respectively (results not shown). Fruit and fruit juice were consumed by 34 % and 11 % of participants eating packed lunches and 16 % and 9 % of those eating school lunches; the quantities consumed were 115 g and 105 g fruit and 216 g and 272 g fruit juice respectively (results not shown).

Discussion

A study of 1265 lunches eaten at school by adolescents in the Cambridgeshire area has shown that a majority of lunches consumed did not meet the recommendations for intakes of energy and most nutrients at lunch. There were some significant differences between packed lunches and those provided by schools but of concern is the finding that school lunches more frequently exceeded recommended intakes for Na and saturated fat. Lunches eaten at school contributed less than one-third of total energy and nutrient intakes but, for girls in particular, packed lunches contributed less of most nutrients to their daily total intake than school lunches. However as there were no significant differences, with the exception of vitamin C (results not shown), in total daily nutrient intakes

between girls eating packed and school lunches, it would appear that nutrient intake at midday was balanced out by that consumed during the rest of the day. However, boys and girls who did not record eating lunch had significantly lower intakes of total daily energy ($P < 0{\cdot}001$; results not shown).

Energy and nutrient intakes for boys and girls reflected food choices offered by school meals and packed lunches. School meals provided more folate through a greater provision of vegetables, compared with packed lunches which provided greater amounts of Ca through cheese and yoghurts.

There have been very few reports of midday meals eaten at school by adolescents. The advantage of the ROOTS study is that it comprised a large sample of teenagers from urban and rural schools in the Cambridgeshire area. The 4 d diet diary of estimated portion sizes is one of the best ways to accurately assess dietary intake[11]. The physical assessments included in the study required close contact between the investigators and the schools and the participants, thus improving the motivation of the participants and the quality of the data collected.

The limitation of the present study was that the cohort is not a true national representation of the population as the participants are all from the Cambridgeshire area, although both urban and rural areas were included. Also a high proportion of the participants were from families of high socio-economic status. The National Diet and Nutrition Survey (NDNS) of young people aged 4–18 years in 1997 was more nationally representative and showed that regional differences in energy and macronutrient intakes were very small, although there were some regional differences in micronutrient intakes[12]. Only two weekday diet records per participant were analysed in the present study whereas the CWT guidelines should be applied to the average lunch intake over 5 d. However, evidence from the NDNS data of young people indicated that daily intakes of nutrients are quite similar on weekdays[13]. The present 2005–2007 study may not represent the quality of recent school meals as the new nutritional standards were released in 2007 and had not reached secondary schools by the time the data were collected[6].

The few significant differences between school meals and packed lunches did not, on balance, show either option to provide a healthier diet at lunch. Whereas school meals provided more Fe and folate, they were also higher in saturated fat and Na. There were no biomarkers measured in the present study, but the nutrient intakes would seem to indicate potentially a different outcome from that reported in a comparison of school and packed lunches in relation to markers of cardiovascular health in 13–16-year-olds. That study showed small but significant differences in several cardiovascular risk factors that were potentially more favourable in teenagers who ate school lunches[14]. However, serum folate concentrations were lower in teenagers eating school lunches. Those data were collected earlier (1998–2000) as part of the Ten Towns Heart Health study so the participant profiles may have been rather different.

The types of foods provided by school or packed lunches, and hence the nutrients contained in those meals, reflected the meals' suitability to either kitchen preparation or transport to school. Protein was significantly higher in school meals for boys, but not girls, due to a greater consumption of meat and pulses which also contributed to the marginally higher intakes of Fe. With the exception of bread there was less opportunity to provide Fe in packed lunches due to the types of foods which lend themselves to packed lunch; cooked meats are a possibility but are relatively expensive. The food-based standards[3] recommended that schools serve three servings of red meat per week and, although there was no significant difference in total Fe intake between packed lunches and school lunches, the latter provided a small but significantly greater quantity of haem Fe (results not shown); as a better absorbed form of Fe, haem Fe is of particular importance to adolescent girls. Significantly higher intakes of folate were also observed among those eating school meals, which was due to their greater content of pulses and vegetables. The food-based standards[3] included the provision of at least two portions of fruit and vegetables per child per day. However, the mean consumption of vegetables in school meals was only 22·3 g and only 29 % of participants were consumers. Vegetables were the main source of vitamin C for pupils eating school meals, as only 16 % of participants consumed fruit in a school meal. Although fruit should have been provided at the schools, options such as biscuits, cake and yoghurts appeared to be more common. Packed lunches, on the other hand, provided most of the vitamin C from fruit and fruit juices, probably due to convenience in transporting these to school. Ca intakes were higher in those consuming packed lunches compared with the school meals as packed lunches were more likely to include bread, cheese and yoghurt. Intakes of total sugars, provided by confectionery, fruit, fruit juices, fizzy drinks and squashes, were greater in those consuming packed lunches. Both types of lunch failed to meet the CWT recommendations for energy, NSP and many micronutrients[2]. The mean intakes of some nutrients were misleading as the range was very wide with the medians consistently lower than the means. This resulted in a very high percentage of individuals failing to meet the standards. Vitamin C intakes were particularly skewed; the mean intakes for all lunches were above the CWT standard but the medians were all below, and 68 % of all participants eating school lunches fell below the recommended intake of 14 mg.

A further analysis of the data from the NDNS of young people aged 4–18 years in 1997 also compared the percentage contribution of school lunches to total energy and nutrient intakes[15]. No data were reported for packed

lunches and data were presented for all secondary-school pupils up to the age of 18 years, whereas the ROOTS data were from 14–15-year-olds only. The contribution of secondary-school lunches to total nutrient intake (23–30 %) in the NDNS was very similar to that in the ROOTS study except for fat, sugar and vitamin C, of which there was a slightly greater contribution from school lunches to the total daily intake. Actual intakes of energy and nutrients at lunchtime were not reported but the total daily intakes in the NDNS sample were very close to those of the ROOTS sample except for lower Ca and vitamin C intakes. This may be due to the NDNS being a nationally representative sample with a wider range of socio-economic backgrounds whereas the ROOTS cohort profile had a greater proportion of the highest socio-economic group compared with the total UK[9]. Also the NDNS data date from 1997 and there has been an increase in vitamin C intakes in all ages over this period, particularly with the increase in fruit juice consumption[16]. In common with the ROOTS study, mean intakes of energy, fibre, Ca, Fe and folate of those eating school lunches were all below the CWT guidelines while the Na intake was above. This comparison shows that in the 10 years between the NDNS study and the ROOTS study there has been little improvement in the quality of school lunches or, possibly, in the choices made by pupils.

The 2004 report by Nelson *et al.* for the DfES showed the results of 5695 school meals consumed in seventy-nine secondary schools[4]; this report followed the 2001 introduction of the food-based guidelines[3]. Although the energy, macronutrient and Na contents of these meals were greater than the school lunches of the ROOTS study, the contents of Fe, Ca and vitamin C were very similar. The percentages of meals failing to reach the CWT guidelines for Fe and Ca were also similar. In the ROOTS study 94 % and 83 % of school lunches failed to meet the guidelines for Fe and Ca, respectively, compared with 93 % and 80 % of the 814 school meals in Nelson *et al.*'s report[4].

There are very few data for comparison of packed lunches eaten by secondary-school pupils. School lunches were compared with packed lunches consumed by 621 children aged 7 years in South West England[8]. The results showed that both types of lunch needed improvement but the standard of lunches brought from home was worse than that served at school. A study solely of packed lunches consumed by 1294 children aged 8–9 years showed that only 1·1 % met the school meal standards[17]. A survey published by the University of Plymouth on the diets of primary-school children found school meals to be healthier than packed lunches, as the children taking packed lunches consumed approximately double the amount of sugar and 50 % more Na and saturated fat, compared with those having a school lunch[7]. Comparison of this study with lunches brought to school by teenagers is not really valid as the latter would probably had more freedom to choose the content of their lunches and may even have bought food on the way to school. In fact the ROOTS study showed little difference in the nutrient content of packed lunches compared with school lunches; rather the differences were in the types of foods consumed. The lack of vegetables in packed lunches and the inclusion of soft drinks, savoury snacks and confectionery are indications that food-based guidelines for school lunches were not carried over into recommendations for packed lunches. A recent report from Ofsted has confirmed that, despite government initiatives, the number of pupils eating school meals has declined and more pupils are bringing in packed lunches. The report raised concerns that the healthier school meals were proving too expensive for low-income families who did not qualify for free school meals. They also reported that not all schools had policies on packed lunches but those that did tended to focus on what should not be included rather than giving guidance on how to provide a balanced meal in a cost-effective way[18].

It is a cause for concern that the midday meal eaten at school by the ROOTS teenagers, while contributing between a quarter and a third of daily energy and nutrients, did not meet the CWT guidelines and, in addition, a significant number of pupils did not report any midday meal. This is an important age group in terms of their increased requirements for some nutrients. Teenage boys have the greatest requirement for energy to match their rapid growth during these years, while teenage girls have increased Fe requirements on reaching puberty. Intakes of Fe and Ca were most likely to fail to meet the guidelines. Median intakes of vitamin C and carotene were very low, indicating that fruit and vegetable intake of some participants could not have reached the food-based guideline: 'Not less than two servings per day per child must be provided; at least one should be vegetables or salad and at least one should be fruit'[19]. Consumption of fruit and vegetables has been shown to have an inverse relationship to several chronic diseases, such as diabetes[20,21] and CVD[22]. It has also been shown that increased consumption of fruit and vegetables was positively associated with bone mineral content in another group of Cambridge adolescents who were at an age when they should have been maximising their peak bone mass to ensure bone health in later life[23]. While being very vulnerable in terms of many aspects of health, teenagers are the age group most difficult to reach. They are more independent, having freedom to make both good and bad choices and are also influenced by peer pressure, particularly with an emphasis on body shape. The rolling programme of improvements in school meals had only begun to reach secondary schools in September 2006. New nutrient-based standards and new food-based standards for school lunches were to be adopted by all secondary schools by September 2009[24]; hence these new guidelines would not have reached secondary schools by the time the data were collected for the present study. However, at the time when the present survey was starting to be carried out there was

a very popular television programme that focused on the need to improve school meals with much subsequent newspaper coverage. This should have raised awareness of the importance of healthy school meals both in those responsible for choosing the contents of packed lunches and those in charge of school catering. The latter already had the food-based guidelines in place, although there was evidence that these were not always adhered to[4]. One might also expect to have seen a change in pupils' attitudes that could have been reflected in their choice of foods. However, the recent analysis of the first year of the new NDNS rolling programme (2008–2009) indicates that inadequate intakes of some nutrients, particularly Fe, Zn, K and Mg, continue to be a problem in teenagers[25]. For girls aged 11–18 years, the mean Fe intake was 58% of the RNI and 46% had intakes below the lower RNI. Only 7% of girls and 22% of boys aged 11–18 met the 5-a-day fruit and vegetable guideline.

The provision of healthy school lunches at a reasonable cost provides a perfect opportunity not only to improve the health of schoolchildren but also to educate them. What they learn about nutrition and health in the school setting may percolate out into their home environment and further. As it is recognised that many children will not take up the offer of school lunches, the present study shows that it is equally important that attention is given to the components of packed lunches and relevant advice offered to parents and children.

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