2011-10-18

Beverage consumption and BMI of British schoolchildren aged 9-13 years

Tara Coppinger
Department of Sport, Leisure & Childhood Studies, Cork Institute of Technology, Cork, Ireland, Tara.Coppinger@cit.ie

Y. M. Jeanes
University of Roehampton

M. Mitchell
University of Roehampton

S. Reeves
University of Roehampton

Recommended Citation

Coppinger, T. et al., 2011. Beverage consumption and BMI of British schoolchildren aged 9–13 years. Public Health Nutrition, 16(7), pp.1244–1249. Available at: http://dx.doi.org/10.1017/S1368980011002795.

Public Health Nutrition: 16(7), 1244–1249 doi:10.1017/S1368980011002795

Beverage consumption and BMI of British schoolchildren aged 9–13 years

Tara Coppinger[1,*], YM Jeanes[2], M Mitchell[2] and S Reeves[2]
[1]Cork Institute of Technology, Rossa Avenue, Bishopstown, Cork, Ireland: [2]School of Human and Life Sciences, Roehampton University, London, UK

Submitted 26 May 2011: Accepted 19 September 2011: First published online 18 October 2011

Abstract

Objective: Adequate fluid intake has been well documented as important for health but whether it has adverse effects on overall energy and sugar intakes remains under debate. Many dietary studies continue to refrain from reporting on beverage consumption, which the present study aimed to address.
Design: A cross-sectional survey investigated self-reported measures of dietary intake and anthropometric measurements.
Setting: Primary and secondary schools in south-west London, UK.
Subjects: Boys and girls (*n* 248) aged 9–13 years.
Results: Boys consumed 10 % and girls consumed 9 % of their daily energy intake from beverages and most children had total sugar intakes greater than recommended. Beverages contributed between a quarter and a third of all sugars consumed, with boys aged 11–13 years consuming 32 % of their total sugar from beverages. There was a strong relationship between consumption of beverages and energy intake; however, there was no relationship between beverage type and either BMI or BMI *Z*-score. Fruit juices and smoothies were consumed most frequently by all girls and 9–10-year-old boys; boys aged 11–13 years preferred soft drinks and consumed more of their daily energy from soft drinks. Milk and plain water as beverages were less popular.
Conclusions: Although current health promotion campaigns in schools merit the attention being given to improving hydration and reducing soft drinks consumption, it may be also important to educate children on the energy and sugar contents of all beverages. These include soft drinks, as well as fruit juices and smoothies, which are both popular and consumed regularly.

Keywords
Beverages
Soft drinks
Fruit juice
Children

In the USA up to 21 % of daily energy intake typically comes from beverages[1]. In the UK, figures closer to 10 % of daily energy intake have been reported by the National Diet and Nutrition Survey 2002[2]. Research has suggested that the energy and carbohydrate contents of liquids are not compensated for in the same way as solids, making beverages less satiating and perhaps making it easier to overconsume energy when in this form[3–5]. Consequently there are studies[6,7] showing that beverages, in particular beverages of the sugar-sweetened variety, can affect body weight and BMI and have a negative impact on weight gain and obesity. Recent work[8] reports that soft drinks can contribute to weight gain and may also increase risk of CVD and diabetes by adding to a high dietary glycaemic load, resulting in inflammation and insulin resistance. Several authors in the USA have also reported increases in soft drinks consumption and sugar intakes over time[9,10]. In the UK[11] a dietary survey of 11–12-year-old Northumbrian children revealed that there had been little change in the total consumption of non-milk extrinsic sugars (NMES) over the previous two decades, but noted that the source of the NMES had changed; NMES from soft drinks had doubled from 15 to 31 g/d. Similarly, Gibson[12] presented data showing trends in energy and sugar intakes and BMI in children in the UK between 1983 and 1997. The data showed the increasing amounts of soft drinks consumed; so much so that they were the biggest contributor to sugar in the diet. Although total sugar intakes were reported to have remained similar, there was a notable shift away from table sugar, counteracted by an increase in sugar from soft drinks. During the same time frame, BMI increased by between 0·7 and 1 kg/m^2. However, the paper does not directly link the increase in BMI to the increase in soft drinks consumption and even suggests that under-reporting and lower levels of physical activity may explain lower energy intakes and the rising BMI for the 1997 data.

Despite the studies that have reported associations between increased soft drinks consumption and weight

*Corresponding author: Email tara.coppinger@cit.ie

gain and/or obesity in adults, this finding has not been consistent. A systematic review by Gibson[13] revealed that only half of all prospective and cross-sectional studies found significant associations between sugar-sweetened soft drinks and BMI. Gibson also noted that many of the studies were American based, where beverages have been found to contribute greater amounts to daily energy intake[1] compared with the UK[2]. Furthermore, these studies did not monitor other diet and lifestyle factors that could influence BMI. Results in children have also been less than clear and sometimes conflicting. Ludwig *et al.*[9] reported that consumption of sugar-sweetened drinks was associated with obesity in American children aged 11·7 years, whereas a British study[14] found no association between sugar-sweetened beverage consumption at ages 5 and 7 years and fatness at age 9 years. Fruit juice consumption has also been linked to adiposity gain in overweight children and reducing fruit juice consumption has been suggested as a good strategy for preventing weight gain[15], although this research focused on children from low-income families in America who were already overweight. In another American study, O'Connor *et al.*[16] focused on the relationship between beverage intake and weight status among pre-school children and found a correlation between the consumption of soft drinks and total energy intake, but this was not reflected in the BMI of the children. It is important to note, however, that the children in that study were very young and the role of beverages on obesity needs clarification.

In light of the conflicting research, and the fact we cannot extrapolate US findings to the UK given the differences in the amount of energy that beverages contribute to overall energy intake, the present study aimed to report on the relationship between beverage consumption and BMI of British schoolchildren.

Methods

The data presented were part of a longitudinal survey[17] approved by Roehampton University's Ethics Committee. Berkey *et al.*'s[18] longitudinal research was used to calculate the power for subject numbers, resulting in a minimum of 100 volunteers in each group being required. Four hundred and three children (216 boys and 187 girls; mean age 11·4 (SD 1·1) years) attending three primary schools and six secondary schools in mid to high socio-economic areas, in south-west London, were recruited. For the purpose of analysis, exclusions were made on the grounds of missing data in the food and beverage diaries, absenteeism and faulty physical activity apparatus (linked to the longitudinal survey). As a result, 248 (124 boys, 124 girls) children completed all aspects of the study. In order to cope with time constraints and the difficulties of tracking children (the present study formed part of a longitudinal survey) from a dispersed geographical area, schools were selected via a one-stage cluster sampling method to ensure a representative sample. The predetermined clusters included: (i) type of school; (ii) school geographical location; (iii) gender make-up of the school; and (iv) secondary school feeding system.

Participants were grouped according to age and gender: 9–10-year-old boys (*n* 29, mean age 9·93 (SD 0·25) years), 11–13-year-old boys (*n* 95, mean age 12·11 (SD 0·79) years), 9–10-year-old girls (*n* 41, mean age 9·88 (SD 0·33) years) and 11–13-year-old girls (*n* 83, mean age 11·63 (SD 0·63) years). All data were collected by trained researchers and permission was granted from the head teacher of each participating school. Child informed consent and parental consent were also obtained prior to study participation.

Dietary intake

Food and beverage intake was measured with a 3 d diary (Friday–Sunday), a method considered to be a valid nutritional tool to measure dietary intake in 9- to 13-year-olds[19]. Both weekday and weekend days were chosen in order to limit interference with the school day and to recognise research undertaken elsewhere highlighting greater variation in food intake over the weekend compared with weekdays[20]. All food, beverages and portion sizes were recorded and diary prompts were used in order to facilitate accurate reporting, e.g. 'Did you have breakfast today?', 'If yes, what did you eat/drink?' and 'How much did you eat/drink?' Beverages were labelled during analysis as follows: (i) fruit juices and smoothies; (ii) milk and milk-based beverages; (iii) plain water; (iv) soft drinks; and (v) low-calorie soft drinks. Soft drinks included all carbonated beverages, sports drinks and cordials. In order to assess under-reporting, photographs and a validated Fruit and Vegetables Screening Measure for Adolescents[21] were used and statistically compared with the food diaries to ensure consistency of data.

The Department of Health[22] recommends that NMES should not exceed 10 % of energy. In order to include sugar from all beverages, data from the present study were presented as total sugars, not NMES. For comparative and labelling purposes, the Institute of Grocery Distributers and the Food and Drink Federation have suggested a guideline daily amount (GDA) of 90 g total sugars/d[23,24].

Height and weight

The Leicester (Crawlea Medical, Birmingham, UK) free-standing stadiometer and Omron M5-1 Intellisense (Kyoto, Japan) weighing scales were used to calculate BMI (kg/m^2) from height and weight measurements taken to the nearest 0·1 cm and 0·1 kg, respectively. While BMI is a useful tool to indicate weight status in adults, it is not always appropriate in growing children. Therefore, in children, BMI is often adjusted for age and gender and compared with growth chart percentiles; this adjustment being known as a *Z*-score[25]. BMI *Z*-scores allow for direct comparisons of BMI in young people worldwide[26] and are well established as a basis for diagnosing obesity in children and appropriate for research, public health and clinical practice[27]. BMI *Z*-scores were calculated using equations based on UK reference data[28] and Pan and Cole's[29] Microsoft® Excel add-in 'ImsGrowth' package. The scores represent graded levels of thinness (−2 to −1), normal weight (0), overweight (1) and obesity (2) of children and are linked to the adult cut-off points[30]. All anthropometric measurements for the cross-sectional aspects of study, presented here, were made at the start of the study.

Data analysis

Food and beverage diaries were analysed using Dietplan 6 (Forestfield Software, Horsham, UK) and all eating and drinking episodes were entered into an eating frequency chart created in Excel 1997 (Microsoft Corporation, Redmond, WA, USA). All diary analyses were then exported from Dietplan 6 into the SPSS statistical software package version 17·0 (SPSS Inc., Chicago, IL, USA). Data were expressed as mean and standard deviation. The one-way Kolmogorov–Smirnov test with $\alpha = 0{\cdot}05$ was used to assess the normality of the data. Differences were investigated between the age and gender groups using ANOVA and Pearson's correlations were used to examine bivariate relationships between the beverages consumed, energy and sugar intakes and BMI.

Results

Boys consumed 7071 (SD 1987) kJ/d and had greater total energy intakes than girls (6473 (SD 1912) kJ/d; $t(246) = 2{\cdot}49$, $P = <0{\cdot}01$), with 9–10-year-old boys (7360 (SD 1749) kJ/d) having the highest intakes and 11–13-year-old girls having the lowest intakes per day (6314 (SD 1770) kJ/d; $t(110) = 2{\cdot}74$, $P = <0{\cdot}01$; Table 1). All age groups fell below the Estimated Average Requirement (EAR) for energy, with 11–13-year-olds being the most likely to be below the EAR. Boys and girls aged 9–10 years consumed 90 % and 96 % of the EAR, respectively, whereas 11–13-year-old boys and girls had total intakes of 76 % and 78 % of the EAR. In order to adjust for under-reporting of energy and micronutrient intakes (energy expenditure/energy intake), the mean values were compared with those found in the most recent National Diet and Nutrition Survey for 7–14-year-olds[31]. The mean micronutrient (or energy) intakes were then multiplied by 1·25; the value derived from data on energy intake/energy expenditure from a study by Smithers *et al.*[32] and recorded in the paper by Livingstone *et al.*[33]. Following the adjustments, only daily energy intakes for girls (8091 kJ/d) were equivalent to, or exceeded, the EAR[22].

Although it was clear from the data that some children were drinking very little, both boys and girls had adequate hydration when comparing intakes with those recommended for their age[34–36]. On average, boys consumed 10 % (690 kJ) and girls consumed 9 % (586 kJ) of their daily energy intake from beverages but no differences were found between gender or age groups (Table 1). From the BMI *Z*-scores, 77 % of the participants were classified as normal weight, 6 % were underweight, 13 % were overweight and 4 % obese. When the data were organised by BMI *Z*-score, there was no significant difference in the mean energy obtained from beverages between the different BMI classifications. However, there were relatively low numbers of children in the underweight and overweight and obese categories.

All groups in this survey had total sugars intake above the GDA of 90 g/d[23,24]. Beverages contributed between a quarter and a third of all sugars consumed (23 % in boys aged 9–10 years, 32 % in boys aged 9–11 years, 25 % in girls aged 9–10 years and 27 % in girls aged 11–13 years), with boys aged 9–10 years consuming the most sugar in total and boys aged 9–11 years the most sugar from beverages (Table 2). A strong positive correlation was evident between daily carbohydrate intake and daily carbohydrate intake from beverages ($r = 0{\cdot}56$; $P \leq 0{\cdot}01$) and a further strong relationship was revealed between daily energy intake from beverages and daily total sugars intake ($r = 0{\cdot}51$; $P = 0{\cdot}001$). The relationships between the amount of the different beverages consumed and both energy intake and BMI were investigated; there was a significant correlation between total energy intake and sugar from beverages ($r = 0{\cdot}56$; $P < 0{\cdot}01$). Positive relationships also existed between total energy intake and the different beverage types; fruit juices and smoothies ($r = 0{\cdot}5$; $P < 0{\cdot}01$), milk and milk-based beverages ($r = 0{\cdot}13$, $P < 0{\cdot}05$), soft drinks ($r = 0{\cdot}39$, $P < 0{\cdot}01$) and low-calorie soft drinks ($r = 0{\cdot}12$, $P < 0{\cdot}05$). However, there were no significant correlations between BMI and the different beverages ($r = 0{\cdot}10$, 0·03, 0·05 and 0·03 for fruit beverages, milk, soft drinks and low-calorie soft drinks, respectively, $P > 0{\cdot}05$). Yet consideration should be given to the large

Table 1 Mean BMI, BMI *Z*-score and daily intakes of energy and energy from beverages by gender: boys and girls aged 9–13 years, south-west London, UK

	BMI (kg/m^2)		BMI *Z*-score		Energy (kJ/d)		Energy from beverages (kJ/d)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Boys (*n* 124)	18·8	2·8	0·33	0·97	7071	1987	690	510
Girls (*n* 124)	18·7	3·6	0·09	1·18	6473	1912	586	343
All participants (*n* 248)	18·7	3·1	0·21	1·10	6774	1912	634	444

Table 2 Mean daily intakes of total sugars and sugar from beverages, and type and quantity of beverages consumed daily, by age group and gender: boys and girls aged 9–13 years, south-west London, UK

	Total sugars (g/d)		Sugar from beverages (g/d)		Plain water (ml/d)		Milk-based beverages (ml/d)		Fruit juices & smoothies (ml/d)		Soft drinks (ml/d)		Low-calorie soft drinks (ml/d)	
Age and gender	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
9–10 years, boys (*n* 29)	152·5	61	34·6	14·2	69	78	57	0·14	333	0·16	195	0·26	69	0·16
11–13 years, boys (*n* 95)	110·2	76	35·4	29·0	66	79	94	0·13	219	0·25	297	0·29	235	0·26
9–10 years, girls (*n* 41)	128·5	67	32·6	19·4	75	96	89	0·13	297	0·29	179	0·24	42	0·12
11–13 years, girls (*n* 83)	101·0	58	27·4	20·4	75	76	75	0·13	235	0·26	143	0·20	69	0·11

standard deviations evident for plain water intake, suggesting that some children refrained from drinking plain water altogether, which may possibly have influenced the findings.

Fruit juices and smoothies were the most popular beverage consumed by girls of all ages and 9–10-year-old boys, while soft drinks were the most popular beverage consumed by 11–13-year-old boys. Boys aged 11–13 years consumed significantly ($P < 0·05$) more soft drinks (297 (SD 0·29) ml/d) than girls and 9–10-year-boys.

Discussion

The present study examined the beverage intake and BMI of a group of 9–13-year-olds from south-west London, UK. Boys were found to obtain more of their energy from beverages and were consuming greater amounts of sugar and drinking more soft drinks than girls. Boys aged 9–10 years were drinking the greatest amounts of fruit juice and smoothies, with more than half of their beverages in this form. It was also evident that some children drank very little and completely refrained from drinking plain water. Our data did suggest that there was a positive relationship between beverages and energy intake and beverages and sugar intakes, but that there was no relationship of beverage consumption and choice of beverage on BMI.

Milk drinks were the least popular beverages reported in the present study and there was no correlation between milk consumed and BMI. Interestingly, some authors have suggested that milk could even have a protective effect against fatness in children when adjusted for confounders such as age, height, socio-economic status and parental BMI, but note that this association was found only in a small sample[14].

High sugar intakes have sometimes been linked to lower micronutrient and fruit and vegetable intakes[37] and all types of sugar-sweetened beverages pose a risk of dental caries if consumed frequently and outside meal times[38]. The popularity of fruit juice and smoothies in all girls and younger boys in our study makes them a substantial contributor in terms of total sugar intakes. According to authors such as Faith *et al.*[15], this may be placing these youngsters at risk of adiposity gain but this needs be viewed in the context of total energy intakes also. Grimm *et al.*[39] report that taste preferences, soft drinks consumption habits of parents and friends, soft drinks availability in the home and school, and television viewing all play an influential role in the beverage intake of American 8–13-year-olds. Applying these findings to UK youth, while also reporting on why British youth select different beverages over others, warrants further research. The finding that some children refrain completely from drinking plain water also needs investigating to ensure this is genuine and not methodological error associated with the use of a food and beverage diary.

Current health promotion campaigns in schools merit the attention being given to reduce soft drinks consumption[40] and allow all children access to free, clean and palatable drinking water to encourage hydration[41]. The School Food Trust[42] has also created a voluntary code of practice for drinks provided in schools that encourages the provision of healthier drinks that are free from additives and are unsweetened, thus allowing all fruit juices and smoothies. Although fruit juices and smoothies can provide one of the five daily fruit and vegetables, the present study suggests that it may also be important to educate children, parents, teachers and catering staff on the energy and sugar contents of these drinks. Offering plain water and whole fruit as an alternative may be beneficial, since this approach is reported to facilitate a reduction in both sugar intake[43] and weight gain[40] in children. However, in order for such a strategy to be successful, more comprehensive action from parents and schools is required[44].

Our data were collected from schools in south-west London, which may not be typical of all British children. Yet our study failed to show a direct relationship between beverage consumption and BMI, and this was similar to the findings of Gibson and Neate[45], who could not show a consistent role for sugar and caloric soft drinks on obesity in British children in their analysis of the UK National Dietary and Nutrition Survey of Young People. Instead, they highlighted a more general role in overeating and possible inactivity. The role of physical activity is an important consideration since it is possible that those who were more active experienced greater thirst and consumed more and/or specific beverages. Analysis of the physical activity data, which we collected as part of a similar study[46], however, found no correlation between steps per day and beverage intake.

The study was a cross-sectional design and the observational findings do not allow us to evaluate whether beverages have a possible direct or causal relationship with BMI over time. The data were also self-reported and although measures were put in place to identify and correct for under-reporting, it is possible that not all beverages consumed were recorded; under-reporting of beverage consumption in children has not been extensively studied[47]. Furthermore, there was a large dropout rate in the study due to incomplete data and absenteeism; since it was not possible to find statistical differences between those participants who completed the study and those who did not, it is likely that there were motivational differences which could also have been a limitation of the study.

To conclude, it was clear from our study that despite the low amounts of beverages consumed in comparison to US data, they still made an important contribution to sugar and energy intakes of young people. There was, however, no association of beverage consumption and choice of beverage with BMI or BMI *Z*-score. Future health promotion campaigns should educate parents and children about the contribution that beverages make to energy and sugar intakes, in the context of a healthy balanced diet.

Acknowledgements

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors. The authors report no conflict of interest. T.C. collected the data and wrote the manuscript. M.M. analysed the data and Y.M.J. and S.R. contributes to the writing of the manuscript.

References

1. Popkin BM, Armstrong LE, Bray GM *et al.* (2006) A new proposed guidance system for beverage consumption in the United States. *Am J Clin Nutr* **83**, 529–542.
2. Henderson L, Gregory J, Irvine K *et al.* (2002) *The National Diet and Nutrition Survey: Adults Aged 19–64 Years: Summary Report*. London: The Stationery Office.
3. Mattes RD (1996) Dietary compensation by humans for supplemental energy provided as ethanol or carbohydrate in fluids. *Physiol Behav* **59**, 179–187.
4. Demeglio DP & Mattes RD (2000) Liquid versus solid carbohydrate: effects on food intake and body weight. *Int J Obes Relat Metab Disord* **24**, 794–800.
5. Benelam B (2009) Satiation, satiety and their effects on eating behaviour. *Nutr Bull* **34**, 127–174.
6. Nissinen K, Mikkilä V, Männistö S *et al.* (2009) Sweets and sugar-sweetened soft beverage intake in childhood in relation to adult BMI and overweight. The Cardiovascular Risk in Young Finns Study. *Public Health Nutr* **12**, 2018–2026.
7. Vanselow MS, Pereira MA, Neumark-Sztainer D *et al.* (2009) Adolescent beverage habits and changes in weight over time: findings from Project EAT. *Am J Clin Nutr* **90**, 1489–1495.
8. Malik VS, Popkin BM, Bray GA *et al.* (2010) Sugar sweetened beverages, obesity, type 2 diabetes mellitus and cardiovascular disease risk. *Circulation* **121**, e1356–e1364.
9. Ludwig DS, Peterson KE & Gortmaker SL (2001) Relation between consumption of sugar-sweetened drinks and childhood obesity: a prospective, observational analysis. *Lancet* **357**, 505–508.
10. Malik VS, Schulze MB & Hu FB (2006) Intake of sugar-sweetened beverages and weight gain: a systematic review. *Am J Clin Nutr* **84**, 274–288.
11. Rugg-Gunn AJ, Fletcher ES, Matthews JNS *et al.* (2007) Changes in consumption of sugars by English adolescents over 20 years. *Public Health Nutr* **10**, 354–363.
12. Gibson S (2010) Trends in energy and sugar intakes and body mass index between 1983 and 1997 among children in Great Britain. *J Hum Nutr Diet* **23**, 371–381.
13. Gibson S (2008) Sugar sweetened soft drinks and obesity: a systematic review of the evidence from observational studies and interventions. *Nutr Res Rev* **21**, 134–147.
14. Johnson L, Mander AP, Jones LR *et al.* (2007) Is sugar-sweetened beverage consumption associated with increased fatness in children? *Nutrition* **23**, 557–563.
15. Faith M, Dennison B, Edmunds L *et al.* (2006) Fruit juice predicts increased adiposity gain in children from low-income families: weight status by environment interaction. *Pediatrics* **118**, 2066–2075.
16. O'Connor T, Yang SJ & Nicklas TA (2006) Beverage intake among pre-school children and its effect on weight status. *Pediatrics* **118**, e1010–e1018.
17. Coppinger T, Jeanes Y, Dabinett J *et al.* (2010) Physical activity and dietary intake of children aged 9–11 years and the influence of peers on these behaviours: a one-year follow-up. *Eur J Clin Nutr* **64**, 776–781.
18. Berkey C, Rockett H, Field A *et al.* (2000) Activity, dietary intake, and weight changes in a longitudinal study of preadolescent and adolescent boys and girls. *Pediatrics* **105**, e56; available at http://pediatrics.aappublications.org/cgi/content/abstract/105/4/e56
19. Rockett H & Colditz G (1997) Assessing diets of children and adolescents. *Am J Clin Nutr* **65**, 1116–1122.
20. De Castro J (1991) Weekly rhythms of spontaneous nutrient intake and meal pattern of humans. *Physiol Behav* **50**, 729–738.
21. Prochaska J & Sallis J (2004) Reliability and validity of a fruit and vegetable screening measure for adolescents. *J Adolesc Health* **34**, 163–165.
22. Department of Health (1991) *Dietary Reference Values for Food Energy and Nutrients for the United Kingdom*. London: The Stationery Office.
23. Institute of Grocery Distributers (2011) GDA's for children. http://www.igd.com/index.asp?id=1&fid=5&sid=42&tid=62&cid=447 (accessed April 2011).
24. Food and Drink Federation (2011) GDA labelling. Five key nutrients: Calories, Sugar, Fat, Saturated Fat and Salt. http://www.gdalabel.org.uk/gda/gdalabel/nutrients.aspx (accessed April 2011).
25. Must A & Anderson SE (2006) Body mass index in children and adolescents: considerations for population-based applications. *Int J Obes (Lond)* **30**, 590–594.
26. Cole T, Flegal K, Nicholls D *et al.* (2007) Body mass index cut offs to define thinness in children and adolescents: international survey. *Br Med J* **335**, 7612.
27. Reilly JJ (2006) Diagnostic accuracy of the BMI for age in paediatrics. *Int J Obes (Lond)* **30**, 590–594.
28. Cole T, Freeman J & Preece M (1995) Body mass index reference curves for the UK, 1990. *Arch Dis Child* **73**, 25–29.
29. Pan H, Cole T 2007. ImsGrowth, a Microsoft Excel add-in to access growth references based on the LMS method. Version 2.2. http://homepage.mac.com/tjcole/FileSharing1.html
30. Cole T, Bellizzi M, Flegal K *et al.* (2000) Establishing a standard definition for child overweight and obesity worldwide: international survey. *Br Med J* **320**, 1240–1243.

31. Gregory J & Lowe S (2000) *National Diet and Nutrition Survey: Young People Aged 4 to 18 Years*. London: The Stationery Office.
32. Smithers G, Gregory J, Coward W *et al.* (1998) British National Diet and Nutrition Survey of young people aged 4–18 years: feasibility study of the dietary assessment method. *Eur J Clin Nutr* **52**, Suppl. 2, S76.
33. Livingstone M, Robson P & Wallace J (2004) Issues in dietary intake assessment of children and adolescents. *Br J Nutr* **92**, 213–222.
34. European Food Safety Authority (2008) Scientific opinion on dietary reference values for water. *EFSA Journal* **8**, 1459.
35. World Health Organization (2003) *Diet, Nutrition and the Prevention of Chronic Diseases. Joint WHO/FAO Expert Consultation. WHO Technical Report Series* no. 916: Geneva: WHO.
36. World Health Organization (2005) *Nutrients in Drinking Water*. WHO: Geneva.
37. Øverby NC, Lillegaard IT, Johansson L *et al.* (2004) High intake of added sugar among Norwegian children and adolescents. *Public Health Nutr* **7**, 285–293.
38. Levine RS, Nugent ZJ, Rudolf MC *et al.* (2007) Dietary patterns, tooth-brushing habits and caries experience of schoolchildren in West Yorkshire, England. *Community Dent Health* **24**, 82–87.
39. Grimm G, Harnack L & Story M (2004) Factors associated with soft beverage consumption in school-aged children. *J Am Diet Assoc* **104**, 1244–1249.
40. Department of Health (2007) Healthier vending machines. http://www.dh.gov.uk/en/Publichealth/Healthimprovement/Foodinschoolsprogramme/Foodinschoolsgeneralinformation/DH_4080834 (accessed April 2011).
41. Department of Health (2009) Healthy schools. http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_094400 (accessed April 2011).
42. School Food Trust (2011) Preliminary Review of Early Years Food, Nutrition and Healthy Eating Guidance in England: A Summary. http://www.schoolfoodtrust.org.uk/download/documents/pdf/sft_early_years_preliminary_review_summary.pdf (accessed April 2011).
43. Epstein E, Gordy C, Raynor H *et al.* (2001) Increasing fruit and vegetable intake and decreasing fat and sugar intake in families at risk for childhood obesity. *Obes Res* **9**, 171–178.
44. Hawkes C (2010) The worldwide battle against soft beverages in schools. *Am J Prev Med* **38**, 457–461.
45. Gibson S & Neate D (2007) Sugar intake, soft beverage consumption and body weight among British children: further analysis of National Diet and Nutrition Survey data with adjustment for under-reporting and physical activity. *Int J Food Sci Nutr* **58**, 445–460.
46. Finnerty T, Reeves S, Dabinett J *et al.* (2010) Effects of peer influence on dietary intake and physical activity in schoolchildren. *Public Health Nutr* **13**, 376–383.
47. Wang YC, Bleich SN & Gortmaker SL (2008) Increasing caloric contribution from sugar-sweetened beverages and 100 % fruit juices among US children and adolescents, 1988–2004. *Pediatrics* **121**, e1604.