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RESEARCH PAPER

Food and nutrient intakes of primary school children: a comparison of school meals and packed lunches

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Abstract

Background New school meal standards are currently being phased in by the government in an attempt to improve the nutritional composition of school food. However, no standards are applied to packed lunches. The present study aimed to compare the food and nutrient intakes of primary school children eating a school meal with those taking a packed lunch.

Methods A sample of 120 children, aged 6–11 years, was observed once at a lunch time and all items consumed were recorded. Nutrient analysis was performed, and differences in nutrient intake between those children consuming packed lunches and school meals were determined.

Results Mean energy and protein intakes were similar. The amount of energy provided by starchy carbohydrate was also similar but, compared with school meals, packed lunches provided twice as much energy from sugar ($P < 0.001$). School meals on average provided more energy from fat ($P < 0.001$), but intakes of saturated fat were lower in the school meals group ($P = 0.021$). Packed lunches provided more sodium ($P < 0.001$), calcium ($P < 0.001$) and iron ($P = 0.016$) than the school meals. Very few packed lunches contained vegetables, and fruit intake was particularly low for those having a school meal.

Conclusions Children taking a packed lunch to school were consuming approximately double the amount of sugar and 50% more sodium and saturated fat in their midday meal compared with those having a school lunch. However packed lunches were providing children with more calcium, iron and fruit.

Conflict of interests, sources of funding and authorship

The authors declare that they have no conflict of interest.

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All authors were involved in the conception and design of the study. CJR and JG collected the data and performed the nutritional analysis. GAR performed the statistical analysis and wrote the paper. All authors critically reviewed the manuscript and approved the final version submitted for publication.

Introduction

With the rising prevalence of obesity in children causing concern in the UK, government and media attention has recently focused on school food, especially the nutritional composition of school meals. Food-based standards for school meals have been in place since 2001, but these have not been effective at improving nutrient intake (Nelson *et al.*, 2007). A national survey conducted in primary schools (Nelson *et al.*, 2006) showed that schools were failing to meet the food-based standards. Of 146 schools, only 23% met all the compulsory standards at the start of service over 5 days.

The government therefore established a review of school meals and set up the School Meals Review Panel (SMRP) to consider nutrient-based standards. In 2005, a new public body 'The School Food Trust' (http://www.schoolfoodtrust.org.uk) was established by the Department for Education and Skills (DfES) to take forward the recommendations of the SMRP (SMRP, 2005).

The new standards for school meals were announced in May 2006 and have been gradually phased in. In September 2006, interim food-based standards were introduced (revised September 2007; School Food Trust, 2007a); 1 year later, food-based standards for food other than lunches served in schools were introduced; and the final food and nutrient-based standards will be introduced in September 2008 (Table 1). DfES is providing £220 million of funding over 3 years (2005–2008) to schools and local authorities in order to introduce the new standards, with an additional £240 million to cover the period 2008–2011 (School Food Trust, 2007a).

Table 1 Nutritional standards for school lunches and other school food (School Food Trust, 2007d)

Energy	30% of the estimated average requirement (± 5%)
Protein	Minimum of 30% of reference nutrient intake (RNI)
Total carbohydrate	Minimum of 50% of food energy
Nonmilk extrinsic sugars	Maximum of 11% of food energy
Fat	Maximum of 35% of food energy
Saturated fat	Maximum of 11% of food energy
Fibre (NSP)	Minimum of 30% of the calculated reference value
Sodium	Maximum of 30% of the SACN recommendation
Vitamin A	Minimum of 35% of the RNI
Vitamin C	Minimum of 35% of the RNI
Folate	Minimum of 35% of the RNI
Calcium	Minimum of 35% of the RNI
Iron	Minimum of 35% of the RNI
Zinc	Minimum of 35% of the RNI

SACN, Scientific Advisory Committee on Nutrition.

The concept of nutrient-based guidelines for school meals is not new. The Caroline Walker Trust first published guidelines in 1992, which were updated in 2005 (Crawley, 2005) and used by the SMRP in establishing the government standards.

Analysis of primary school children's nutritional intake at lunchtimes before the introduction of the interim standards shows both school meals and packed lunches to be far from meeting the targets (Rogers *et al.*, 2007). Intake of total and saturated fat, sugar and sodium were too high and micronutrients too low, although school meals were found to be slightly more healthy than packed lunches.

A recent survey published in summary by the School Food Trust (2007b) of children aged 8–10 years old in six primary schools in Sheffield showed lower intakes of total fat, saturated fat and sodium, and higher intakes of some micronutrients compared with previous surveys. This could be the beginning of food provided by schools undergoing a beneficial change to meet the new food and nutrient standards set by the SMRP.

Many children prefer to take a packed lunch to school and so their lunchtime meal will not be

covered by the new standards. The take-up of school meals in primary schools in England has fallen by 1% between 2005/6 (42%) and 2006/7 (41%) but there is wide local variation (School Food Trust, 2007c). For example, in the South East region, a reduction of 4% was observed between these dates, and now only 28% of children are having a school meal. Inner London experienced a reduction of 2.4% but had the highest current uptake at 57%. In the South West region, there was a substantial increase of 8.2%, with 36% of children having a school meal. Primary school caterers have experienced the change in menus differently; although 9.5% of primary school caterers agreed that the provision of 'healthy' options in the last year had resulted in more pupils bringing in packed lunches, 10.6% cited 'healthy options' as a reason for the increase in the uptake of school meals.

With large numbers of children bringing food in from home, it is important that packed lunches also follow healthy guidelines. Some schools do have restrictions on items such as fizzy drinks and sweets but this does not necessarily mean the lunch will be healthy.

The present study aimed to assess the food and nutrient intake of a sample of primary school children at lunchtime, comparing those consuming meals provided by schools with children consuming packed lunches. Nutrient intakes are also compared with government standards for primary school meals that will be introduced in September 2008. Schools were surveyed in November and December 2006 (i.e. after the introduction of the interim food-based standards).

Materials and methods

Four primary schools in Cornwall were asked to participate in the study and all agreed. The percentage of children receiving free school meals at the schools was between 1.8% and 17%. All parents were provided with an information leaflet and consent form. Ethical approval was granted by the ethics committee of the Faculty of Science, University of Plymouth. Children were chosen at random from class lists of those children for whom informed consent had been granted. Approximately equal numbers of girls/boys, packed lunch/school lunch were chosen. The children were in the age range 6–11 years and all were of white ethnic origin.

Participants were observed once at a meal time and the food items consumed were recorded. Wastage was also observed and the weight estimated visually. Portion sizes for school meals were estimated using household measures with help from the catering staff. For packed lunches, some assumptions were made regarding portion sizes. For example, for fruit, the weight of a medium sized fruit was used; bread was either brown or white, medium slice thickness from a large loaf. Portion sizes were estimated using the portion size guide on the nutrient analysis programme, CompEat (Nutrition Systems, Banbury, Oxon, UK). Additional information was obtained from packaging and some recipes were obtained from catering staff. It was not possible to weigh food because it was considered too disruptive for the schools' lunchtime routine and, as there was only a limited time available for the study, far fewer children would have been surveyed. Statistical analysis was performed using SPSS, version 14.0 (SPSS Inc., Chicago, IL, USA). The differences in means between groups were determined by independent samples *t*-tests.

Results

There were 120 pupils that took part (school meals, $n = 62$; packed lunches, $n = 58$; females, $n = 61$; males, $n = 59$). The mean energy intake was similar between pupils eating school meals (Table 2) (1856 kJ; 440 kcal, range 44–895 kcal) and packed lunches (2058 kJ; 480 kcal, range 53–813 kcal). This is just below the government standards for a child aged 7–10 years old of 530 kcal (30% of estimated average requirement; Table 1) (Department of Health, 1991). Although the amount of energy provided by starchy carbohydrate was similar, compared with school meals, packed lunches provided twice as much energy from sugar (Fig. 1). Conversely, on average, the school meals provided more energy from fat.

From Table 2, it can be seen that, although children having school meals consumed more

Table 2 Differences in nutrient intake: school meals compared with packed lunches

	School meals (n = 62)		Packed lunch (n = 58)		
	Mean	(SD)	Mean	(SD)	P
Energy (kJ)	1856	(677)	2058	(681)	0.108
Energy (kcal)	440	(162)	480	(163)	
Protein (g)	18	(9)	18	(7)	0.951
Carbohydrate (g)	52	(21)	71	(27)	<0.001
Fat (g)	20	(10)	16	(9)	0.03
Sugar (g)	13	(9)	28	(18)	<0.001
Saturated fat (g)	5.3	(4.3)	7.2	(4.4)	0.021
NSP(g)	3	(1)	4	(2)	0.002
Na (mg)	542	(323)	834	(340)	<0.001
Ca (mg)	124	(72)	295	(176)	<0.001
Fe (mg)	1.8	(0.6)	2.2	(0.9)	0.016
Vitamin C (mg)	17	(15)	24	(25)	0.076

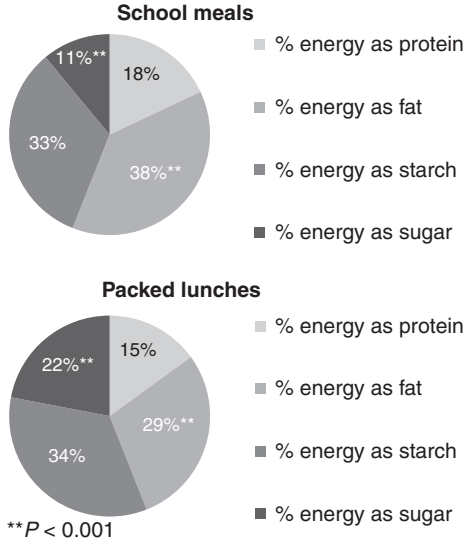

Figure 1 The percentage of energy provided by macronutrients.

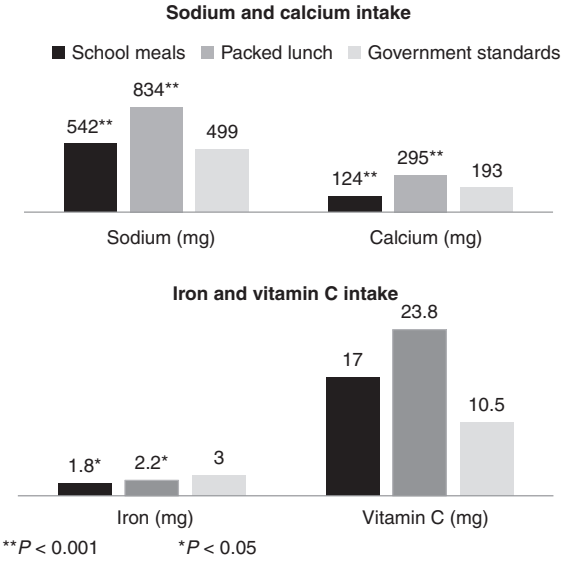

Figure 2 Micronutrient intake compared with Government Standards.

Table 3 Percentage of pupils consuming different food items

Food item	School meals (% of pupils)	Packed lunches (% of pupils)
At least one portion of fruit (not juice)	13	58
At least one portion of vegetables/salad/beans	81	8
Chocolate bar/cake/biscuit	31	50
More than one chocolate bar/cake/biscuit	0	10
Savoury snacks	0	56
Fish	31	2
Fruit juice	10	1
Other sugary drinks	0	10

total fat, their intake of saturated fat was lower than the children having a packed lunch. Sodium, iron and calcium intakes were all significantly higher in those children consuming packed lunches. There was no statistically significant difference in vitamin C intakes between the two groups. Sodium intake in the school meals group was above the government maximum of 499 mg in the midday meal for this age group (Fig. 2). Calcium and iron intakes from the school meals were below the standards.

Although most (81%) pupils consuming school lunch ate at least one portion of vegetables with their meal, only 13% consumed a portion of fruit (Table 3). Conversely, in the packed lunch group, 58% of pupils consumed a portion of fruit but only 8% (five pupils) ate a portion of vegetables. Eighty-one percent of pupils bringing a packed lunch ate ham, cheese or prepackaged ham/cheese with crackers or breadsticks (Fig. 3). Eleven percent had no source of protein (e.g. jam or chocolate spread sandwiches) with only 8% having poultry or fish.

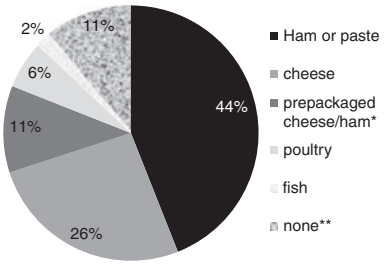

Figure 3 Main protein sources in packed lunches. *Prepackaged cheese/ham comprised individually packaged cheese spread or ham with breadsticks or crackers (e.g. 'Dairylea dunkers', 'Lunchables'). **None comprises jam, marmalade, chocolate spread, marmite, only cucumber.

Discussion

Sodium

The high intake of sodium provided via the packed lunches is not surprising considering that nearly all packed lunches consisted of bread or crackers, the majority of pupils had ham or cheese as a filling, and 56% had a packet of crisps or similar salted snack on the day of the survey. The intake of sodium in our packed lunch group (834 mg) is very similar to that found by Evans *et al.* (2007) (868 mg) in a recent survey of packed lunches commissioned by the Food Standards Agency, but much more than that found by the School Food Trust (2007b) (577 mg). In our study, 76% of children taking packed lunches were consuming over 600 mg of sodium in their meal and 15% were consuming over 1000 mg. Although the mean sodium intake for the school meals group was below that of the packed lunch group, 52% consumed over 600 mg and 8% consumed over 1000 mg. The amount of sodium in the school meals was very variable: one day the children surveyed ate roast chicken and vegetables (low sodium) and different children on another day ate sausage and bean pie (high sodium). The main limitation of the study is that we were unable to survey for a whole week for a more representative indication of intake.

This high sodium intake is of particular concern because a recent analysis by He *et al.* (2008) of the salt intake and blood pressure data from the National Diet and Nutrition Survey for young people (Gregory *et al.*, 2000) found a significant association in children and adolescents between salt intake and systolic blood pressure after adjustment for age, sex, body mass index and potassium intake. An increase in 1 g day^{-1} was related to 0.4 mmHg in systolic blood pressure. The government target for children 7–10 years old is to consume less than 5 g salt per day; the packed lunch group in our study were consuming on average 2.1 g in their midday meals alone compared with 1.4 g in the school meals.

Sugar and saturated fat

Sugar and saturated fat intakes were also significantly higher in those consuming packed lunches compared with school meals. Confectionary, cakes and biscuits were the main sources of saturated fat and sugars. Although many schools have banned 'sweets', some children were still bringing chocolate confectionary and full coated chocolate biscuits, and 10% were bringing more than one of these items. Our findings on sugar intake (11% of energy via school meals versus 22% for packed lunch) are similar to those found by Rogers *et al.* (2007) who found that sugar provided 14% of energy for children having school meals and 21% of energy for those having a packed lunch. Rogers' study, part of the Avon Longitudinal Study of Parents and Children, involved 3-day unweighed food records of over six hundred 7-year-old children. Worryingly, they found that children having packed lunches had higher daily intakes of sugar and saturated fat and lower daily intakes of potassium and zinc than those having a school meal. Thus, meals consumed at home do not appear to compensate for the high sugar and fat content of the packed lunches.

Fruit, vegetables and vitamin C

Most children having a school lunch consumed at least one vegetable and those not consuming a portion of vegetables had left them uneaten (19%). Only five children with packed lunches ate some vegetables. This is similar to the findings of the School Food Trust (2007b), which found that 72% of children taking school meals consumed

vegetables compared with only 6% of children taking a packed lunch.

Unfortunately, most children (87%) were not consuming fruit with their school meal (although 10% did have pure fruit juice). During our survey, fresh fruit salad, fruit crumble and other fresh fruit were available, but these were chosen by a minority of children. With options such as yogurts, whips, biscuits and sponges still on offer, fruit was not being chosen. Fifty-eight percent of pupils with a packed lunch consumed fruit. Most often, if it was provided, it was eaten along with other dessert items, such as yogurts and biscuits. Children having a school meal choose only one dessert and, unsurprisingly, fruit is not the first choice for most. Our findings are different to those of the School Food Trust (2007b) who found that 31% of children having packed lunches consumed fruit compared with 23% of children having a school meal.

Vitamin C intakes were well above Government standards, with those consuming packed lunches having slightly more, although this was not a statistically significant difference. This was not only due to the higher fruit intake (we surveyed just before Christmas and satsumas were popular) but also 10% were consuming fruit-based drinks containing vitamin C, which were of a larger portion size than the fruit juice provided by schools.

Although it is difficult to relate childhood diet to adult disease risk due to many possible confounders and the difficulty of estimating childhood diet in retrospective studies, epidemiological studies have associated increased childhood fruit intake with a reduced risk of cancer incidence (Maynard *et al.*, 2003) and increased vegetable intake with reduced risk of stroke (Ness *et al.*, 2005). Thus, it would seem important to address the poor fruit and vegetable intake in young children.

Calcium and iron

Calcium intakes were significantly higher in the packed lunches compared with the school meals. With 26% of the packed lunches containing cheese and many also having a yogurt or fromage frais, this is not surprising. However, children consuming school meals were not meeting the government standard of 35% of reference nutrient intake (RNI) (193 mg for a child aged 7–10 years). This was due in part to children not eating all the food provided and, although yogurt and cheese and biscuits were a dessert option, they were rarely chosen.

Likewise, iron intakes were slightly but significantly higher in those consuming a packed lunch, mostly coming from bread and meat sandwich fillings. Food consumed from the school meals did not meet the new standards for iron (35% of RNI; i.e. 3.0 mg for a child aged 7–10 years). The school meals offered lower iron choices, such as chicken and fish in place of red meat, which is only required to be offered twice a week. Potatoes, which are low in iron, were the main form of complex carbohydrate.

Other studies have found similar results. In a small scale study of dietary recalls with Brownies and Cubs ($n = 26$), James & Wickett (2007) found that iron and calcium intakes were reported to be lower in the school meals group than the packed lunch group.

Protein

Mean protein intakes were 18 g in both groups and above the government guideline of 30% of RNI (which is 7.5 g for a child aged 7–10 years). Although the mean for the groups were more than adequate, 11% had no meat, fish, vegetarian alternative or cheese in their packed lunch. The alternative sandwich fillings, such as jam, marmalade and chocolate spread, were contributing to high sugar intakes.

Government standards require school meals to offer fish once per week, which is why a large number of the children in our sample had eaten fish. Only one child ate tuna fish in their packed lunch.

Limitations of the study

It is perhaps unfair to compare our results to the government standards because the standards are meant be applied to 5 days of consecutive meals,

which we did not do. We only surveyed children on 1 day and, although we surveyed on different days and weeks of the menu cycle, we were unable to survey a whole week at a time. By only surveying each child once, we were unable to obtain a more reliable estimation of habitual intake. In addition, we analysed food that was eaten, which, for some children, was considerably less than what was served.

There are also likely to be errors in estimation of portion size because the foods eaten and wasted were not weighed, but these were minimized by consultation with the catering staff and close inspection of the packed lunches. It is possible that bias was introduced by the school cooks who may have served larger portions of foods that they thought were healthy and smaller servings of foods that they thought were unhealthy. However, children were able to leave unwanted food and the wastage was estimated by the researchers.

Conclusions

The present study has demonstrated that, on average, children taking a packed lunch to school are consuming approximately double the amount of sugar and 50% more sodium and saturated fat in their midday meal compared with those having a school lunch. This is useful information for two reasons. First, it demonstrates the nutritional advantages of school meals over packed lunches which could be used to help promote school meals to parents, and, second, it shows that, for those still wanting to bring a packed lunch, more needs to be done to reduce the sugar, sodium and saturated fat content.

Improvements are needed in fruit intake in both groups but especially for children having school meals. This can be addressed in school meals by reducing the number of times other desserts are offered to increase the times that a fruit-based dessert is chosen. Limiting the choice for unhealthy foods has been called for by others (Nelson *et al.*, 2007). This strategy would appear to have had some success for sodium and saturated fat in our schools by reducing the number of times processed meat and fried foods are offered.

Many schools and organizations such as the Food Standards Agency and the School Food Trust provide advice on healthy packed lunches but educating and engaging parents can be a difficult task. Perhaps one way forward, as advocated by The School Food Trust, is the adoption of a packed lunch policy as part of a whole school healthy eating policy (http://www.schoolfoodtrust.org.uk/packedlunches). Further research could evaluate such policies and other interventions aimed at improving the content of children's packed lunches. Future surveys of school meals will be able to document continued improvements in school meals and determine whether nutrient standards for micronutrients are met.

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