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Evans, CEL, Mandl, V, Christian, MS et al. (2016) Impact of school lunch type on nutritional quality of English children's diets. *Public Health Nutrition*, 19 (1). pp. 36-45. ISSN: 1368-9800

<https://doi.org/10.1017/S1368980015000853>

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Impact of school lunch type on nutritional quality of English children's diets

Charlotte EL Evans, Vera Mandl, Meaghan S Christian, Janet E Cade,

Correspondence to:

Charlotte Evans: c.e.l.evans@Leeds.ac.uk

Nutritional Epidemiology Group, School of Food Science & Nutrition, University of Leeds, Leeds, LS2 9JT, UK

Telephone: 0113 343 3956

Fax: 0113 343 2982

Authors:

¹Charlotte EL Evans, Lecturer in Nutritional Epidemiology

¹Vera Mandl, MSc student

¹Meaghan S Christian, Research Fellow

¹Janet E Cade, Professor in Nutritional Epidemiology

Address for all authors:

¹School of Food Science & Nutrition, University of Leeds, Leeds, LS2 9JT, UK

^{1 2}School of Health and Wellbeing, Leeds Beckett University, Leeds, LS1 3HE, UK

Running title: comparisons between school meal type

Key words: children, school meal, packed lunch, dietary quality, food intake, nutrients

Word Count: 3642

Acknowledgements

The authors acknowledge the involvement of schools and children for their involvement in the project

Financial Support

This research was funded by the University of Leeds and received no specific grant from any funding agency in the public, commercial or not-for-profit sectors. This project was originally commissioned by the MRC NPRI (MRC registry code G0501297). The views and opinions expressed therein are those of the authors and do not necessarily reflect those of the NPRI programme or the MRC.

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Conflict of interest

CELE, VM, MSC and JEC have no further financial support. CELE, VM, MSC and JEC have no other relationships with companies that might have an interest in the submitted work. CELE, VM, MSC and JEC have no non-financial interests that may be relevant to the submitted work.

Statement on ethics

This study was approved by the University of Leeds Ethics Committee. The trial registry code is G0501297.

Author contributions

CELE and VM designed the research protocol and statistical analysis plan, VM and CELE wrote the first manuscript, carried out the analysis and contributed to all versions of the manuscript. JEC secured the funding for the original project and contributed to all versions of the manuscript. MSC managed the data collection of the NPRI project and contributed to the final version of the manuscript.

1 **ABSTRACT**

2 **Background:** Nutrient and food standards exist for school lunches in English primary schools although
3 packed lunches brought from home are not regulated. The aim of this study was to determine nutritional
4 and dietary differences by lunch type.

5 **Design:** A cross-sectional survey was carried out in 2007 assessing diet using the Child and Diet Evaluation
6 Tool (CADET), a validated 24 hour estimated food diary. The data were analysed to determine nutritional
7 and dietary intake over the whole day by school meal type; school meals and packed lunches.

8 **Setting:** 54 primary schools across England

9 **Participants:** 2709 children aged 6 to 8 years

10 **Results:** Children having a packed lunch consumed on average 11.0g more total sugars (CI 6.6 – 15.3g)
11 and 101mg more sodium (CI 29 – 173mg) over the whole day. Conversely, children having a school meal
12 consumed, on average, 4.0g more protein (CI 2.3 – 5.7g), 0.9g more fibre (NSP) (CI 0.5 – 1.3g) and 0.4mg
13 more zinc (0.1 – 0.6mg). There was no difference in daily energy intake by lunch type. Children having a
14 packed lunch were more likely to consume snacks and sweetened drinks; whilst children having a school
15 meal were more likely to consume different types of vegetables and drink water over the whole day.

16 **Conclusions**

17 Compared with children having a school meal, children taking a packed lunch to school consume a lower
18 quality diet over the whole day, including higher levels of sugar and sodium and fewer vegetables. These
19 findings support the introduction of policies that increase school meal uptake.

20 INTRODUCTION

21 The increasing prevalence^(1; 2) and economic burden⁽³⁾ of childhood obesity in the UK, and elsewhere, have
22 led to the UK Government's decision to introduce policies to improve the quality of children's diets.
23 Research in this area has identified important dietary risk factors for obesity, which include a high
24 proportion of energy dense foods high in fats and sugars as well as large intakes of sugar sweetened
25 beverages.^(1; 4; 5) In addition, low consumption of fruits and vegetables and fibre are strongly associated
26 with a range of important health outcomes in adults including CVD and some cancers.^(6; 7; 8) This has
27 resulted in a number of western countries including the UK, focusing on improvements in school food and
28 introducing school meal standards.^(9; 10) Further changes in school meal policy are planned for 2014
29 whereby all young school children (aged 4 to 7 years) in England will be offered a free school meal.⁽¹¹⁾

30 Food and nutrient based standards were introduced by law into primary schools in England between
31 September 2006 and 2008^(12; 13), and were based on recommendations from the School Meal Review Panel
32 formed in 2006.⁽¹⁴⁾ Before these standards, school meals had not been regulated for many years in the UK,
33 although the Caroline Walker Trust provided recommendations in 2001 for schools to follow voluntarily.^{(15;}
34 ¹⁶⁾ Information on how to implement the standards was consequently provided for schools by the School
35 Food Trust. Nutrient based standards included minimum or maximum standards for a school meal
36 (averaged over a menu cycle, commonly one to three weeks) for 13 nutrients and energy (energy alone had
37 both a minimum and maximum recommended level).⁽¹⁷⁾ In addition to the nutrient based standards, a
38 number of foods were restricted such as low quality meat, savoury snacks and confectionery products in
39 order to exclude foods high in sodium, saturated fats and sugars.⁽¹⁸⁾ More nutritious foods such as fruit and
40 vegetables and bread without spreads were made part of every school meal. When first introduced, the
41 standards were enforced by Ofsted who inspect schools periodically; however, since the change of
42 government in 2011, further amendments were made to the law and school compliance to the standards is
43 no longer formally assessed.⁽¹⁹⁾

44 Cross-sectional studies carried out by the School Food Trust indicate that the quality of school meals has
45 improved since the introduction of the school meal standards, both in primary schools⁽²⁰⁾ and secondary
46 schools.⁽²¹⁾ School meals are now higher in vegetables and lower in sugars and sodium than they were in

47 the past. Analysis of the Low Income Diet and Nutrition Survey⁽²²⁾ by Stevens and Nelson⁽²³⁾ reported
48 similar findings: children who had a packed lunch had higher daily intakes of total fat, saturated fat and
49 sodium at lunchtime than children having a free school meal in this study of low income children. A
50 separate study of packed lunches only, also found that sugars, saturated fat and sodium were particularly
51 high in children's packed lunches.⁽²⁴⁾ Although there is strong evidence that school meals have improved
52 lunch-time intake for children, it is necessary to determine the impact of meal type on children's diets over
53 the whole day to determine whether differences at lunchtime are maintained over the rest of the day. There
54 are few published studies comparing the nutritional intake over the whole day by school meal type that
55 have collected data after the introduction of the school meal standards in 2006. Evans et al. reviewed
56 cross-sectional studies comparing daily intake by school meal type carried out before the introduction of
57 standards,⁽²⁵⁾ and concluded that even before the improvements in school meals, packed lunches were **less**
58 **healthy** in terms of sugars, fats and sodium. A recent study on older primary school children aged 9 to 10
59 years, published since the review **and** looking at consumption of specific foods by meal type, reported that
60 children having packed lunches had more savoury snacks and importantly, that lunchtime intake makes a
61 significant contribution to overall dietary intake.⁽²⁶⁾

62 Approximately half of primary school children bring a packed lunch from home⁽²⁷⁾ and this has remained
63 stable in the last few years.⁽²⁶⁾ The quality of packed lunches therefore remains a concern, and it is
64 important that information on both packed lunches and school meals is periodically collected in order to
65 assess the impact of policy changes affecting school lunches.⁽²⁸⁾ This study uses data collected from a
66 large number of primary school children across England to determine the effect of meal type on important
67 nutrients over the whole day, as well as the consumption of common children's foods.

68 **METHODS**

69 *Study design*

70 Data was collected in 2007 from 2709 children attending 54 primary schools randomly selected from all
71 state schools across England. One class from year 2 was randomly sampled from each school. The schools
72 reflected a wide range of social classes and ethnic backgrounds. The data analysed here are part of a cluster

73 randomised controlled trial and further details on sampling procedures are provided in the published trial
74 protocol.⁽²⁹⁾ Power calculations were based on identifying differences in daily fruit and vegetable
75 consumption of 0.5 portions with power of 80% and significance level of p less than 0.05.

76 Dietary data was collected using the “Child and Diet Evaluation Tool” called CADET which has
77 previously been validated in a similar age group⁽³⁰⁾. CADET is a paper-based 24-hr estimated food diary
78 with foods separated into different categories and times of the day. During the school day the trained
79 administrators completed the diary for each child. After school, parents recorded all the food their child ate
80 during the day by ticking the foods their child consumed at each meal or snack time. CADET uses gender
81 and age appropriate portion sizes for each food category that are estimated using results on portions from
82 the children’s NDNS.⁽³¹⁾ In addition to dietary data, personal information was requested including gender,
83 education level of parents, ethnicity and postcode (on which index of multiple deprivation (IMD) was
84 estimated) and information on aspects of diet including school meal type. This tool was chosen for being
85 one of the few valid but simple tools that accurately reflects the diet of children.

86 A selection of nutrients were analysed to determine whether there was a difference in daily nutrient intake
87 between school meals and packed lunches. These included energy (Kcal and KJ/day), total and saturated
88 fat (g/day), carbohydrate (g/day), starch (g), total sugar (g/day), protein (g/day), fibre (NSP) (g/day),
89 calcium (mg/day), iron (mg/day), zinc (mg/day), folate (mg/day), vitamin A (mcg/day), vitamin C (mg/day)
90 and sodium (mg/day). These nutrients were chosen because they are included in the nutrient standards for
91 school meals.

92 A range of foods **was** analysed to determine differences in consumption by food type. The CADET diary
93 contains 117 food groups; however, this included individual fruits and vegetables. Vegetables were
94 categorised into five groups, namely dark green, red and orange, legumes, starchy and other. Fruits were
95 categorised into two groups; fresh or frozen (combined) or dried. After combining fruit and vegetable types
96 there were 85 food groups in total. Foods consumed by at least 10% of children were reported in the tables
97 for ease of use.

98 *Statistical analysis*

99 All statistical analyses were carried out using STATA 11.0.⁽³²⁾ In order to compare nutrient intake
100 multilevel regression modelling was used to take into account the clustering effect of children within
101 schools. The variation in nutrients between children in a school having the same school meal may be
102 smaller than variation for all children and therefore multilevel regression is required. A separate regression
103 model was performed for each nutrient. The normality of the variables was checked by **generating**
104 histograms and inspecting the mean value in comparison with the standard deviation. Variables showing a
105 skewed distribution were transformed to the natural logarithm before carrying out any statistical tests.
106 Model fit was checked by inspecting histograms of the residuals. Results were displayed unadjusted for all
107 children (model 1) and adjusted for age, gender, index of multiple deprivation (IMD) in quartiles and
108 ethnicity (model 2).

109 The percentage and 95% confidence interval of children consuming each food **were** calculated, as well as
110 the percentage by each lunch type. In order to test whether children having a packed lunch were more or
111 less likely to consume a certain food or drink, logistic regression was used to generate the odds of
112 consuming each food compared with children having a school meal. **P values and 95% confidence**
113 **intervals** were also generated. For each food, two models were presented, model 1 which was adjusted for
114 clustering of children within schools only and model 2; a fully adjusted model adjusting for age, gender,
115 IMD quartiles and ethnicity.

116 Children were excluded from the analysis if they had energy values above 4,000kcal per day. If there was
117 no information on school meal type children were excluded from the regression models but were included
118 in the descriptive analysis. These children were compared with children having school meals and packed
119 lunches to assess any potential response bias.

120 **RESULTS**

121 Dietary data was collected from 2709 children. Thirty-seven children were excluded because of unfeasibly
122 high daily energy intakes of more than 4000kcal, leaving 2672 children in the preliminary analysis.

123 Background descriptive information on the total group and boys and girls only is provided in table 1. The
124 children in this group have similar BMI values compared to national data collected by the Health Survey

125 for England for this age group.⁽³³⁾ There were no obvious differences between genders in terms of
126 anthropometric measures.

127 Information on school lunch type was available from 2373 children; however this information was missing
128 from 299 (11%) of children. The number of boys and girls was similar, with 50% of the total sample being
129 boys. The proportion of boys and girls having a school meal, where information on meal type was
130 available, was similar; 44% of boys had a school meal and 45% of girls had a school meal with the
131 remaining children reporting taking a packed lunch. Some of the children with missing lunch information
132 may have gone home for lunch. The results from the total sample of 2373 children indicated that
133 anthropometric measures were similar in both groups of children, those having school meals and those
134 having packed lunches.

135 Adjusting only for clustering within schools and no other factors, daily energy intake for boys and girls
136 combined was similar for those having a school meal or a packed lunch. However, daily intake of some
137 nutrients was different when comparing school meal type. Vitamin A and vitamin C were log transformed
138 for analysis **as they were not normally distributed**. Children having a school meal had higher mean daily
139 intakes of protein, fibre (NSP) and zinc (see table 2). Conversely, mean daily intakes of carbohydrate, total
140 sugars and sodium were all higher in children taking a packed lunch to school. The results for boys and
141 girls separately were broadly similar to the results from all children (data not shown). The adjusted models
142 included fewer children due to missing data on ethnicity and IMD (see table 2). Differences in daily
143 nutrient intakes between meal type, broadly remained the same in these models and were not attenuated for
144 most nutrients. In the fully adjusted models children having school meals consumed higher amounts of
145 protein, fibre and zinc and lower levels of total sugars and sodium as seen in the unadjusted models. In
146 addition, daily folate consumption was also significantly higher in children having a school meal. These
147 results were similar for boys and girls separately (data not shown).

148 Frequencies of consumption for all children, children having a school meal and children having a packed
149 lunch were generated for all of the food groups from the CADET assessment tool. The results for 33 foods
150 were consumed by less than 10% of the sample and were excluded from further analysis. The frequencies

151 and confidence intervals are displayed in table 3 for the 47 remaining foods plus total vegetables and total
152 fruit. The most commonly consumed foods in this group of children were bread, spreads, milk, yoghurts,
153 crisps (potato chips), vegetables and potatoes. The most common drinks were sweetened drinks and juices.
154 Odds ratios calculated for each food indicated that there were many foods that were more likely to be
155 consumed (over the whole day) by children having a school meal; and other foods **that were** more likely to
156 be consumed (over the whole day) by children having a packed lunch (table 4). The most popular foods
157 more likely to be consumed by children having a packed lunch included bread, spreads, ham, cheese-
158 spread, crisps, jam, yoghurt, chocolate biscuits, cake, cereal bars and dried fruit. Popular foods more likely
159 to be consumed by children having a school meal included hot food such as all types of vegetables,
160 **including dark green vegetables and legumes**, pasta, stew, fish fingers, pizza, sausages, rice, potatoes, gravy
161 and custard. Children having a packed lunch were more likely to have sweetened drinks and fruit juice
162 over the whole day while children having a school meal were more likely to drink water during the day.

163 **DISCUSSION**

164 This large survey of children across England investigated differences in daily consumption of important
165 nutrients and foods, by school meal type, consumed at lunchtime. The results suggest that children having
166 a school meal consume a healthier diet over the whole day compared to children who take a packed lunch
167 to school. Children having a school meal, on average, consumed lower levels of total sugars and sodium
168 and higher levels of protein, fibre, zinc and folate over the whole day. The differences were in the region
169 of 5 to 10% for all nutrients. Children having a school meal were more likely to have **all types of**
170 **vegetables and drink water during the day;** and were less likely to consume sweet and savoury snacks and
171 sweetened drinks. These differences in foods consumed explain why, sugar and sodium consumption are
172 lower and zinc, folate and fibre intakes are higher in children who have a school meal. There were no
173 appreciable differences in energy, total fat or saturated fat intakes over the whole day between meal types.
174 The data from this study were collected in the same year the food standards for school meals were
175 introduced into primary schools. The changes may not have been fully implemented in all schools;
176 however, it was expected that if there was no improvement in packed lunches but an improvement in

177 school meals the gap may have widened compared with data from before 2006. A review of surveys
178 carried out between 1990 and 2007⁽²⁵⁾ reported that daily energy and saturated fat intakes were higher if
179 children had a packed lunch. However we did not see a difference in these nutrients. This may be because
180 food companies have made efforts to reduce saturated fat from snack foods such as crisps (potato chips), in
181 recent years and these improvements have affected packed lunches more than school meals.

182 The review of studies carried out between 1990 and 2007 broadly concurred with the results from this
183 study **regarding** sodium and sugar intakes. The children having packed lunches in this study had, on
184 average, equivalent to an extra two spoons (10g) of sugar per day than those having a school meal. This
185 equates to about a 10% difference in sugar consumption over the day for an average child. The higher
186 sugar intake of children having a packed lunch reflects the higher consumption of biscuits, yoghurts, cakes
187 and sweetened drinks in these lunches which has also been reported in **other** surveys^(24; 34; 35). The difference
188 in sodium consumption between meal types reported in this study is about 100mg, a smaller difference
189 compared with the review of studies before 2007. This **attenuated** difference could be due to lowered
190 sodium content of key lunchtime foods such as bread and crisps (potato chips). The food composition data
191 were updated prior to this analysis to reflect lower sodium levels of these foods. However, the lower
192 sodium intake by children having a school meal reflects the persistent difference in dietary pattern with
193 more meat, potatoes, gravy and vegetables consumed by children having a school meal and more bread,
194 spreads, ham, cheese spread and crisps by children having a packed lunch.

195 Previous research studies looking at lunchtime intake rather than intake over the whole day, generally
196 report larger differences in nutrient intake between lunch type, compared with whole day intake. A survey
197 of more than 10,000 primary school children carried out by the School Food Trust in 2009⁽³⁶⁾ reported
198 differences between lunch type of many of the same nutrients **that** were found in this study. We have
199 shown that the differences in lunchtime intake of some nutrients persist over the whole day but this was not
200 the case for all nutrients. The School Food Trust reported higher levels of total fat and saturated fat and
201 calcium in packed lunches which we did not see in our analysis of intake over the whole day. This
202 indicates that there may be some compensation during the rest of the day outside school for some nutrients
203 but not others. Stevens analysed nutrient intake of school meals and packed lunches from the Low Income

204 Diet and Nutrition Survey over both lunchtime and over the whole day and found that although there were
205 differences in lunchtime intake by meal type these differences rarely persisted over the whole day.⁽³⁷⁾ This
206 may have been because the sample size was smaller than our analysis and therefore the study was not
207 powered to see more modest differences.

208 In the case of iron, few differences were seen between the two types of lunches on whole day intake. In the
209 previous review⁽²⁵⁾, a higher content of iron in packed lunches was reported which may have been due to
210 the financial restrictions of providing red meat in school meals. Compared with the recommended nutrient
211 intake (RNI) for iron for this age group, both groups were on average consuming adequate amounts of iron.

212 Compared with the RNIs set by the Department of Health (DoH) mean values of starch, fibre and zinc were
213 lower than recommended for the whole sample and sodium and sugar intakes were higher than
214 recommended. The long term improved health impact of a decrease in the region of 10% of key nutrients
215 such as sugars and sodium is not clear as the majority of the evidence available on diet and health outcomes
216 is from research on adults not children. There is little published evidence that children who have a packed
217 lunch are more likely to be overweight or obese or have worse health markers. Indeed, we saw no
218 difference in daily energy intake by lunchtime meal type in this large study. However, a study in London
219 on markers of CVD and type 2 DM risk by Whincup et al. reported that adolescents having school meals
220 had significantly lower systolic blood pressure and fasting insulin levels⁽³⁸⁾ which may be linked to our
221 results in terms of sugar and sodium consumption. A US school based study reported improvements in
222 blood lipid profiles with the introduction of a healthier school lunch lower in total and saturated fat⁽³⁹⁾
223 providing some evidence of the potential importance of lunch time meals in children on long term health.

224
225 There are notable strengths of this study. It included a large number of children in more than 50 schools
226 across the whole of England. The children were representative of the region with broadly similar levels of
227 deprivation to the national average⁽⁴⁰⁾ and a similar proportion of children having a school meal compared
228 to the national average of 45% at this time.⁽⁴¹⁾ Compared to the National Diet and Nutrition Survey,
229 intakes were generally higher in our survey, probably due to the difference in dietary assessment
230 methodology.⁽⁴²⁾ Compared with the original NDNS carried out in 1997 in the UK, daily intake was higher

231 in energy and all nutrients with the exception of sodium in our study. A further strength was the advanced
232 statistical methods applied to these data. Multilevel regression analysis was used that took into
233 consideration the similarity of pupils clustered within schools, and furthermore, results were reported as
234 unadjusted and adjusted for social factors. Results were similar for both models indicating that age,
235 gender, ethnicity and deprivation were broadly similar in both groups.

236 There are limitations to the study that need to be highlighted. This study is based on a cross-sectional, self-
237 reported, one day food diary that uses estimated portion sizes based on age and gender. This may lead to
238 unreliable reporting of energy and nutrient intake. The difficulties of accurately measuring dietary intake
239 are well established.⁽⁴²⁾ Some of the parents did not complete the non-diet data and therefore the adjusted
240 models included fewer children which could result in bias.

241 In summary, half of families in England choose to send their child with a packed lunch to school and
242 children having a packed lunch generally consume a less healthy diet over the whole day, higher in sugars
243 and sodium and lower in fibre and zinc even after adjusting for IMD and ethnicity. Sweet snack foods and
244 drinks and savoury snacks are more commonly consumed by children having a packed lunch, findings
245 which are consistent with previous studies. In order to improve children's diets we recommend that
246 policies are implemented that increase the proportion of school children of all ages having a school meal.
247 Cost of school meals may be an important reason why more families do not choose a school meal and
248 historical data indicates that as the cost of school meals increases, uptake decreases.⁽⁴³⁾ Potentially
249 successful policies may include increasing the number of children eligible for a free school meal or
250 **subsidising** the cost of school meals. The current UK government has recently introduced free school
251 meals for all 4 to 7 year olds in England at a cost of £600M per year. We further suggest that high quality
252 prospective studies are carried out to determine the benefits of school meals to children on markers of
253 health such as blood pressure and blood sugars in order to quantify the health benefits by school lunch type.

254 **Tables**255 **Table 1 Characteristics of children and schools included in the analysis. Figures are not adjusted for clustering**
256 **within schools**

Descriptor	N	All children	Boys	Girls
Children (Mean(SD))				
Age (years)	2656	7.02 (0.30)	7.02 (0.30)	7.01 (0.30)
Weight (kg)	2652	25.1(4.8)	25.3 (4.6)	24.9 (4.8)
Height (cm)	2652	122.8(5.5)	123.4 (5.6)	122.2 (5.4)
BMI (kg/m ²)	2651	16.6(2.3)	16.5 (2.2)	16.6(2.4)
Standardised BMI	2651	0.4(1.1)	0.4 (1.1)	0.3 (1.1)
Schools (Median(IR))				
Free School Meals (%)	2656	11(4,25)	11(4,24)	11(4,26)
KS2 achievement**	2441	4.2(3.9,4.4)	4.2 (3.9,4.3)	4.2 (3.9,4.4)
EAL (%)**	2656	2(1,9)	2 (1,7)	2 (0,10)
IMD score**	2282	16.8(9.4,30.9)	16.7 (9.4,30.8)	17.2 (9.4,30.9)

257 Abbreviations: SD: standard deviation; BMI: body mass index; EAL: English as a second language; IMD: index of
258 multiple deprivation. KS2: Key stage 2 level (target is 4 for all students by age 11 years)

259 **Median and Interquartile range provided

260

Table 2 Mean (se) for anthropometric measures and daily nutrient intakes of 2373 children aged 6 to 8 years by school lunch type adjusted for clustering within schools only (model 1) and fully adjusted (model 2) for age, gender, ethnicity and Index of Multiple Deprivation (IMD)*. Results are for school meals compared with packed lunches

	School meal (n= 1053)	Packed lunch (n= 1320)	All children (n=2373)	Difference (model 1)	95% CI (model 1)	P value (model 1)	Difference (model 2)	95% CI (model 2)	P value (model 2)
Anthropometric measures									
Age (Years)	7.00 (0.01)	7.02 (0.01)	7.02 (0.01)	-0.02	-0.05 – 0.01	0.16			
Weight (kg)	25.2 (0.1)	25.0 (0.1)	25.1 (0.1)	0.2	-0.2 – 0.6	0.28			
Height (cm)	122.8 (0.2)	122.7 (0.2)	122.8 (0.1)	0.2	-0.3 – 0.6	0.45			
BMI	16.6 (0.1)	16.6 (0.1)	16.6 (0.1)	0.1	-0.1 – 0.2	0.38			
Standardised BMI	0.41 (0.03)	0.38 (0.03)	0.38 (0.03)	0.04	-0.04 – 0.11	0.34			
Energy/nutrients									
Energy (KJ)	6752 (80)	6884 (57)	6662 (53)	-132	-310 - 46	0.15	-98	-285 - 87	0.29
Protein (g)	57.4 (0.8)	53.4 (0.5)	53.9 (0.5)	4.0	2.3 – 5.7	<0.01	4.3	2.6 – 6.0	<0.01
Carbohydrate (g)	227.2 (2.6)	236.6 (2.0)	226.4 (1.9)	-9.3	-15.4 - -3.2	<0.01	-7.9	-14.4 - -1.5	0.02
Total fat (g)	58.0 (0.9)	59.3 (0.6)	57.5 (0.6)	-1.3	-3.3 – 0.6	0.18	-1.2	-3.2 – 0.9	0.26
SFA (g)	21.1 (0.4)	21.1 (0.2)	20.6 (0.2)	0.0	-0.8 - 0.9	0.95	0.1	-0.8 – 1.0	0.82
Total sugar (g)	118.7 (1.9)	129.6 (1.5)	120.9 (1.4)	-11.0	-15.3 - -6.6	<0.01	-10.3	-15.0 - -5.7	<0.01
Starch (g)	105.6 (1.0)	103.8 (0.7)	104.7 (0.6)	1.7	-0.7 – 5.1	0.3	2.3	-1.1 – 5.7	0.18
Fibre (g of NSP)	12.5 (0.2)	11.6 (0.1)	11.7 (0.1)	0.9	0.5 – 1.3	<0.01	1.0	0.5 – 1.4	<0.01
Calcium (mg)	739.0 (11.1)	734.6 (8.7)	716.9 (7.5)	4.4	-21.7 – 30.5	0.74	5.5	-22.3 – 33.3	0.39
Iron (mg)	9.4 (0.1)	9.3 (0.1)	9.1 (0.1)	0.1	-0.2 - 0.4	0.40	0.2	-0.1 – 0.5	0.15
Zinc (mg)	6.5 (0.1)	6.2 (0.1)	6.2 (0.1)	0.4	0.1 - 0.6	<0.01	0.40	0.2 – 0.6	<0.01
Folate (µg)	199.4 (2.8)	192.8 (2.1)	190.3 (1.9)	6.6	0.1 – 13.0	0.05	9.2	2.6 – 15.8	<0.01
Vitamin C* (mg)	81.5 (3.1)	82.3 (2.0)	78.3 (2.0)	2.4	-2.9 – 7.7	0.37	5.0	-0.6 – 10.7	0.08
Vitamin A* (µg)	6.3 (0.04)	6.31 (6.25)	533.8 (19)	11.8	-34.8 – 58.5	0.62	13.2	-14.6 – 41.1	0.35
Sodium (mg)	2045 (32)	2145 (21)	2057 (20)	-101	-173 – -29	<0.01	-91	-167 - -15	0.02

*calculated using natural logarithm. Abbreviations: SFA (saturated fatty acids)

Table 3: Percent of children (and 95% confidence interval) consuming each food type for all children (N=2672), children having a school meal (N=1053) and children having a packed lunch (N=1320) for foods consumed by more than 10% of all children.

Percent consuming Foods	All children (%)	95% CI (all children)	School meal (%)	95% CI (school meal)	Packed lunch (%)	95% CI (packed lunch)
Bread & Cereals						
Bread	76.7	75.1-78.3	63.2	60.2-66.1	90.2	88.5-91.8
Sugar cereals	11.6	10.4-12.9	11.9	9.9 – 13.8	11.5	9.8-13.2
Hi fibre cereal	27.3	25.6-29.0	28.1	25.4-30.8	28.9	26.5-31.4
Other cereals	27.4	25.7-29.1	27.4	24.7-30.1	28.9	26.4-31.3
Milk on cereal	46.4	44.6-48.3	47.3	44.3-50.3	49.4	46.7-52.1
Spreads	54.5	52.6-56.4	36.8	33.9-39.8	71.8	69.4-74.2
Jam	14.4	13.0-15.7	11.8	9.8-13.7	17.5	15.4-19.6
Snack foods						
Cake	34.0	32.2-35.8	38.7	35.8-41.7	31.3	28.8-33.8
Cereal bar	13.1	11.8-14.3	10.9	9.0-12.8	15.8	13.8-17.7
Chocolate biscuit	26.5	24.8-28.2	14.8	12.7-17.0	36.3	33.7-38.9
Other biscuit	25.9	24.2-27.5	25.5	22.9-28.2	26.8	24.4-29.2
Sweets	13.7	12.4-15.0	14.4	12.3-16.6	14.1	12.2-16.0
Chocolate	17.4	16.0-18.9	16.9	14.6-19.2	19.1	17.0-21.2
Crisps	40.7	38.8-42.5	24.1	21.5-26.7	55.1	52.4-57.8
Cheese/meat/fish						
Hard cheese	25.7	24.1-27.4	25.5	22.9-28.2	27.0	24.6-29.4
Cheese spread	17.4	15.9-18.8	8.7	7.0-10.4	24.8	22.4-27.1
Sliced chicken	18.5	17.0-20.0	21.9	19.4-24.4	17.7	15.6-19.7
Meat stew	12.7	11.5-14.0	15.4	13.2-17.6	11.4	9.7-13.2
Ham	23.6	22.0-25.2	13.0	11.0-15.0	32.9	30.3-35.4
Sausage	17.0	15.6-18.5	19.8	17.4-22.3	16.1	14.1-18.0
Pizza	10.5	9.4-11.7	13.2	11.2-15.2	7.3	5.9-8.8
Fish fingers	11.3	10.1-12.5	15.7	13.4-17.9	6.8	5.5-8.2
Gravy	16.0	14.6-17.4	24.5	21.9-27.1	10.3	8.7-11.9
Ketchup	13.3	12.0-14.6	14.6	12.5-16.8	13.1	11.3-14.9
Rice/pasta/potatoes						
Boiled rice	12.3	11.1-13.6	14.2	12.0-16.3	11.6	9.9-13.3
Plain pasta	8.0	6.9-9.0	10.1	8.2-11.9	6.4	5.1-7.8
Tomato pasta	6.7	5.8-7.7	8.3	6.6-9.9	5.4	4.2-6.6
Cheese pasta	3.8	3.1-4.5	6.0	4.5-7.4	2.3	1.5-3.1
Meat pasta	10.9	9.7-12.0	13.2	11.2-15.2	9.3	7.7-10.9
Boiled potatoes	36.9	35.1-38.8	51.0	48.0-54.0	28.6	26.1-31.0
Fried potatoes	32.0	30.3-33.8	42.0	39.0-45.0	25.6	23.2-28.0
Desserts						
Yoghurt	50.3	48.4-52.2	38.5	35.5-41.4	63.9	61.3-66.5
Ice cream	14.0	12.6-15.3	14.8	12.7-17.0	13.6	11.7-15.4
Custard	13.3	12.0-14.6	23.0	20.4-25.5	5.5	4.2-6.7
Fruits/vegetables						
Total vegetables	84.5	83.1-85.8	90.6	88.8-92.4	82.0	79.9-84.0
Dark green veg	18.5	17.0-19.9	24.3	21.7-26.9	15.8	13.9-17.8
Orange/red veg	46.4	44.5-48.3	48.7	45.7-51.7	45.8	43.1-48.4
Legumes	20.4	18.8-21.9	25.5	22.8-28.1	16.7	14.7-18.8

Starchy veg	32.1	30.3-33.9	40.2	37.2-43.1	28.0	25.5-30.4
Other vegetables	50.0	48.0-51.7	56.9	53.9-59.9	47.2	44.5-49.9
Total fruit	89.7	88.6-90.9	90.4	88.6-92.2	91.2	89.7-92.7
Fresh/tinned fruit	89.0	87.8-90.1	89.9	88.1-91.8	90.3	88.7-91.9
Dried fruit	10.0	8.9-11.1	5.6	4.2-7.0	14.3	12.4-16.2
Drinks						
Milk drink	59.7	57.9-61.6	64.8	61.9-67.7	57.7	55.0-60.3
Soft drink	52.9	51.0-54.8	44.4	41.4-47.4	62.1	59.5-64.7
Low cal drink	11.5	10.3-12.7	10.8	8.9-12.7	13.6	11.8-15.5
Juice	43.8	41.9-45.7	42.2	39.2-45.1	49.6	46.9-52.3
Water	78.1	76.5-79.7	86.5	84.4-88.6	73.6	71.3-76.0

Table 4 Probability of consuming each food type for children having a school meal compared with children having a packed lunch (odds ratios and 95% confidence intervals and p values).

Selected foods	Odds ratio (model 1)	95% CI (model 1)	P value (model 1)	Odds ratio (model 2)	95% CI (model 2)	P value (model 2)
Cereals						
Bread	0.17	0.13-0.21	<0.01	0.16	0.13-0.21	<0.01
Sugar cereals	1.04	0.80-1.33	0.79	1.08	0.83-1.42	0.56
Hi fibre cereal	0.96	0.80-1.15	0.66	0.99	0.82-1.19	0.88
Other cereals	0.91	0.75-1.09	0.30	0.93	0.76-1.13	0.46
Milk on cereal	0.92	0.78-1.08	0.31	0.93	0.78-1.10	0.40
Spreads on bread	0.22	0.19-0.27	<0.01	0.22	0.18-0.27	<0.01
Jamo on bread	0.63	0.50-0.81	<0.01	0.57	0.44-0.74	<0.01
Snack foods						
Cake	1.63	1.33-2.01	<0.01	1.63	1.31-2.03	<0.01
Cereal bar	0.70	0.54-0.92	0.01	0.69	0.52-0.91	<0.01
Chocolate biscuit	0.29	0.24-0.36	<0.01	0.31	0.25-0.39	<0.01
Other biscuit	0.92	0.75-1.12	0.41	0.89	0.72-1.11	0.31
Sweets	1.03	0.82-1.31	0.78	1.07	0.83-1.38	0.61
Chocolate	0.86	0.70-1.07	0.17	0.85	0.68-1.07	0.16
Crisps	0.26	0.21-0.31	<0.01	0.26	0.21-0.32	<0.01
Cheese/meat/fish						
Hard cheese	0.89	0.73-1.09	0.27	0.85	0.69-1.05	0.13
Cheese spread	0.29	0.23-0.37	<0.01	0.30	0.23-0.39	<0.01
Sliced chicken	1.24	0.98-1.57	0.08	1.28	1.00-1.64	0.05
Meat stew	1.52	1.17-1.97	<0.01	1.59	1.21-2.10	<0.01
Ham	0.29	0.23-0.36	<0.01	0.29	0.22-0.36	<0.01
Sausage	1.38	1.08-1.75	<0.01	1.39	1.08-1.79	0.01
Pizza	2.02	1.48-2.76	<0.01	1.99	1.42-2.77	<0.01
Fish fingers	2.85	2.06-3.94	<0.01	2.62	1.85-3.71	<0.01
Gravy	2.67	2.05-3.46	<0.01	2.71	2.07-3.54	<0.01
Ketchup	1.17	0.92-1.50	0.21	1.23	0.95-1.59	0.12
Rice/pasta/potatoes						
Boiled rice	1.32	1.01-1.73	0.04	1.44	1.07-1.92	0.02
Plain pasta	1.57	1.13-2.19	<0.01	1.58	1.12-2.24	0.01
Tomato pasta	1.58	1.11-2.24	0.01	1.67	1.16-2.40	<0.01
Cheese pasta	2.62	1.60-4.27	<0.01	2.64	1.55-4.47	<0.01
Meat pasta	1.53	1.16-2.01	<0.01	1.56	1.17-2.08	<0.01
Boiled potatoes	2.74	2.26-3.32	<0.01	2.93	2.39-3.59	<0.01
Fried potatoes	2.13	1.75-2.59	<0.01	2.15	1.76-2.64	<0.01
Desserts						
Yoghurt	0.34	0.28-0.41	<0.01	0.34	0.28-0.41	<0.01
Ice cream	1.10	0.85-1.41	0.47	1.12	0.86-1.46	0.39
Custard	6.55	4.75-9.04	<0.01	6.43	4.58-9.02	<0.01
Fruits/vegetables						
Total vegetables	2.58	1.95-3.42	<0.01	2.63	1.96-3.55	<0.01
Dark green veg	1.72	1.36-2.16	<0.01	1.81	1.42-2.31	<0.01
Red/orange veg	1.33	1.10-1.61	<0.01	1.36	1.11-1.67	<0.01
Legumes	1.74	1.40-2.17	<0.01	1.66	1.32-2.09	<0.01
Starchy veg	1.85	1.53-2.24	<0.01	1.91	1.56-2.33	<0.01
Other veg	1.53	1.28-1.82	<0.01	1.58	1.32-1.91	<0.01
Total fruit	0.85	0.63-1.15	0.29	0.84	0.61-1.16	0.29

Fresh/tinned fruit	0.90	0.67-1.21	0.48	0.88	0.65-1.20	0.42
Dried fruit	0.35	0.25-0.48	<0.01	0.36	0.26-0.51	<0.01
Drinks						
Milk drink	1.23	1.02-1.48	0.03	1.23	1.01-1.50	0.04
Soft drink	0.46	0.38-0.55	<0.01	0.46	0.38-0.55	<0.01
Low cal drink	0.77	0.59-0.99	0.05	0.76	0.58-0.99	0.05
Juice	0.72	0.60-0.86	<0.01	0.78	0.65-0.94	0.01
Water	2.64	2.06-3.39	<0.01	2.71	2.09-3.52	<0.01

Abbreviation:IMD: index of multiple deprivation.

Model 1 (N=2373) is adjusted for clustering within schools only and model 2 (N=2172) is the fully adjusted model adjusted for age, gender, ethnicity and IMD quartiles (Index of multiple deprivation) in addition to clustering within schools.

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