

## Childhood consumption of fruit and vegetables across England: a study of 2306 6–7-year-olds in 2007

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### Abstract

The School Fruit and Vegetable Scheme (SFVS) provides children in government-run schools in England with a free piece of fruit or a vegetable each school day for the first 3 years of school. The present study examines the impact of the SFVS, in terms of its contribution towards the total daily intake of fruit and vegetables by children across England. Quantitative dietary data were collected from 2306 children in their third year of school, from 128 schools, using a 24 h food diary. The data were examined at different spatial scales, and variations in the impact of the scheme across areas with different socio-economic characteristics were analysed using a deprivation index and a geodemographic classification. The uptake of the SFVS and the total intake of fruit and vegetables by children varied across different parts of England. Participation in the SFVS was positively associated with fruit and vegetable consumption. That is, in any one area, those children who participated in the SFVS consumed more fruit and vegetables. However, children living in deprived areas still consumed less fruit and vegetables than children living in more advantaged areas: the mean daily frequency of fruit and vegetables consumed, and rates of consumption of fruit or vegetables five times or more per d, decreased as deprivation increased ( $r = -0.860$ ;  $P = 0.001$ ;  $r = -0.842$ ;  $P = 0.002$ ). So the SFVS does not eliminate the socio-economic gradient in fruit and vegetable consumption, but it does help to increase fruit and vegetable consumption in deprived (and affluent) areas.

**Key words:** Fruit and vegetables: Children's diet: Dietary scheme

There is a substantial body of evidence that associates diets rich in fruit and vegetables with multiple benefits, including a reduced risk of obesity<sup>(1)</sup>, stroke<sup>(2)</sup>, diabetes<sup>(3)</sup>, CHD<sup>(4)</sup> and some cancers<sup>(5,6)</sup>. In spite of this, however, many people (particularly children) fail to eat the recommended amount of fruit and vegetables<sup>(7–9)</sup>.

In England, the Department for Health administers a '5 A Day' programme, which forms part of the government's strategy to encourage and enable people to eat more fruit and vegetables<sup>(10)</sup>. One aspect of England's 5 A Day programme is the School Fruit and Vegetable Scheme (SFVS), which provides every child in government-run schools with a free piece of fruit or a vegetable each school day for the first 3 years of school<sup>(11)</sup>. The rationale behind the SFVS is that early dietary intervention will provide children with life-long health benefits, because eating behaviours initiated in early childhood tend to persist into adulthood<sup>(12–19)</sup>. The SFVS aims to reduce rates of childhood obesity, as well as

other health problems, through encouraging and enabling children to eat more fruit and vegetables.

The SFVS involves distributing about 440 million pieces of fruit and vegetables each year to over two million children in 18 000 schools, making it one of the largest and most expensive UK public health interventions in children's diets in recent years<sup>(20)</sup>. Given the scale and cost implications of the SFVS, it is essential to consider the extent of the scheme's success. To date, three academic studies have assessed the impact of the SFVS on children's diets. In all three cases, it was concluded that uptake of the SFVS encourages children in the first 3 years of school to eat more fruit and vegetables, but it does little to sustain consumption of these foods when children move into the fourth year of school and beyond<sup>(21–23)</sup>. These studies each involved an assessment of children's diets in a study region and a control region, before, during and after the introduction of the SFVS to schools in the study region.

**Abbreviations:** CADET, Child and Diet Evaluation Tool; GOR, Government Office Region; IMD04, Index of Multiple Deprivation 2004; OAC, Output Area Classification; SFVS, School Fruit and Vegetable Scheme.

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Research into health variations in relation to neighbourhood or household deprivation has highlighted a link between deprivation and a range of illnesses<sup>(24–28)</sup>. Similar research has also been conducted in order to contextualise children's dietary habits. Various studies have highlighted how children from deprived areas tend to eat less fruit and vegetables than children from advantaged areas, regardless of whether these foods are available through schemes such as the SFVS<sup>(21,23,29,30)</sup>. These studies build on other investigations, which highlight regional variations in fruit and vegetable consumption by children, where children from the North of England (which is widely regarded as being more deprived) tend to eat less fruit and vegetables than children from the South<sup>(31)</sup>.

This suggests that the impact of the SFVS may vary across different parts of England and across different socio-economic and sociodemographic settings. Interventions aimed at encouraging fruit and vegetable consumption need to suit the children most in need of support and encouragement (i.e. those who are likely to consume less fruit and vegetables).

To date, no research has been undertaken to investigate the impact of the SFVS in different parts of England. Accordingly, the present paper aims to explore geographic and demographic variations in the uptake of the SFVS and the amount of fruit and vegetables that children consume on a daily basis.

## Methods

The impact of the SFVS was examined in terms of its contribution towards the total daily intake of fruit and vegetables by a cross-sectional sample of children in their third year of school (aged 6–7 years). Ethical approval was obtained from the University of Leeds Research Ethics Committee (Faculty of Medicine and Health).

## Data sources

Dietary data were collected using a 24 h FFQ, known as the Child and Diet Evaluation Tool (CADET)<sup>(32,33)</sup>. The CADET comprised a list of food and drink categories (including 'Fruit' and 'Vegetables and Beans'), which, in turn, contained a number of specific subcategories (such as 'apple', 'pear', 'banana'). Alongside each subcategory were seven tick-boxes, each representing a different meal or snack time (e.g. 'Morning Break', 'Lunch Time' and 'Evening Meal' or, in the case of fruit and vegetables, 'as part of the SFVS'). The CADET also included each child's residential postcode.

The dietary data were collected from children in their third year of school from a randomly selected sample of government-run schools in England containing pupils in the third to fifth years of school with a minimum year group size of fifteen pupils. Independent schools, special schools, schools without all three year groups, and small schools with fewer than fifteen pupils per year group were excluded. In order to reduce bias, schools connected with previous SFVS studies or other projects being conducted by the National Foundation for Educational Research and the Nutritional Epidemiology Group at the University of Leeds were excluded from the

selection process. Of 129 schools approached, 128 participated in the study. All 128 schools were also taking part in the SFVS. The schools were nationally representative in terms of ethnicity (percentage of non-white British children), deprivation (proportion of children receiving free school meals), achievement (average performance in the third to sixth years of school) and region of England (North, Midlands or South). Thus, across all 128 schools, the average percentage of non-white British children was 18.0% (compared with 19.4% for England<sup>(34)</sup>), the average percentage of children receiving free school meals was 17.5% (compared with 16.0% for England<sup>(35)</sup>) and the average Key Stage 2 achievement of children was 4.1 (pupils are expected to achieve Level 4<sup>(36)</sup>). The sample included forty-five schools from Northern England, twenty-eight schools from the Midlands and fifty-five schools from Southern England. If schools had more than one class in the correct age group, then one class per school was randomly selected to provide data. The number of boys and girls sampled was approximately equal. Data collection was carried out in February–March 2007.

For the participating schools, parents and guardians were given the opportunity for their child to opt-out of the study. During the 24 h data collection period, all foods and drinks consumed by the participating children were recorded in the CADET. They were completed by one of sixteen National Foundation for Educational Research-trained administrators during the school day, and then sent home with each child for a parent or guardian to finish. The diaries were returned to school the following day and sent back to the researchers.

The UK Index of Multiple Deprivation 2004 (IMD04)<sup>(37)</sup> was used as the measure of deprivation at Lower Layer Super Output Area level. These census tracts, which have a minimum population of 1000 and a mean population of 1500, are a subdivision of Middle Layer Super Output Areas, which in turn are subdivisions of local authorities. There are 34 378 Lower Layer Super Output Areas in England and Wales. The IMD04 comprises thirty-seven indicators, pertaining to seven domains of deprivation: income, employment, health, living conditions and barriers to housing and services. The indicators include census variables such as disability, lack of educational attainment and unemployment, as well as non-census variables, including poor air quality, high rates of road traffic accidents and high rates of crime. A higher IMD04 score indicates a higher degree of deprivation.

Geodemographic classification data were also used. These classifications allow users to profile geographical locations (via easily understood labels) based on the characteristics of the people who live there. Accordingly, the Output Area Classification (OAC) of the UK's Office for National Statistics, developed in collaboration with the University of Leeds<sup>(38)</sup>, was utilised. The OAC uses forty-one variables selected from the 2001 Census of Population for the whole of the UK at Output Area level to indicate the character of local areas, and works by assigning Output Areas (socially homogeneous areas with a minimum population size of 100 and a mean size of 297) to one of seven super-groups, twenty-one groups and fifty-two subgroups. The CADET data were analysed at the twenty-one-category group level.



### Data analysis

The CADET data were used to calculate each child's intake of fruit and vegetables in terms of frequency (i.e. each time a fruit or vegetable was consumed, it constituted a frequency of one), in accordance with the Department for Health's 5 A Day guidance<sup>(39)</sup>. That is, fruit juice was included, but counted only once (even if a child had drunk more than one serving); beans, lentils and pulses were also included, but only counted once. The mean daily frequency of fruit and vegetables consumed by all children was calculated. Children were considered to have participated in the School Fruit and Vegetable Scheme if they had consumed fruit or vegetables on the day of recording which were ticked as part of the SFVS. Outliers were identified as the data points greater than 2 standard deviations from the mean. Each child's residential postcode was converted into a National Grid coordinate using Code-Point: an Ordnance Survey product that provides a precise geographical location for each of the 1.7 million postcode units in the UK<sup>(40)</sup>. Each child's postcode was then linked to the corresponding Output Area, and accordingly Lower Layer Super Output Area, using Geoconvert<sup>(41)</sup> and ArcGIS software (version 9.0; ESRI, Redlands, CA, USA). This enabled the Index of Multiple Deprivation and the appropriate OAC group to be attached to each child's home address.

### Geographic analysis

Through analysing the CADET data at different geographic scales, it was possible to examine how the impact of the SFVS varies across England. The percentage of children who participated in the scheme (i.e. who consumed at least one piece of fruit or a vegetable as part of the SFVS) was calculated. The percentage of children who consumed fruit or vegetables five times or more per d (whether as part of the SFVS or not) was also calculated, as was the mean daily frequency of fruit and vegetables that children consumed (whether as part of the SFVS or not). These three variables were stratified by region (Northern England, Midlands and Southern England) and by Government Office Region (GOR, of which there are nine in England). Multilevel logistic regression was used to produce OR in order to determine regional variations in both the proportion of children who participated in the SFVS, and the proportion of children who consumed fruit or vegetables five times or more per d. The impact of the SFVS was also analysed at the more disaggregated GOR level.

### Deprivation and geodemographic classifications

The data for participation in the SFVS, consuming fruit or vegetables at least five times per d, and the mean daily frequency of fruit and vegetables consumed were also stratified by deprivation score. The deprivation score data were divided into ten groups, ranging from least deprived (group 1) to most deprived (group 10). The Spearman's rank correlation coefficient for the relationship between deprivation category and (1) participation in the SFVS, (2) consumption of fruit or

vegetables at least five times per d, and (3) the mean daily frequency of fruit and vegetables consumed was calculated.

To examine the impact of the SFVS across areas with different demographic characteristics, the OAC was used at group level to identify the 'types' of children in each of four categories: more or less likely to participate in the SFVS, and more or less likely to consume fruit or vegetables five times or more per d. This was done by calculating the segmentation index for the twenty-one OAC groups. This index expresses the prevalence of the variable of interest (e.g. percentage of children who participated in the SFVS) within each group, compared with that group's share of the total number of children in the whole CADET dataset.

Segmentation index<sub>*j*</sub> =

$$\frac{100 \times \% \text{ children in OAC group } j \text{ who participated in the SFVS}_j}{\% \text{ of children in OAC group } j}$$

The calculation produces a segmentation index where 100 is average: values greater than 100 thus indicate a higher than expected concentration in a group and values of less than 100 a lower than expected concentration.

### Results

From a total of 3296 CADET distributed, 2709 were completed and returned. A total of fifty-eight outlier values were identified from the CADET dataset (i.e. children who ate more than thirteen portions of fruit and vegetables daily) and were not included in the analysis. Of the remaining 2651 completed CADET, 345 included erroneous, partial or no postcode, and could not be geocoded. Postcodes from the remaining 2306 CADET were converted, attaching IMD04 and OAC group, and data from these questionnaires were included in the analysis.

The data showed that, on a national scale, 1421 children (61.6% of the 2306 children surveyed) ate at least one fruit or vegetable from the SFVS, 1364 children (59.2% of the 2306 children surveyed) consumed fruits or vegetables five times or more per d, and the mean daily frequency of fruits and vegetables consumed was 5.4 (95% CI 5.3, 5.5). When fruit and vegetables eaten as part of the SFVS are excluded, 1125 children (48.8% of the 2306 children surveyed) consumed fruit or vegetables five times or more per d, and the mean daily frequency of fruit and vegetables consumed was 4.7 (95% CI 4.6, 4.8).

### Geographic analysis – regional level

When disaggregated by region (as depicted in Table 1), the data showed that more children from the North of England (71.6% of the 797 children surveyed) ate at least one fruit or vegetable from the SFVS, compared with the Midlands (48.5% of the 491 children surveyed) and the South (60.1% of the 1018 children surveyed). Compared with the North, OR for the proportion of children consuming at least one fruit or vegetable from the SFVS for the Midlands and South,

**Table 1.** Breakdown of the survey sample by geographical areas

Name of region or Government Office Region	Number of schools surveyed	Percentage of all schools surveyed	Number of children surveyed	Percentage of all children surveyed
<b>Regions</b>				
Northern England	45	35.2	797	34.6
The Midlands	28	21.9	491	21.3
Southern England	55	43.0	1018	44.1
Total	128	100.0	2306	100.0
<b>Government Office Regions</b>				
East Midlands	15	11.7	271	11.8
East of England	13	10.2	247	10.7
London	10	7.8	151	6.5
North East	8	6.3	143	6.2
North West	23	18.0	417	18.1
South East	17	13.3	342	14.8
South West	15	11.7	278	12.1
West Midlands	13	10.2	220	9.5
Yorkshire and The Humber	14	10.9	237	10.3
Total	128	100.0	2306	100.0

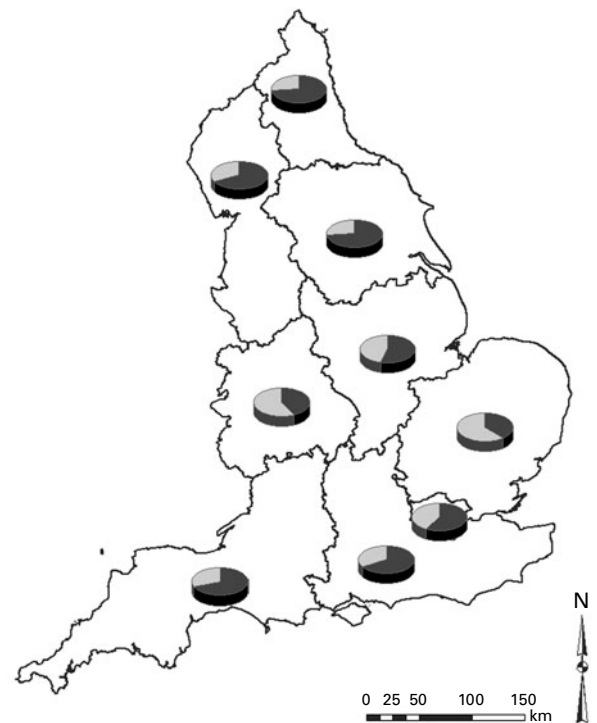
respectively, were 0.37 (95% CI 0.18, 0.78) and 0.60 (95% CI 0.36, 0.99). However, fewer children from the North of England (54.1% of the 797 children surveyed) and the Midlands (55.0% of the 491 children surveyed) consumed fruit or vegetables five times or more per d compared with children from the South (65.1% of the 1018 children surveyed). Compared with the South, OR for the proportion of children consuming fruit or vegetables five times or more per d for Northern England and the Midlands, respectively, were 0.63 (95% CI 0.48, 0.83) and 0.65 (95% CI 0.49, 0.88). Children from Northern England and the Midlands, on average, ate less fruit and vegetables compared with children from the South. The mean daily frequency of fruit and vegetables consumed were 5.1 (95% CI 4.9, 5.3) in Northern England, 5.2 (95% CI 4.9, 5.4) in the Midlands and 5.7 (95% CI 5.6, 5.9) in the South.

When fruit and vegetables eaten as part of the SFVS are excluded, the proportion of children who consumed fruit or vegetables five times or more per d were as follows: 42.3% in Northern England, 46.4% in the Midlands and 55.0% in the South. In this respect, the impact of the SFVS was greatest in Northern England, where the SFVS increased the percentage achieving the five a day goal by 11.8%. The mean daily frequencies of fruit and vegetables (not including the SFVS) consumed were as follows: 4.3 (95% CI 4.1, 4.5) in Northern England, 4.6 (95% CI 4.4, 4.9) in the Midlands and 5.0 (95% CI 4.9, 5.2) in the South. In this respect, the impact of the SFVS was greatest in Northern England (where the SFVS increased the frequency of fruit and vegetable portions consumed per d by 0.8).

#### Geographic analysis – Government Office Region level

The data were then analysed at the more disaggregated GOR level (as depicted in Table 1). With regard to participation in the SFVS, some Southern GOR reached comparable rates with their Northern counterparts (see Fig. 1). For example, in the South West, participation rates reached 70.9% (of the 278 children surveyed) compared with the highest Northern

GOR of Yorkshire and The Humber, which had a participation rate of 74.3% (of the 237 children surveyed). With regard to the total intake of fruit and vegetables, children from Southern GOR were again more likely to consume fruit or vegetables at least five times per d, but so were children from some of the Northern GOR (see Appendix 1). For example, a similar proportion of children from Yorkshire and The Humber (63.3% of the 237 children surveyed) and the South West (64.4% of the 278 children surveyed) ate fruit or vegetables five times or more per d. It is also shown that the mean daily frequency



**Fig. 1.** Proportion (%) of children who participated (or not) in the School Fruit and Vegetable Scheme. ■, Participated; □, did not participate.



of fruit and vegetables consumed was higher for children in the South or East of England.

With respect to the proportion of children who consumed fruit or vegetables five times or more per d, the impact of the SFVS was greatest in Yorkshire and The Humber. Here, when fruit and vegetables eaten as part of the SFVS are excluded, the proportion of children who consumed fruit or vegetables five times or more per d was 47.3% compared with 63.3% including the SFVS (a difference of 16.0%). However, with respect to the mean daily frequency of fruit and vegetables consumed, the impact of the SFVS was greatest in the South West. Here, when fruit and vegetables eaten as part of the SFVS are ignored, the mean daily frequency consumed was 4.8 (95% CI 4.6, 5.1), compared with 5.7 including the SFVS (95% CI 5.4, 5.9) (a difference of 0.9). (A full breakdown of the results at the regional level and the GOR level is included in Appendix 1.)

### Deprivation analysis

The dietary data were then stratified by deprivation score into ten approximately equal-sized groups. This analysis showed the variation in participation in the SFVS, in consumption of fruit or vegetables five times or more per d, and in the mean daily frequency of fruit and vegetables consumed across deprivation categories (see Table 2). The results showed highest rates of participation in the SFVS and lowest rates of consumption of fruit or vegetables five times or more per d in children residing in areas with the highest deprivation score. It also showed a lower mean daily frequency of fruit and vegetable consumption in children from more deprived areas, and a higher mean daily frequency of fruit and vegetable consumption in children from less deprived areas.

With respect to the proportion of children who consumed fruit or vegetables five times or more per d, the impact of the SFVS was greatest in the most deprived category (group 10). In this group, when fruit and vegetables eaten as part of the SFVS are excluded, the proportion of children who consumed fruit or vegetables five times or more per d was 31.2% compared with 45.3% including the SFVS (a difference of 14.1%). Similarly, with respect to the mean daily frequency of fruit and vegetables consumed, the impact of the SFVS was greatest in three of the most deprived categories (groups 7, 8 and 10). When fruit and vegetables eaten as part of the SFVS are ignored, the mean daily frequency consumed was 4.5 (95% CI 4.2, 4.9) compared with 5.3 including the SFVS (95% CI 4.9, 5.6) (group 7), 4.5 (95% CI 4.1, 4.8) compared with 5.3 including the SFVS (95% CI 4.9, 5.6) (group 8) and 3.7 (95% CI 3.3, 4.0) compared with 4.5 including the SFVS (95% CI 4.2, 4.8) (group 10). In all three cases, the difference was 0.8.

The data suggest that the uptake of the SFVS increased as deprivation increased ( $r$  0.855;  $P=0.002$ ), that consumption of fruit or vegetables five times or more per d and deprivation were negatively associated ( $r$  -0.842;  $P=0.002$ ), and that the mean daily frequency of fruit and vegetables consumed was also negatively associated with deprivation ( $r$  -0.860;  $P=0.001$ ).

**Table 2.** Breakdown of School Fruit and Vegetable Scheme (SFVS) dietary data by deprivation category (Mean values and 95% confidence intervals)

Deprivation category (and deprivation score) (group 1 is least deprived, group 10 is most deprived)	Proportion (%) of children who participated in the SFVS	Proportion (%) of children who consumed fruit or vegetables at least five times per d*	Proportion (%) of children who consumed fruit or vegetables at least five times per d†	Daily frequency of fruit and vegetables consumed*		Daily frequency of fruit and vegetables consumed†	
				Mean	95% CI	Mean	95% CI
Group 1 (0.04–2.72) (n 231)	58.9	67.1	59.7	5.9	5.6, 6.2	5.2	4.9, 5.5
Group 2 (2.73–5.32) (n 225)	47.1	59.1	51.1	5.4	5.0, 5.7	4.8	4.5, 5.1
Group 3 (5.33–8.22) (n 236)	60.2	69.9	61.0	6.0	5.7, 6.3	5.4	5.0, 5.7
Group 4 (8.23–11.53) (n 228)	59.6	68.4	58.8	5.8	5.5, 6.1	5.1	4.8, 5.5
Group 5 (11.54–14.72) (n 233)	66.1	58.8	49.4	5.4	5.1, 5.7	4.7	4.4, 5.0
Group 6 (14.73–19.73) (n 228)	60.5	60.1	50.0	5.5	5.2, 5.9	4.9	4.5, 5.2
Group 7 (19.74–25.74) (n 233)	62.2	44.2	44.2	5.3	4.9, 5.6	4.5	4.2, 4.9
Group 8 (25.75–33.09) (n 230)	69.1	54.8	43.0	5.3	4.9, 5.6	4.5	4.1, 4.8
Group 9 (33.10–46.15) (n 228)	61.8	50.9	39.5	5.0	4.6, 5.3	4.3	3.9, 4.6
Group 10 (46.16–79.48) (n 234)	70.1	45.3	31.2	4.5	4.2, 4.8	3.7	3.3, 4.0

\* Including fruit and vegetables from the SFVS.

† Excluding fruit and vegetables from the SFVS.

### Geodemographic analysis

To examine the impact of the SFVS across areas with different demographic characteristics, the OAC was used at group level to identify the 'types' of children in each of four categories: more or less likely to participate in the SFVS, and more or less likely to consume fruit or vegetables five times or more per d. In all cases, this was done by calculating the segmentation index for the twenty-one OAC groups.

Fig. 2 shows that children from the following groups were more likely to participate in the scheme: Younger blue collar; Settled in the city; Prospering semis; Thriving suburbs; Senior communities; Public housing; Settled households; Young families in terraced homes; Asian communities; Afro-Caribbean communities. That is, these groups had a segmentation index of over 100. Apart from the area type Thriving suburbs, these areas could be considered to be less advantaged. They have common features that include public and private rented housing, terraces and flats, unemployed people, no central heating, reliance on public transport, and black and minority ethnic residents. Children were more likely to consume fruit or vegetables five times or more per d if they were from the following groups: Settled in the city; Village life; Agricultural; Accessible countryside; Prospering older families; Thriving suburbs; Settled households; Least divergent; Young families in terraced homes; Aspiring households; Asian communities. The area type with the greatest segmentation index was Thriving suburbs (segmentation index 122), which is characterised by high rates of car ownership and owner-occupied detached housing. Other shared characteristics included people with higher education qualifications, a low population density, private rented accommodation, terraces and flats, black and minority ethnic residents, and people employed in agriculture and fishing.

### Discussion

The present paper offers a unique insight into the geography of the impact of the SFVS and shows that the uptake of the SFVS and the intake of fruit and vegetables by children vary across England. Participation in the scheme was broadly higher in the North of England, and frequency of fruit and vegetable consumption higher in the South. This consumption trend is in keeping with findings from other dietary studies<sup>(31)</sup>. However, it seems that the SFVS does not ensure that children in every region eat more fruit and vegetables. As the spatial scale of the analysis reduced using the more disaggregated GOR level, the trends were less clear-cut and more intra-regional variations became apparent.

The results of the present study provide further evidence of the low levels of fruit and vegetable consumption by children generally, with more than 40% of the children surveyed eating fruit or vegetables less than five times per d despite all having access to these foods once per d via the SFVS. The findings are in line with previous research<sup>(7–9)</sup> and demonstrate the scale of the problem of poor diet in children in England. It could be argued that the impact of the SFVS is restricted by the fact that it only targets one meal event (e.g. morning break).

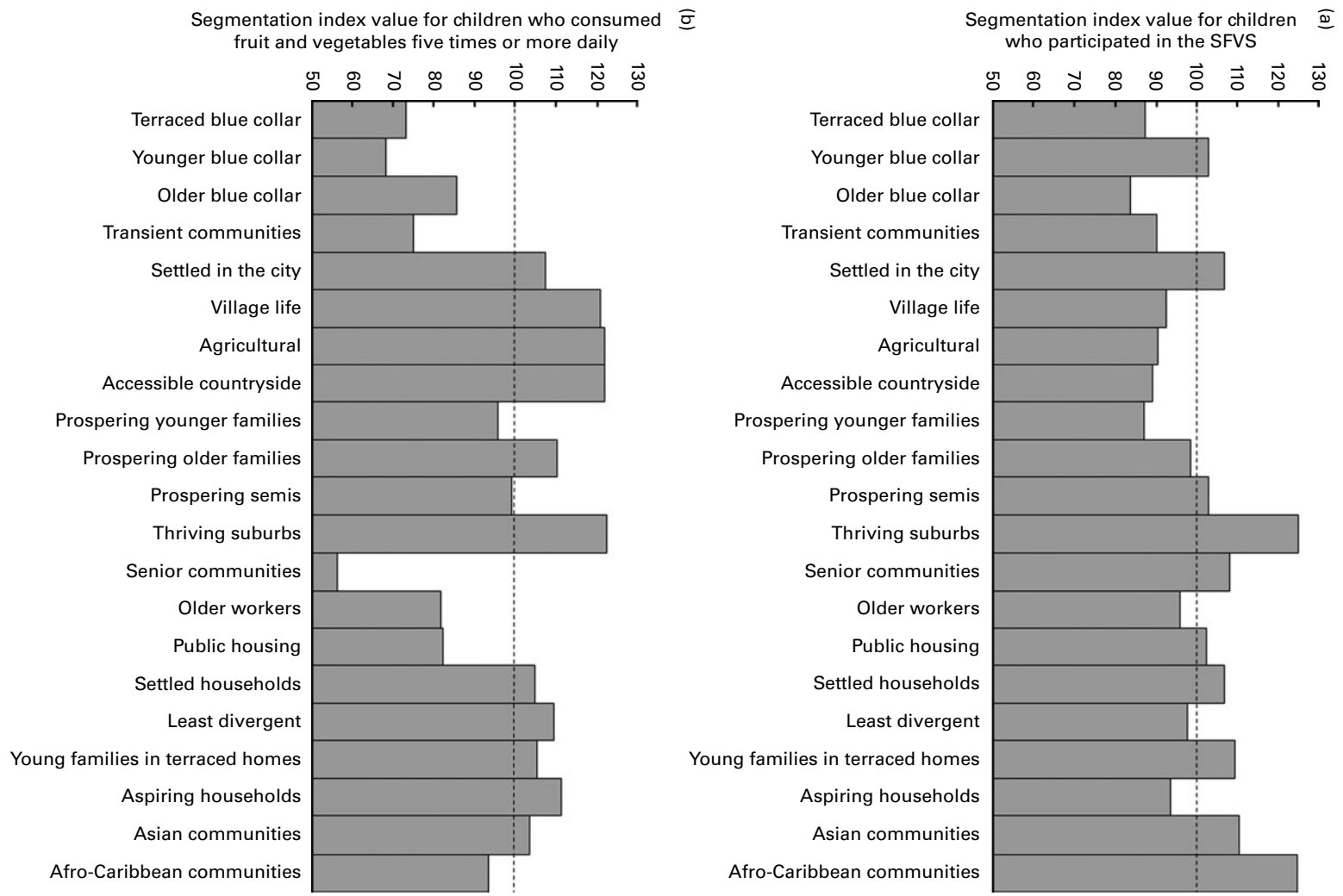
If more meal events were targeted, or key meals (such as lunch) were the point of intervention, the scheme might have a greater impact. An intervention targeting improving packed lunches at schools has shown higher weights of fruit and vegetables provided in the intervention group<sup>(42)</sup>. However, further investigation would be required in order to determine the impact across the day.

The results also suggest that the impact of the SFVS was greatest in more deprived areas, with children from these areas being more likely to participate in the scheme. However, these children were less likely to consume fruit or vegetables at least five times per d compared with children from advantaged areas. The finding that children from deprived areas consumed fruit and vegetables less frequently corresponds with earlier studies<sup>(21,23,29,30)</sup>. The data suggest that the SFVS is having a greater impact in deprived, than in advantaged, areas because it makes a greater contribution towards the total intake of fruit and vegetables by these children. As children from deprived areas tend to eat less fruit and vegetables, their intake of these foods would be even lower without the positive contribution made by the SFVS. This, combined with the fact that a low fruit and vegetable intake is one of the lifestyle factors that may contribute to the health inequalities between different sectors of society, suggests that providing free fruit and vegetables to children has the potential to reduce socio-economic gradients in health.

It has been suggested that fruit and vegetable consumption is lower in areas of deprivation because residents lack direct access to healthy foods: the so-called 'food desert' phenomenon<sup>(43,44)</sup>, although the evidence is not uniform<sup>(45,46)</sup>. It has also been suggested that the gap between advantaged and disadvantaged – and therefore 'healthy' and 'unhealthy' – is likely to widen over time, as accessibility for persons in deprived areas is improving at a relatively slow rate<sup>(47)</sup>.

Other authors have suggested that it is the social characteristics of the families living in deprived areas that determine whether children are more or less likely to consume fruit and vegetables. For example, the fact that families from deprived areas tend to have a relatively low income could have some impact on children's dietary habits: a low family income has been shown to present a barrier to healthy eating because fruit and vegetables are deemed by people on a tight budget to be costly<sup>(48)</sup> and a 'flexible' item with respect to bills and debt arrears<sup>(49)</sup>. In addition to being associated with family income, educational attainment has also been linked to health consciousness in food choices<sup>(50)</sup> and, with regard to children's diets, a positive relationship between maternal education and the intake of fruit and vegetables by children has been reported<sup>(51)</sup>. Other studies have suggested that social and cultural factors, such as ethnicity, have a direct bearing on fruit and vegetable intake, with children from black and minority ethnic communities eating more fruit than white children, and children from schools with a higher incidence of English as an additional language being more likely to consume more fruit and vegetables<sup>(21)</sup>. This may be attributable to differences in the types of foods served in the home<sup>(52)</sup>.





**Fig. 2.** Segmentation index for children who (a) participated in the School Fruit and Vegetable Scheme (SFVS) and (b) ate fruit and vegetables five times or more per d (including fruit and vegetables from the SFVS). Values greater than 100 indicate a high concentration of children in a demographic group and values less than 100 indicate a low concentration.

When the CADET data were analysed by geodemographic group, it was found that different demographic characteristics are linked to the uptake of the SFVS and intake of fruit and vegetables. This finding could be used to target future developments of the SFVS more effectively. We have previously shown that activities promoting fruit and vegetable intakes in school are associated with increases in the intake of vegetables, but not fruit. This result was independent of deprivation status or ethnicity<sup>(53)</sup>. Further research is needed to confirm any associations and might seek to identify causal links between demographic characteristics and the uptake of the scheme and so highlight other initiatives that might be instituted to run alongside the SFVS.

The CADET was quick and simple to complete, thus encouraging respondents' cooperation and accuracy. In addition to this, the closed answer tick-box format of the questionnaire ensured that comparable datasets were generated. However, the present study is not without limitations. First, with regard to data sources, although the CADET were completed, in part, by a team of National Foundation for Educational Research-trained fieldworkers, it is possible that some parents may have misreported their child's fruit and vegetable intake, thus meaning that the true picture of fruit and vegetable consumption may have been skewed. Misreporting of dietary intake in children has been shown to occur more commonly among lower educated mothers and least in higher educated mothers<sup>(54)</sup>. Furthermore, the CADET only provides an insight into a single day, thus preventing longitudinal comparisons from being made. In addition to this, as only government-run schools were included in the sample, the results of the present study may not be applicable to other types of schools in England, e.g. independent, special or small schools. Second, with regard to data analysis, deprivation indices, such as IMD04, and geodemographic classifications, such as the OAC, which are derived from census data, have attracted a degree of criticism, with some commentators suggesting that they give misleading impressions of areas and individuals. These concerns are based on the historic nature of census data, the risk of errors within census data, the fact that census data are area-based (i.e. not available at the individual level) and the questionable relevance of census variables to the intended purpose<sup>(55–57)</sup>. Additionally, these analyses do not permit the existence of links or the establishment of causal relationships between geographical, socio-economic and sociodemographic variables, and the impact of the SFVS, as the data are cross-sectional. However, they do indicate some interesting trends and patterns.

### Conclusion

The SFVS is one of the largest public health interventions in children's diets in recent years. Its objective is to improve the diets of children and to reduce their risk of health problems, both now and in later life. Researchers have reported that the scheme encourages and enables a greater number of children to eat more fruit and vegetables per d, at least during the period of the intervention. The present study adds to this body of evidence by breaking down the impact

of the SFVS by geographic region and by different socio-economic and demographic groups. It is clear that some regions/groups are more likely to participate than others. The impact on the amount of fruit and vegetables consumed daily also varies. The SFVS is positively associated with dietary fruit and vegetable intake in young children, particularly those who live in deprived areas. So although the SFVS does not eliminate the socio-economic gradient in fruit and vegetable consumption, it does help to increase fruit and vegetable consumption in deprived (and affluent) areas.

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**Appendix 1.** Breakdown of School Fruit and Vegetable Scheme (SFVS) dietary data by geographical area (Mean values and 95% confidence intervals)

Name of region or GOR	Proportion (%) of children who consumed fruit or vegetables at least five times per d*	Proportion (%) of children who consumed fruit or vegetables at least five times per d†	Daily frequency of fruit and vegetables consumed*		Daily frequency of fruit and vegetables consumed†	
			Mean	95% CI	Mean	95% CI
<b>Regions</b>						
Northern England	54.1	42.3	5.1	4.9, 5.3	4.3	4.1, 4.5
The Midlands	55.0	46.4	5.2	4.9, 5.4	4.6	4.4, 4.9
Southern England	65.1	55.0	5.7	5.6, 5.9	5.0	4.9, 5.2
<b>GOR</b>						
East Midlands	58.3	49.4	5.4	5.1, 5.8	4.8	4.5, 5.1
East of England	61.9	56.3	5.6	5.3, 6.0	5.2	4.9, 5.5
London	53.6	45.7	5.4	4.9, 5.9	4.6	4.1, 5.0
North East	35.0	23.8	4.2	3.8, 4.5	3.4	3.0, 3.7
North West	55.4	45.8	5.2	4.9, 5.4	4.4	4.2, 4.7
South East	73.1	60.8	6.0	5.8, 6.3	5.3	5.0, 5.5
South West	64.4	51.8	5.7	5.4, 5.9	4.8	4.6, 5.1
West Midlands	50.9	42.7	4.9	4.5, 5.2	4.4	4.1, 4.7
Yorkshire and The Humber	63.3	47.3	5.5	5.2, 5.8	4.7	4.3, 5.0

GOR, Government Office Region.

\* Including fruit and vegetables from the SFVS.

† Excluding fruit and vegetables from the SFVS.