Abstract

Aims: Although previous research has shown the Food Dudes programme increases children's lunchtime fruit and vegetable consumption, research has seldom evaluated whether the intervention can decrease the consumption of high fat and sugar foods. This study is the first, independent evaluation of the Food Dudes programme to explore whether the programme could change children's lunchtime fruit and vegetable consumption and consumption of high fat and sugar foods following the intervention and explore any relationship between these variables.

Methods: The Food Dudes programme was evaluated in 15 primary schools in the West Midlands UK (n=2,433) at baseline (pre intervention), 3 months and 12 months post intervention. Consumption was measured across five consecutive days in each school using weighed intake (school provided meals) and digital photography (home provided meals).

Results: A significant increase in the consumption of lunchtime fruit and vegetables was found at 3 months for children in the intervention schools, but only for those eating school-supplied lunches. For children consuming school meals, consumption of high fat and sugar foods for children in the intervention and control schools increased over time. No relationship was found between increases in fruit and vegetable consumption and decreased in consumption of high fat and sugar foods following the Food Dudes intervention.

Conclusions: The Food Dudes programme has a limited effect on decreasing consumption of high fat and sugar foods at lunchtime. Targeting unhealthy food consumption in addition to increasing fruit and vegetables may facilitate this. Restricted access to high fat and sugar foods may also reduce intake however this needs to be part of a multi-faceted approach to changing children's dietary patterns involving the whole school community.

Introduction

There is now a substantial body of epidemiological evidence that suggests an association between increased fruit and vegetable consumption and reduced risk of chronic diseases such as cardiovascular disease, stroke and some forms of adult cancer [1, 2]. However, despite the positive health outcomes associated with consuming fruit and vegetables and recommendations that children over five years of age should consume five portions of fruit and vegetables per day, most children in the UK and other Western countries fail to meet recommended levels of intake [3,4].

In response to this, interventions to increase fruit and vegetable consumption have been implemented in a variety of settings, predominantly within the school environment. One intervention that has been suggested to be effective in increasing children's fruit and vegetable consumption is the Food Dudes programme [5], a school-based behaviour change intervention targeted at primary school children. The programme is based upon repeated tasting, role modelling and rewards, psychological principles shown to reliably impact upon consumption [5, 6]. Research has indicated that the Food Dudes programme does produce increases in children's fruit and vegetable consumption [7-9] however there is limited evidence that the programme decreases the consumption of unhealthy foods. Further exploration of this relationship is therefore essential. It is unlikely that the positive health outcomes associated with eating more fruit and vegetables such as weight loss will be achieved if this is not accompanied by a decrease in the intake of foods high in fat and sugar. As Tak and colleagues note [10], interventions that can change consumption of unhealthy foods to healthier foods (such as fruit and vegetables) may contribute to the treatment of childhood obesity by reducing calorific intake. Indeed, there is no evidence to suggest that targeting fruit and vegetable consumption alone reduces adiposity [11]. Further research which examines other aspects of children's diet, such as unhealthy food consumption is therefore required

Relationship between increased fruit and vegetable consumption and high fat and sugar intake

Although little is known about whether interventions targeting fruit and vegetable consumption also produce changes in consumption of unhealthy foods, research has shown that restricting access to high fat and sugar foods provides a useful strategy for increasing fruit and vegetable consumption [12-14].

Interventions that provide free school fruit have also been shown to be effective in reducing the frequency of high fat and sugar foods consumed [15]. However, studies evaluating the impact of healthy eating interventions on high fat and sugar consumption are, to some extent, limited. Research has mostly been conducted outside of the UK and focused on the restriction of high fat and sugar foods.

The current study

This study formed part of a large scale, independent evaluation of the Food Dudes programme [16] which examined the effectiveness of the programme in increasing primary school children's fruit and vegetable consumption. The present study aimed to explore whether a school-based intervention that promotes fruit and vegetable consumption can reduce children's consumption of high fat and sugar foods. Existing studies evaluating the impact on unhealthy food consumption have only been conducted on a small scale [17] or focused only on changes in break-time behaviour [18]. Therefore, there is a need to explore this relationship further, particularly with regard to lunchtime consumption as children are typically presented with a wider variety of unhealthy foods than at break-time. This may be particularly relevant for children who consume home provided lunches as these are not regulated to the same extent at school provided meals. Whilst schools may provide guidelines as to what constitutes a healthy lunchbox, the nutritional content of packed lunches remains far lower than that of school-supplied meals [19], containing only half the recommended amount of fruit and vegetables [20]. In contrast, the food-based and nutrient-based standards [21] regulate the number of snacks that can be provided during lunchtime and so the potential for interventions such as the Food Dudes programme to bring about changes in consumption of high fat and sugar foods may be more pronounced for these children. It is therefore important that the potential for the Food Dudes programme to decrease consumption of high fat and sugar foods for all children, including those who eat school or home provided meals, is explored.

The aim of this study was therefore to explore the impact of the Food Dudes intervention on the following:

- The lunchtime consumption of fruit and vegetables by children eating either school or home provided meals.
- The lunchtime consumption of high fat and sugar foods by children eating either school or home provided meals.

Methods

Design

Two groups of children participated in the study; one receiving the Food Dudes intervention and a matched control group who did not receive the intervention. Children's lunchtime fruit and vegetable consumption and consumption of high fat and sugar foods was assessed at baseline (pre intervention), 3 and 12 months post intervention.

Participants

The programme was evaluated in 15 primary schools in the West Midlands, predominantly in areas of high deprivation as indicated by the proportion of children eligible for free school meals (FSM), 24.7% were eligible for FSM, above the national average of 18.1% [22]. Participants were 2,433 children aged between 4-11 years, 1,282 in the intervention schools (690 boys and 592 girls) and 1,151 in the control schools (596 boys and 555 girls). Intervention schools were selected by the local health authority and control schools matched as far as possible in terms of: school size, proportion of children entitled to free school meals (a proxy measure of deprivation) and proportion of children from ethnic minorities. Characteristics of the study sample are shown in Table 1.

>>Insert Table 1<<

Description of the Food Dudes programme

The Food Dudes programme is a school-based intervention developed by the Bangor Food and Research Activity Unit (BFARU) and supported by a number of sponsors including Higher Education Institutions, Research Councils, Industry representatives, Local Authorities and Retail companies [23]. The programme consists of an initial 16 day intervention phase (phase one) and a maintenance phase (phase two), implemented by class teachers with the support of a Food Dudes School Coordinator. Each day during phase one, either before break-time or lunchtime, children watch a DVD episode featuring the adventures of the Food Dudes: Raz, Tom, Charlie and Rocco, four super-heroes who gain special powers

by eating their favourite fruit and vegetables that help them maintain the life force in their quest to defeat General Junk and the Junk Punks. The Dudes encourage children to 'keep the life force strong' by eating fruit and vegetable every day. Class teachers also a read letter to the children from the Food Dudes each day during the intervention phase to reinforce the DVD messages. On each day of the intervention phase, children are given rewards for either tasting or consuming both the target fruit and vegetables (one fruit and one vegetable each day). Children are also provided with a Food Dudes home pack containing information and tips for parents on healthy eating to encourage children to eat fruit and vegetables at home as well as school [24]. Following the intervention, a maintenance phase of up to one year is implemented during which fruit and vegetable consumption is encouraged, but with less intensity than the intervention phase. Classroom wall charts are used to record consumption of fruit and vegetables and children are rewarded with further Food Dudes prizes and certificates. This phase of the programme aims to enable the school to develop a self-sustaining approach to rewarding fruit and vegetable consumption and a culture of healthy eating [25]. A full description of the Food Dudes programme has been provided elsewhere [9].

Procedure

The procedure, described below, was implemented at each time point and measures were recorded across five consecutive days in each school. As the study employed an ecological design, no changes were implemented to school practices which could impact upon the everyday experience and choices of children, i.e. school lunchtime menus remained as prescribed by the Local Education Authority. However, food standards developed by the School Food Trust [21] require that at least one portion of fruit and one portion of vegetables or salad must be provided per pupil per day thus ensuring consistency in fruit and vegetable provision, both between menus and schools across the UK.

School provided lunches

Consumption at lunchtime for children having school provided lunches was assessed using the weighed intake method, the gold standard method for measuring dietary intake [26]. Prior to lunchtime, each child was given a label with their ID number, name and class. Due to the short time frame of lunchtime service, mean portion size of all fruit, vegetable and high fat and sugar foods available on the menu were taken

and five weights of each food recorded to obtain a mean weight. Size of serving information for all menus was also provided by the local authority school meals service. At the beginning of the lunchtime period, children's food choices were recorded on a spreadsheet and, once the children had finished their meal, the weight of any food waste for each child was recorded. The weighing area was adjacent to the rubbish bin and the return of trays monitored by the research team to ensure that children did not throw away any uneaten food. Salter digital scales were used accurate to 1 gram and were calibrated prior to use according to published guidelines [27]. The amount of fruit, vegetables or high fat and sugar foods consumed was calculated by subtracting the leftover weight from the average portion weight recorded.

Home provided lunches

At the start of the day, lunchboxes were labelled with the child's ID number, name and class and a digital photograph taken of lunchbox contents. Following lunchtime, lunchboxes were collected from each class and a photograph taken of any leftovers. Children were instructed by lunchtime staff to leave any uneaten food or wrappers in their lunchboxes. All rubbish bins were located away from tables to ensure that the children did not throw any food items away and also enabling close monitoring of food disposal by the research team. The number of portions of fruit, vegetables and high fat and sugar foods consumed was visually estimated on a five point likert scale (0, ¼, ½, ¾, 1) using guidelines previously validated [27]. Inter-rater reliability analysis was performed using correlation to determine consistency among raters. Agreement was calculated for 25% (n=80) of the study sample at baseline and was found to be excellent (r (78) = .98, p<0.01.)

Definitions of portion size

In line with guidelines developed by the Health Promotion Agency [29], a child's portion of fruit or vegetables was defined as 80g. Fruit juices were included to a maximum of one portion. In accordance with information regarding size of servings supplied by the authority's school lunch service, high fat and sugar foods (desserts such as chocolate cake, flapjacks etc) were defined as 80g. In the absence of clearly defined guidelines, non-standard portion sizes, opaque containers and a greater diversity of foods, some assumptions had to be made regarding portion size of high fat and sugar foods for children consuming home provided lunches. An average of 30g was used to constitute a portion based upon weight of a standard packet of crisps or chocolate bar. High fat and sugar foods included: chocolate bars,

cakes, biscuits, sweets, crisps and other snacks containing a high fat and/or sugar content evident on any packaging where available. High fat and sugar foods were classified according to recognised guidelines [30, 31] whereby fats represented more than 17.5g of total fat per 100g and carbohydrates (of which sugars) represented over 22.5g of total sugars per 100g.

Ethical approval

Ethical approval was gained from the University ethics committee. Informed consent was obtained from the head teacher at each school. Consent was sought from headteachers acting in loco parentis, supplemented by parental "opt-out" consent whereby the child is included in the study unless their parents withdraw them [32].

Data analysis

Mean consumption values for fruit and vegetables and high fat and sugar foods were computed for all children for whom data was available for at least 3 out of 5 days during each data collection phase. Preliminary analyses were conducted to establish the potential impact of age, sex, ethnicity and index of multiple deprivation on the study findings; no significant effects were found. Data were analysed using the Statistical Package for Social Science version 21.0 (IBM, USA) and differences in consumption tested using repeated measures ANOVA, where the between group factor was school setting (intervention or control schools) and the within group factor was study phase (baseline, 3 month and 12 month follow-up). Post-hoc t tests determined the source of any variance and effect sizes, using Cohen's d, were calculated to establish practical significance. Additional analyses using Pearson product moment correlation were conducted to explore the relationship between fruit and vegetable and high fat and sugar foods for children consuming school provided and home provided lunches. An α level of 0.05 was used in all statistical analyses unless otherwise stated.

Results

Description of the study sample

Participation at each study phase is shown in Figure 1.

>>Insert Figure 1<<

School provided lunches

Table 2 shows the mean consumption of fruit and vegetables and high fat and sugar foods at each study phase. Analysis of fruit and vegetable consumption identified a significant main effect of study phase ($F(2, 519) = 14.26$, $p<0.01$, $\eta_p^2 = 0.02$) and school setting ($F(1, 519) = 45.83$, $p<0.001$, $\eta_p^2 = 0.09$). However, there was no significant interaction between study phase and school setting ($F(2, 519) = 1.20$, $p>0.05$, $\eta_p^2 = 0.005$). Post-hoc t tests (bonferroni adjustment 0.05/4 = 0.012) demonstrated that fruit and vegetable consumption in the intervention schools was statistically higher at 3 month follow-up than baseline and of small practical significance (t=-2.54, p<0.01, d= 0.26, CI= -5.39-6.10) but not in the control schools (t=-0.97, p>0.05, d=0.07, CI=-4.46-4.01). A statistically significant decrease was evident in the intervention and control schools at 12 month follow-up but was of greater practical significance for the control group (t=1.40, p<0.01, d=-0.14, CI= -5.46- 5.71) and t=2.63, p<0.01, d=-0.21, CI=-3.57-3.73 respectively).

>>Insert Table 2<<

Analysis of foods high in fat and sugar identified a significant main effect of study phase ($F(2, 519) = 30.01$, $p<0.05$, $\eta p2= 0.05$) and school setting ($F(1, 520) = 7.04$, $p<0.05$, $\eta p2= 0.01$). However, there was no significant interaction between study phase and school setting ($F(2, 519) = 0.54$, $p>0.05$, $\eta p2= 0.001$). Post hoc t tests (bonferroni adjustment 0.05/4 = 0.012) suggested that in the intervention schools, consumption of high fat and sugar foods was statistically higher at 3 month follow-up compared to baseline (t=-4.87, p=<0.001, d=0.49, CI = -5.33-5.59) and between baseline and 12 month follow-up (t=-4.40, p=<0.001, d=-0.44, CI = -4.83-5.54). Similarly, in the control schools, high fat and sugar consumption increased significantly at both 3 month follow-up (t=-4.49, p<0.001, d=0.35, CI=-3.78-4.05) and 12 month follow-up (t=-4.59, p<0.01, d=0.36, CI= -3.60-4.06) compared to baseline.

Home provided lunches

Table 3 shows the mean consumption of fruit and vegetables and high fat and sugar foods at each study phase. Results of lunchtime fruit and vegetable consumption showed a significant main effect of study phase ($F(2, 343) = 3.52$, $p<0.05$, $\eta_p^2=0.01$) but not school setting $F(1,343) = 1.52$, $p>0.05$, $\eta_p^2=0.004$). The interaction between study phase and school setting was also not significant ($F(2, 343) = 1.65$

p>0.05, η_p^2=0.005) suggesting that changes in consumption over time were not due to school setting (intervention or control).

>>Insert Table3<<.

Analysis of high fat and sugar foods indicated no significant main effect of study phase (F (2, 343) = 2.19, p>0.05, ηp2 = 0.06). However, a significant effect was found for school setting (F (1, 343) = 10.37, p<0.05, (ηp2= 0.02); children in the control schools consumed significantly more high fat and sugar foods than children in the intervention schools (1.25 and 1.05 portions respectively). The interaction between study phase and school setting was not significant (F (2, 343) = 2.52, p>0.05, ηp2= 0.007).

Relationship between fruit and vegetable consumption and high fat and sugar consumption

Additional analyses using Pearson product moment correlation were conducted to explore the relationship between fruit and vegetable and high fat and sugar foods for children consuming school provided and home provided lunches. For children consuming school provided lunches, the correlation between the difference scores for fruit and vegetable consumption (3 months post intervention-baseline) and consumption of high fat and sugar foods (3 month post intervention-baseline) was r =-0.034 for children in the intervention schools and r=-0.143 in the control schools. To compare the correlation coefficient for the intervention and control schools, Z_{obs} values were calculated. There was no statistically significant difference in the strength of the correlation between fruit and vegetable consumption and high fat and sugar food consumption for children in the intervention and control schools (Z_{obs} = -1.25).

For children consuming home provided lunches, the correlation between the difference scores for fruit and vegetable consumption (3 months post intervention-baseline) and consumption of high fat and sugar foods (3 months post intervention-baseline) was r =-0.202 for children in the intervention schools and r=-0.220 in the control schools. No statistically significant difference in the strength of the correlation between fruit and vegetable consumption and consumption of high fat and sugar foods was found for children in the intervention and control schools (Z_{obs} = -0.20).

Discussion

This study suggested that the Food Dudes programme had a limited impact on children's consumption of foods high in fat and sugar. A significant increase in the consumption of fruit and vegetables was found at 3 months for children in the intervention schools, but only for those eating school-supplied lunches suggesting that the Food Dudes programme had a limited effect in producing even short-term changes in children's fruit and vegetable consumption at lunchtime. Results further indicated that consumption of high fat and sugar foods for children consuming school provided lunches increased over time. Children's consumption of unhealthy foods for those consuming home provided lunches was higher for the control schools than the intervention schools however the non-significant interaction effect suggests that differences in consumption between groups did not reflect a programme effect. It was expected that increases in fruit and vegetable consumption following the intervention would result in decreases in the consumption of high fat and sugar foods; however, no significant relationship was found for children consuming school provided or home provided lunches.

Whilst current findings provided limited evidence for the effectiveness of the intervention in decreasing consumption of high fat and sugar foods; these may be explained by a number of factors. Firstly, the programme focused on the intrinsic values associated with eating fruit and vegetables, avoiding negative messages or the health outcomes associated with consuming unhealthy foods [9]. Consequently, the programme does not explicitly target the consumption of high fat and sugar foods. Whilst it has been suggested that targeting fruit and vegetables is an effective strategy in health promotion interventions, it may also be argued that interventions should focus on displacement of unhealthy foods from children's diets [10], or substituting these foods for other activities [14]. Indeed, the assumption that an increase in fruit and vegetables will lead to a reduction in the consumption of unhealthy foods is not necessarily justified and children may simply consume more. This is crucial as failure to account for this may lead to an overall increase in children's dietary intake and perpetuate the childhood obesity epidemic.

Secondly, children can only eat what is available to them [33] and environmental factors such as the provision of fruit and vegetables will, of course, impact upon consumption patterns. As such, the effectiveness of behaviour change interventions such as the Food Dudes programme may be constrained

by the broader food environment. To develop a healthy eating environment, it is not only important that healthy foods are provided but also that the availability of unhealthy foods is limited both at school [12] and in the home [34]. According to behaviour choice theory, an important concept in eating behaviour change is the substitution or replacement of one food over another. Individuals may select an alternative for a preferred product when the availability of that product is constrained [14]. In the present study, the provision of fruit and vegetables may have been limited, specifically in the school environment. For example, increases in the consumption of high fat and sugar foods for children who consumed school provided meals may be the result of low availability of fruit and vegetables, with children selecting unhealthy foods as an alternative for the preferred fruit or vegetable product. Research that reports both provision and consumption of unhealthy and healthy foods may help evaluate this hypothesis further thus accounting for the role of the environmental factors in changing children's eating behaviours. Furthermore, despite the requirement of the food-based and nutrient-based standards [21] to provide at least one portion of fruit and one portion of vegetables or salad per pupil per day, these standards may not be consistently implemented. This may have been confounded by timing of data collection or seasonal variation in school menu provision. Baseline measurements were recorded in the summer term whereas follow-up measurements were recorded during the autumn/winter school term thus increases in consumption of high fat and sugar foods could be explained by seasonal variation. Whilst the standards should ensure consistency in fruit and vegetable provision, both between menus and schools across the UK, this may not always be the case.

Restricting access to high fat and sugar snacks may therefore be an effective strategy in school meal provision. Decreasing availability of unhealthy foods and replacing these with a variety of fruits and vegetables may encourage children to choose healthier options whilst retaining children's choice. Indeed, research has found that restrictive policies surrounding high fat and sugar foods increased children's fruit and vegetable consumption [12, 13]. However, restricting foods may also have adverse effects. For example, research [35] has shown that when both fruit and sweets are restricted, children consumed more of the forbidden food during a taste session compared to the no-prohibition condition. Therefore, decreasing children's consumption of unhealthy foods may require more than just restriction. Indeed, a whole school approach to healthy eating should be advocated, including an understanding of the attitudes

of school caterers in response to school meal provision and the importance of school policies that shape children's eating behaviours [36]. One strategy which has recently been introduced as part of the Food Dudes programme is the 'Choice Architecture of School Catering' which aims to encourage children to make healthier choices. The scheme runs in parallel with the main Food Dudes programme and designed by the Bangor research team in collaboration with caterers, school staff, parents and commissioners. Part of the scheme aims to maximise cues for choosing fruit and vegetables and minimise cues for unhealthy foods through creating Food Dudes menus that promote healthier options for main courses and desserts e.g. labelling them after Food Dudes characters, e.g. "Rocco's Dish of the Day", displaying fruit and vegetables more prominently than unhealthy foods and improving the way that healthy food is presented. Catering, supervisory and teaching staff also act as behaviour change champions, supporting children to make healthy choices through verbal encouragement and offering small rewards [37].

In conclusion, the study suggests that the Food Dudes programme had little impact on decreasing consumption of high fat and sugar foods. Targeting unhealthy food consumption in addition to increasing fruit and vegetables may facilitate this. Restricted access to unhealthy foods may also reduce intake however this needs to be part of a multi-faceted approach to changing children's dietary patterns involving the whole school community.

Ethical approval was gained from the University of Worcester research ethics committee. This work was supported by the Department of Health West Midlands; and Wolverhampton Primary Care Trust. The authors have no conflict of interests to declare.

References

1. Boeing H, Bechthold A, Bub A, Elinger S, Haller D, Kroke A. et al. Critical review: Vegetables and fruit in the prevention of chronic diseases. *Eur J Nutr* 2012; 51: 637-663.
2. O'Flaherty M, Flores-Mateo G, Nnoaham K, Lloyd-Williams F and Capewell S. Potential cardiovascular mortality reductions with stricter food policies in the united kingdom of Great Britain and Northern Ireland. *Bull World Health Organ* 2012; 90: 522-531.

3. Department of Health. *The National School Fruit Scheme*. Report, Department of Health, 2000. London: The Department of Health.
4. World Health Organisation. *Promoting Fruit and Vegetable Consumption Around the World*. Report, World Health Organisation, 2005. Geneva: WHO.
5. Horne PJ, Lowe CF, Fleming PFJ and Dowey AJ. An effective procedure for changing food preferences in 5-7 year-old children. *Proc Nutr Soc* 1995; 54: 441-452.
6. Lowe CF, Dowey AJ and Horne PJ. Changing what children eat. In: Murcott A (ed) *The Nation's Diet: The Social Science of Food Choice.* London: Longman, 1998, pp 57-80.
7. Horne PJ, Tapper K, Lowe CF, Hardman C, Jackson M and Woolner J. Increasing children's fruit and vegetable consumption: a peer-modelling and rewards-based intervention. *Eur J Clin Nutr* 2004; 58: 1649-1660.
8. Horne PJ, Hardman CA, Lowe CF, Tapper KK, Le Noury JJ, Madden P et al. Increasing parental provision and children's consumption of lunchbox fruit and vegetables in Ireland: the Food Dudes intervention. *Eur J Clin Nutr* 2009; 63: 613-618.
9. Lowe CF, Horne PJ, Tapper KK, Bowdery MM and Egerton CC. Effects of a peer modelling and rewards-based intervention to increase fruit and vegetable consumption in children. *Eur J Clin Nutr* 2004; 58: 510-522.
10. Tak NI, te Velde SJ, Sing AS and Brug J. The effects of a fruit and vegetable promotion intervention on unhealthy snacks during mid-morning school breaks: results of the Dutch Schoolgruiten Project. *J Hum Nutr Diet* 2010; 23: 609-615.
11. Ledoux TA, Hingle MD and Baranowski T. Relationship of fruit and vegetable intake with adiposity: a systematic review. *Obes Rev* 2011; 12: 143-50.
12. Moore L and Tapper, K. The impact of school fruit tuck shops and school food policies on children's fruit consumption: A cluster randomized trial of schools in deprived areas. *J Epidemiol Community Health* 2008; 62: 926-931.
13. Gonzalez W, Jones SJ, Frongillo EA. Restricting Snacks in U.S. Elementary Schools Is Associated with Higher Frequency of Fruit and Vegetable Consumption. *J Nutr* 2009; 139: 142-144.

14. Goldstein GS and Epstein LH. Can Fruits and Vegetables and Activities Substitute for Snack Foods? *Health Psychology* 2002; 21: 299-303.
15. Øverby N, Cecilie, Klepp K and Bere E. Introduction of a school fruit program is associated with reduced frequency of consumption of unhealthy snacks. *Am J Clin Nutr* 2012; 96: 100-1103.
16. Upton D, Taylor C and Upton P. Increasing children's lunchtime consumption of fruit and vegetables: an evaluation of the Food Dudes programme. *Public Health Nutr* 2012*;* 6: 1066-1072.
17. Horne PJ, Lowe CF, Bowdery M and Egerton C. The way to healthy eating for children. *Br Food J* 1998; 100: 133-140.
18. Presti G, Zaffanella M, Milani L, Lowe C and Moderato P. Increasing fruit and vegetable consumption in young children: The Food Dudes Italian trial short-term results. *Psychol Health 2009;* 24: 326-326.
19. Rees G, Richards C and Gregory J. Food and nutrient intakes of primary school children: a comparison of school meals and packed lunches. *J Hum Nutr Diet* 2008; 21**:** 420-427.
20. Rogers IS, Ness AR, Hebditch KK Jones, LR and Emmett PM. Quality of food eaten in English primary schools: school dinners vs packed lunches. *Eur J Clin Nutr* 2007; 61: 856-864.
21. School Food Trust. A Guide to Introducing the Government's Food-Based and Nutrient-Based Standards for School Lunches, http://www.healthyeatinginschools.co.uk/pdfs/sft_nutrition_guide.pdf (2008, accessed January 2013).
22. Department for Education. Schools, Pupils and their Characteristics: January 2012. https://www.gov.uk/government/publications/schools-pupils-and-their-characteristics-january-2012, accessed October 2013).
23. Food Dudes. Sponsors. http://www.fooddudes.co.uk/sponsors.aspx (2013, accessed October 2013).
24. Lowe CF, Horne PJ, Tapper KK, Bowdery MM and Egerton CC. Effects of a peer modelling and rewards-based intervention to increase fruit and vegetable consumption in children. *Eur J Clin Nutr* 2004; 58: 510-522.

25. Lowe F and Horne P. Food Dudes: Increasing children's fruit and vegetable consumption. *Cases in Public Health Communication & Marketing* 2009; 3: 161-185.
26. Wrieden W, Peace H, Armstrong J and Barton K. A Short Review of Dietary Assessment Methods used in National and Scottish Research Studies, http://www.food.gov.uk/multimedia/pdfs/scotdietassessmethods.pdf (2003, accessed June 2013).
27. Henerson L, Gregory J and Swan G. The National Diet & Nutrition Survey: adults aged 19 to 64 years: Types and quantities of foods consumed, http://food.gov.uk/multimedia/pdfs/ndnsprintedreport.pdf (2002, accessed December 2013).
28. Dresler-Hawke E, Whitehead D and Coad J. What are New Zealand children eating at school? A content analysis of 'consumed versus unconsumed' food groups in a lunch-box survey. *Health Educ J* 2009; 68: 3-13.
29. Health Promotion Agency. Nutritional Standards for School Lunches: A guide for implementation.http://www.healthpromotionagency.org.uk/Resources/nutrition/pdfs/food_in_school_09/Nutritional_Standard-1EEBDB.pdf (2009, accessed June 2013)
30. NHS Choices. Fat: the facts. http://www.nhs.uk/Livewell/Goodfood/Pages/Fat.aspx (2013, accessed October 2013).
31. NHS Choices. Sugars. http://www.nhs.uk/Livewell/Goodfood/Pages/sugars.aspx (2013, accessed October 2013).
32. Severson H and Biglan A. Rationale for the use of passive consent in smoking prevention research: politics, policy and pragmatics. *Prev Med* 1989; 18**:** 267-279.
33. Taylor, S. School Fruit And Vegetables Schemes Have A Downside. *Nursing Standard,* 2007; *22*: 32-33.
34. Hang C, Lin W, Yang H and Pan, W. The relationship between snack intake and its availability of 4^{th}-6^{th} graders in Taiwan. *Asia Pac J Clin Nutr* 2007; 16: 547-553.
35. Jansen, E., Mulkens, S., Emond, Y., & Jansen, A. From the Garden of Eden to the land of plenty: Restriction of fruit and sweets intake leads to increased fruit and sweets consumption in children. *Appetite* 2008; 51: 570-575.

36. Bevans KB, Sanchez B, Teneralli R and Forrest CB. Children's Eating Behavior: The Importance of Nutrition Standards for Foods in Schools. *J Sch Health* 2011; 81: 424-429.
37. Food Dudes. Choice Architecture of School Catering http://www.fooddudes.co.uk/school-catering.aspx (2013, accessed December 2013).

Table 1. Demographic characteristics of the study sample

Group	N	Boys (n)	Girls (n)	Index of Multiple Deprivation	Rank (%)	FSM (%)	Ethnic Minorities (%)
Intervention							
1	152	84	68	1 768	5.44*	40.7	22
2	67	37	30	1 217	3.75*	39.0	27
3	177	95	82	7 242	22.3	13.2	10
4	165	92	73	3 639	11.2	30.5	82
5	48	33	15	1 768	5.44*	57.9	14
6	295	155	140	2 822	8.69*	25.9	18
7	265	162	103	20 609	63.45	7.8	74
8	282	135	147	20 609	63.45	8.7	71
Control							
9	149	69	80	2 528	7.78*	36.6	25
10	168	88	80	3 432	10.57	28.0	15
11	143	65	78	8 199	25.24	35.8	10
12	336	183	153	26 581	81.83	2.8	10
13	215	125	90	9 748	30.01	35.5	80
14	170	86	84	6 195	19.07	7.8	51
15	105	56	49	14 977	46.11	14.5	10

NB. IMD: 1 = Most deprived, 32 482 = least deprived *Schools within 10% most deprived areas.
FSM = Free School Meal entitlement, region average = 24.7%, national average = 18.1% [22]

Figure 1. Participation at each phase of the study

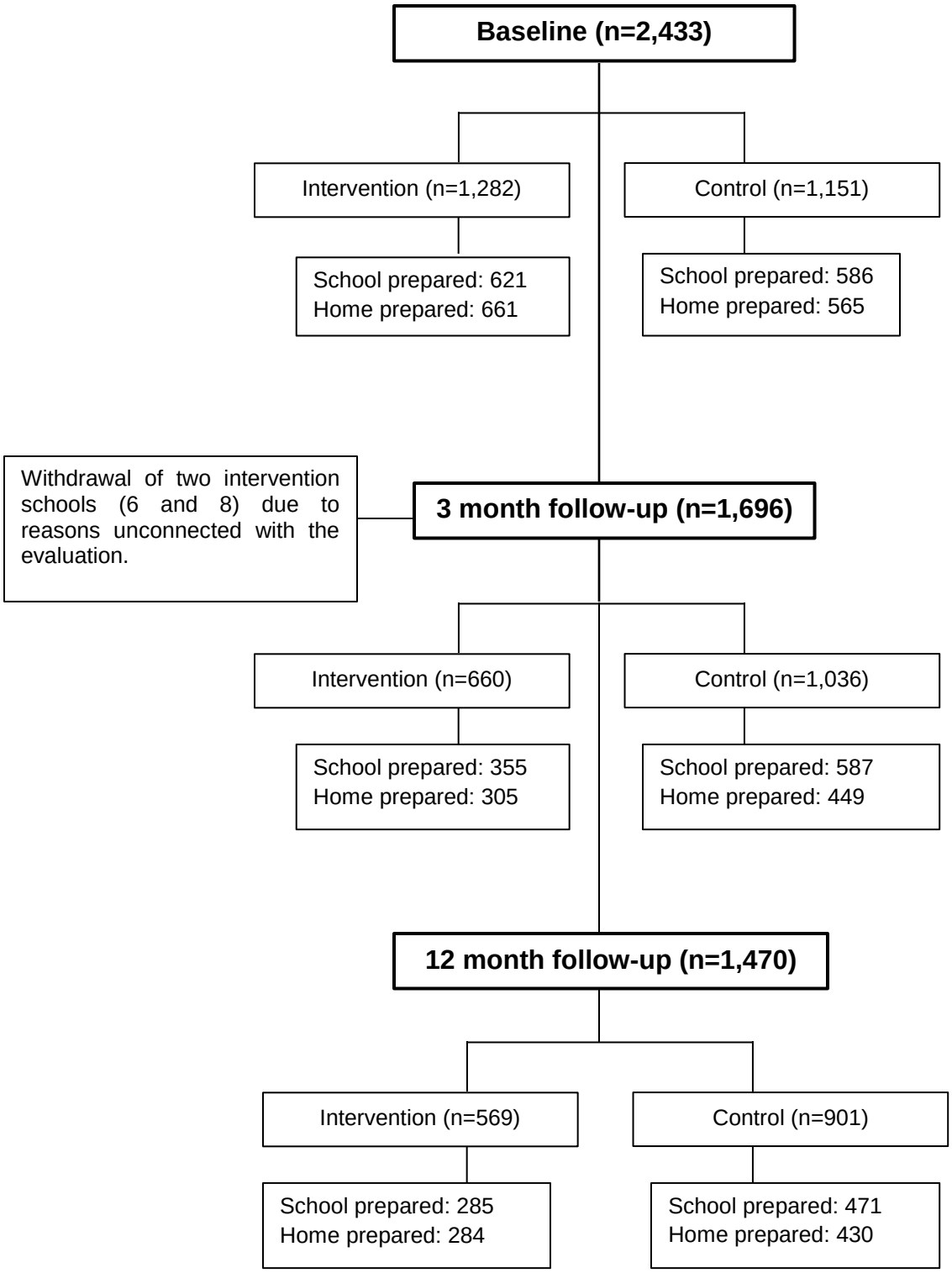

Table 2. Mean consumption of fruit and vegetables and high fat and sugar foods (in grams) for children consuming school provided lunches in the intervention and control schools at each study phase (N=522)

	Intervention					Control				
	Baseline mean (SD)	3 month follow-up mean(SD)	12 month follow-up mean (SD)	BL and FU[1] comparison , t value (df)	BL and FU[2] comparison , t value (df)	Baseline mean (SD)	3 month follow-up mean(SD)	12 month follow-up mean (SD)	BL and FU[1] comparison , t value (df)	BL and FU[2] comparison , t value (df)
Fruit and vegetables	53.67 (41.98)	62.11 (40.55)	48.85 (38.19)	-2.54* (197)	1.40* (197)	39.59 (36.14)	41.93 (41.66)	33.15 (30.85)	-0.97 (323)	2.63* (323)
High fat and sugar foods	42.44 (36.59)	59.37 (41.77)	57.48 (37.88)	-4.87* (197)	-4.40* (197)	38.77 (33.96)	51.40 (37.95)	50.85 (36.34)	-4.49 (323)	-4.59 (323)

*Significant at p<0.012 (bonferroni adjustment)

BL = Baseline, FU[1] = 3 month follow-up, FU[2] = 12 month follow-up

Table 2. Mean consumption of fruit and vegetables and high fat and sugar foods (in portions) for children consuming home provided lunches in the intervention and control schools at each study phase (N=345)

	Intervention			Control		
	Baseline mean (SD)	3 month follow-up mean(SD)	12 month follow-up mean (SD)	Baseline mean (SD)	3 month follow-up mean(SD)	12 month follow-up mean (SD)
Fruit and vegetables	0.75 (0.94)	0.75 (0.86)	0.62 (0.89)	0.72 (0.82)	0.91 (1.01)	0.76 (0.93)
High fat and sugar foods	0.95 (0.68)	1.11 (0.81)	1.03 (0.82)	1.23 (0.78)	1.22 (0.74)	1.30 (0.79)