Can a school gardening intervention improve children's fruit and vegetable intake? An evaluation of two clustered randomised controlled trials.

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Submitted in accordance with the requirements for the degree of

Doctor of Philosophy

The University of Leeds

School of Food Science and Nutrition

June 2013

Declaration

"The candidate confirms that the work submitted is her own, except where work which has formed part of jointly-authored publications has been included. The contribution of the candidate and the other authors to this work has been explicitly indicated overleaf. The candidate confirms that appropriate credit has been given within the thesis where reference has been made to the work of others."

Publications

Based on the grant proposal for the RHS project MSC wrote the following paper which has formed the basis for chapter 4. The co-authors commented upon the paper drafts prior to submission.

> Christian, MS., Evans, CEL., Conner, MT., Ransley JK., & Cade JE. (2012) *Study Protocol*: *Can a school gardening intervention improve children's diets?* BMC Public Health 12: 304

MSC performed the analysis and the writing of the following paper which forms the basis of the second half of chapter 5. The co-authors commented upon the paper drafts prior to submission.

> Christian, MS., Evans, CEL., Hancock, N., Nykjaer, C., & Cade JE. (2012*) Family meals can help children reach their 5 A Day: a cross-sectional survey of children's dietary intake from London primary schools* Journal of Epidemiology and Community Health *jech-2012-20160*

Chapter 7 - Impact of a school gardening intervention on children's knowledge and attitudes towards fruit and vegetables was completed jointly by MSC and Jayne Hutchinson. The statistical analyses (results) for this chapter were conducted by Jayne Hutchinson. The introduction for this chapter was written by MSC whilst the methodology and discussion were completely jointly by MSC and Jayne Hutchinson.

The following publication has also expressed my opinons and knowledge about the effectiveness of gardening interventions based on conclusions from Chapter 9.

> Christian, M., Gatto, N. M. & Collins, C. E. (2013) *School gardens: growing and eating abcs (asparagus, broccoli, and cauliflower)*. Ican: infant, child, & adolescent nutrition, 5, 154-156.

Acknowledgements

I am extremely grateful to my two supervisors Janet Cade and Charlotte Evans; without their help and support I would not have been able to complete this thesis. I am also incredibly grateful for the support and encouragement Janet has given me throughout my academic career in the Nutritional Epidemiology Group.

My friends in the Nutritional Epidemiology Group have also been incredible supportive throughout this process; with a special thanks to Neil Hancock, Jayne Hutchinson, Claire McLoughlin and Camilla Nykjaer, whose involvement in these two trials has been essential.

I would also like to thank my parents and my brother for their support throughout my academic studies and always for being willing to proof read my work. Most of all, I would like to thank my husband Bradley, who has always supported me throughout my academic endeavours.

Abstract

Background

This thesis describes the findings from the first clustered randomised controlled trials (RCT) designed to evaluate if a school gardening programme, the Royal Horticultural Society (RHS) Campaign for School Gardening, has an effect on children's fruit and vegetable intake.

Methodology

Primary schools from 8 London boroughs were invited to take part in one of two related RCTs. Trial 1 consisted of 23 schools; randomised into either the RHS-led or the Teacher-led intervention. Trial 2 consisted of 31 schools; randomised into either the Teacher-led or a comparison group. A 24-hour food diary (CADET) collected baseline and follow-up dietary intake. Questionnaires were designed to measure children's knowledge and attitudes towards fruit and vegetables and assess intervention implementation.

Results

In Trial 1, 1256 children were randomised to receive either the RHS-led (n=529) or Teacher-led (n=727) intervention. Of these, 356 children from the RHS-led and 329 from the Teacher-led arm provided data for the primary analysis. In Trial 2, 1475 children were randomised to receive either the Teacher-led (n=756) or comparison (n=719) intervention. Of these, 488 children from the Teacher-led and 428 from the comparison arm provided data for the primary analysis. Baseline analysis of children's fruit and vegetable intake showed that eating a family meal together, cutting up fruit and vegetables and parental modelling of fruit and vegetable intakes were all associated with higher intakes of fruit and vegetables in children. Results from the RCTs found that in Trial 1, for combined fruit and vegetable intake, the Teacher-led group had a higher mean change of 8 g (95%CI: -19, 36) compared to the RHS-led group -32 g (95%CI: -60, -3). However, after adjusting for possible confounders this difference was not significant (intervention effect: -40 g, 95%CI: -88, 1; p=0.06). In Trial 2, the Teacher-led group consumed on average 15 g (95%CI: -36, 148) more fruit and vegetables than the comparison group; this difference was not significant. No change was found in children's knowledge and attitudes. The process measures revealed that if schools improved their RHS gardening score by 3 levels, children had on average an increase of 81 g of fruit and vegetables (95%CI: 0, 163; p=0.05) compared to schools that had no change in gardening score, after adjusting for confounders.

Conclusion

The primary analysis of these two trials has found very little evidence to support claims that school gardening alone can improve children's fruit and vegetable intake. Only when a gardening intervention is implemented at a high level within the schools can it improve children's fruit and vegetable intake.

Table of Contents

List of Tables

List of Figures

Abbreviations

CADET	Child And Diet Evaluation Tool
CRB	Criminal Records Bureau
DANTE	Diet And Nutrition Tool for Evaluation
g	Grams
ITT	Intention-to-treat
NMES	Non-milk Extrinsic Sugars
IMDS	Index of Multiple Deprivation Score
mg	Milligram
Ed	Education
NDNS	National Diet and Nutrition Survey
PhD	Doctor of Philosophy
RCT	Randomised controlled trial
RHS	Royal Horticultural Society
USA	United States of America
WFD	Weighed Food Diary

Chapter 1 - Introduction

1.1 Contribution of fruit and vegetables to diet and health

Fruit and vegetables are fundamental components of a healthy diet, providing vital micronutrients such as vitamin C, E, B_2 – riboflavin, folate, carotenoid (e.g. beta-carotene and lycopene) and selenium. The World Health Organisation (WHO) recommends that adults should eat at least 400 g of a variety of fruit and non-starchy vegetables every day. This is the recommended minimum intake not a finite target; however it is the recommended intake promoted by the UK Government with their 5 A Day campaign (five portions of fruit or vegetables). A standard portion of fruit or vegetables is assumed to be 80 g (WHO, 2004). This can include fresh and frozen, or tinned fruit and/or vegetables. An example of a portion (80 g) of fruit would be two plums, or two kiwi fruit, or one apple. The 5 A Day policy also states that bean or pulses can count as one portion, up to 150mls of unsweetened fruit juice can count as one portion, or a fruit smoothie containing edible pulp can also count as 2 portions. Consuming low energy density foods such as vegetables could help prevent obesity (Butland et al., 2012). All fruit and vegetables provide useful amounts of dietary fibre (Department of Health, 1991). A short summary of essential micronutrients that fruit and vegetables provide us with are described below.

1.1.1 Fibre

The main source of dietary fibre, or non-starch polysaccharides are cereals (grains), vegetables and potatoes (Department of Health, 1991). For adults the recommended intake is 18 g per day using the Englyst method (Holland et al., 2002). Diets high in dietary fibre are associated with a decreased risk of colorectal and oesophageal cancer (World Cancer Research Fund, 2007). High fibre intake has also been shown as protective against cardiovascular disease and diabetes mellitus (Salas-Salvado et al., 2006, Liu S, 2002, Lupton and Turner, 2003, Montonen et al., 2003, Pereira et al., 2004). Furthermore, epidemiological evidence suggests fibre is associated with weight management; an important factor in preventing obesity (Newby et al., 2005).

1.1.2 Folate

Folate is found in vegetables such as peas and dark leafy vegetables e.g. spinach and cabbage. Folate intake is associated with decreasing neural tube defects, and research suggests folate could be protective against pancreatic cancer, and may reduce risk of cardiovascular disease

(World Cancer Research Fund, 2007). Approximately 80 g of peas would contain 47.2 µg of folate, a third of a child's recommended intake (Holland et al., 2002).

1.1.3 Non-haem iron

Iron is essential for metabolic processes such as oxygen transport and DNA synthesis (Lieu et al., 2001). Non-haem iron is found in both vegetables and fruits. Examples are apricots and spinach.

1.1.4 Potassium

High sources of potassium are bananas, apricots, prunes and spinach. Cohort studies have found an association between potassium intake and decrease risk of stroke (WCRF, 2007).

1.1.5 Vitamin A (retinol equiv)

Vitamin A can be found in tomatoes, carrots and spinach. A deficiency causes corneal damage and blindness, which is highly prevalent in developing countries.

1.1.5.1 Carotene

Some examples of vegetables that contain carotene are carrots and squash. The WCRF (2007) reports that carotene could be protective against several types of cancers such as cancer of the mouth, pharynx, larynx and lung cancer.

1.1.6 Vitamin C

Vitamin C is found in blackberries, strawberries, citrus fruit (oranges, grapefruit and lemons), broccoli, brussels sprouts, cauliflower, cabbage, spinach, as well as asparagus. A portion of oranges provides 47 mg of vitamin C, more than a child's daily requirement (Holland et al., 2002). Consuming foods containing vitamin C can help protect against tissue damage due to its antioxidant properties (Hutchinson, 2011).

The daily dietary requirements for children aged 7-11 years old are presented Table 1.1.

Table 1.1 Recommended daily nutrient intakes for children aged 7 to 11 years (Department of Health, 1991)

Nutrient	Function in the body	Girls	Boys
Energy (MJ)	Providers of energy	7.3	8.2
Protein (g)		28	28
Total fat (g)		68	77
Saturated fat (g)		21	24
Non-milk Extrinsic Sugars (g)		44	49
Non-starch polysaccharides (g)		12	12
Iron (mg)	Blood/circulation, maintenances of homeostasis	8.7	8.7
Sodium (mg)		1150	1150
Folate (mg)	Cellular and whole body metabolism	150	150
Zinc (µg)		7	7
Calcium (mg)	Structural	550	550
Vitamin A (µg)	Structural, protective/defense	500	500
Vitamin C (mg)	Protective/defense	30	30

1.2 Non-communicable disease

Epidemiological evidence indicates that in adults a diet rich in fruit and vegetables can decrease the risk of developing cardiovascular disease, stroke, hypertension, type 2 diabetes mellitus, obesity and several forms of cancer (WHO, 2009, World Cancer Research Fund, 2007). A diet low in fruit and vegetable intake is one of the top ten risk factors for global mortality (Horton, 2012). Research has also revealed that dietary habits are developed in childhood and persist throughout life; therefore it is vital that children at a young age consume adequate levels of fruit and vegetables (Singer et al., 1995, Skinner et al., 2002). Several studies indicate that children's fruit and vegetable intake is positively associated with their parent's intake (Fisher, 2002).

The impact of poor nutrition in children is causing major public health concerns across the globe (WHO, 2009). Of particular public concern is the rise of obesity in children (The NHS Information Centre Lifestyles Statistics, 2012). Childhood obesity has reached epidemic proportions, with the highest rates of obesity found in developed countries (Butland et al., 2012). Obesity is also increasing in developing countries (Brown and Summerbell, 2009). The National Child Measurement Programme for England, 2011/12 revealed that 22.6% of children in Reception Year (aged 4-5 years old) and 33.9% of children in Year 6 (aged 10-11) were either overweight or obese, with the current predictions stating that approximately 25% of children aged between 6-10 years in the UK will be obese by the year 2025 (Butland et al., 2012). For

Australia, the predictions are that a third of children aged 5-19 years will be either overweight or obese by 2025 (Department of Human Services, 2008). In the USA obesity has more than doubled in the last 25 years (Skinner et al., 2002).

Diet plays a fundamental role in weight management; having a healthy diet rich in fruit and vegetables, which are low energy density foods, could help tackle the obesity epidemic (National Centre for Social Research, 2005). A diet rich in fruit and vegetables is the key for children to develop mentally and physically (WHO, 2009). The benefits of consuming a diet rich in fruit and vegetables in childhood has been verified by research conducted using the historical Boyd Orr Cohort (Van Der Pols et al., 2007, Maynard et al., 2003). The research explored chronic diseases in adulthood and confirmed that fruit and vegetable consumption in childhood appears to have a protective effect against some cancers in later life (Maynard et al., 2003). Research has also revealed that dietary habits are developed in childhood and persist throughout our life; therefore it is vital that children at a young age consume adequate levels of fruit and vegetables (Skinner et al., 2002, Singer et al., 1995). The importance of childhood eating patterns has been illustrated through longitudinal research concluding that eating fruit and vegetables in childhood has positive health benefits on cardiovascular disease, asthma and other respiratory diseases (Nicklas et al., 1997, Perez Rodrigo et al., 2004, Maynard et al., 2003, McAleese and Rankin, 2007). Public health interventions need to change children's lifestyles to reduce the intake of non-essential foods which are high in fat, sugar and salt, and encourage an increase in a variety of fruits and vegetables. Strategies to reduce obesity in children are urgently required (Summerbell et al., 2009).

1.3 Current consumption levels

Currently, children's consumption of fruit and vegetables is low in the United States of America, Australia and most European countries (Timperio et al., 2008, Magarey et al., 2001, Maynard et al., 2003). The average intake of fruit and vegetables for children in the UK is around 2.8 servings per day – approximately 224 g (Health, 2011). In British children the main sources of energy intake are chips, biscuits and crisps (Nelson et al., 2007); the need for public health intervention to improve children's overall diet habits is evident (Connolly et al., 2002). Children from low income families consume even less fruit and vegetables than the average. Boys only consume 64 g or 0.8 of a portion while girls consume 1.1 portions, approximately 88 g of fruit and vegetables daily (Nelson et al., 2007).

1.4 Interventions to improve children's fruit and vegetable intake from across the globe – What is already known

Several different nutrition education programmes have been developed for school, home and community settings in an attempt to improve children's diets (Fogarty et al., 2007, Yeo and Edwards, 2006, Wells and Nelson, 2005, Cullen et al., 1998, Patrick et al., 2001, Baranowski et al., 2000, Bere et al., 2005, Ciliska et al., 1999). Evidence suggests that the most effective interventions are multi-component with both school and home based components (Evans et al., 2012a, Perry et al., 1998 , Reynolds et al., 2000). Successful intervention studies have included a variety of components: integrating teaching about fruit and vegetables into the curriculum; training teachers in theories of behaviour change and nutritional education; increasing fruit and vegetable availability at school and in school meals; training of catering staff (verbal encouragement); hands-on exposure (tasting and preparation sessions); parental involvement through newsletters and homework activities; whole school approach (developing a nutrition policy, evening activities) and community involvement (local fruit and vegetable industry) (Auld et al., 1998, Perry et al., 1998 , Baranowski et al., 2000, Reynolds et al., 2000, Sahota et al., 2001, Perry et al., 2004, Cullen et al., 2005, Bere et al., 2006, Te Velde et al., 2008). These intervention programmes report a moderate increase in children's fruit and vegetable consumption of approximately one third of a portion of fruit and or vegetable (Howerton et al., 2007, Ciliska et al., 1999, French and Wechsler, 2004).

1.5 Potential barriers to changing children's fruit and vegetable consumption

Changing children's fruit and vegetable consumption is a challenging task. Academic literature shows that the main barriers to increasing children's fruit and vegetable intake are availability, accessibility, convenience, taste preferences, peer pressure, parental/school support and knowledge (O'Dea, 2003). Whilst school based interventions attempt to battle against these issues, the successful implementation of an intervention is often determined by the time allocated to the programme and perceived importance by school teachers and parents. The main barrier for teachers not implementing school based interventions is preparation time. For parents the cost of fruit and vegetables is often cited as being too high, with parents opting to buy items of food that are less nutrient rich, such as biscuits, sweets and crisps, but are guaranteed to be consumed (Evans, 2010).

Research has attempted to design complex interventions to improve the understanding and education of children on the importance of healthy eating. The complexity of these interventions is matched by the complexity of our relationship with food. Children's desires, understanding and knowledge of nutrition come not only from the school and family environment, but also from different types of media, from supermarkets and packaging, from television advertising, and these all influence their nutritional preferences. Literature suggests that in highly populated areas such as inner cities, a gap has been created between children's understanding of processes of agriculture and the end result – the supermarket (Blair, 2009, Hatloy, 1997). To increase children's intake of fruit and vegetables, it is necessary to increase children's general knowledge of fruit and vegetables. There is increasing evidence to suggest that gardening might be a vehicle to facilitate fruit and vegetable intake (Somerset, 2005, Blair, 2009, Ozer, 2007, Robinson-O'Brien et al., 2009b).

1.6 UK and international school gardening programmes literature search strategy

To explore how school gardens have been used as an educational tool to improve children's fruit and vegetable intake, a literature search was conducted. Articles published between 1990 through to November 2012 were identified by searching Ovid Medline. The following keywords were used to search abstracts: child* and fruit or vegetable*; and grow or growing or garden*. Articles were considered relevant to this literature review if they included; a school gardening based nutrition program; knowledge or attitudes about gardening or fruit and vegetable intake; a willingness to try fruit and vegetable; or fruit and vegetable consumption. Articles were excluded if the study population was adolescents or adults, or were about gardening at home or in the community. Due to the small amount of research in this area, all study designs were included. This search identified 26 relevant articles, and an additional 11 articles were found through hand searching. From the 37 relevant articles, three were literature reviews, 15 discussed gardening in schools and 19 articles discussed 17 individual intervention studies (Table 1.2 and Table 1.3).

1.7 Why should we invest in school gardening programmes?

The implementation of school gardens as an educational tool is a relatively new approach. From the literature review results, 15 articles discussed the reasons why gardening should be implemented into the school curriculum. The first article published about school gardening was in 1995 (Alexander, 1995). Of the 15 articles that discussed a school gardening programme, 12 were based in USA, and three papers were based in Australia. The majority of

these articles were cross sectional surveys completed by a teacher, discussing how the school garden was used in their school. The main states that have implemented school gardens are California and Florida in the US and Queensland and Victoria in Australia. These states all have very good climates for growing fruit and vegetables throughout the year. The main themes for implementing gardening in schools were: to improve educational knowledge of the environment, nutrition, psychosocial and physical effects (Hackman, 1990, Armstrong, 2001, Faber et al., 2002, Morris et al., 2002, Somerset, 2005). Having a lack of access to fruit and vegetables is considered one of the main barriers to consumption. Therefore, increasing children's access to fruit and vegetables has been shown to increase consumption (Blair, 2009). The schools discussed in these articles who have implemented a school garden perceived it as an innovative way of teaching nutrition and health education; an alternative to classroom teaching that is hands-on and engaged the children's attention (Knai et al., 2006).

The psychological theory behind school gardens is based on the social cognition theory (SCT). The SCT is based on the assumption that to change a person's behaviour you need to changes their knowledge, values and beliefs to be successful (Morris, 2000). It is believed that active engagement in gardening activities can reinforce healthy messages about eating, and increase children's willingness to try different fruit and vegetables. Devine (Devine, 1999) found that planting, growing and eating vegetables can improve children's consumption patterns. However, there is now a gap between the implementation of school gardens and the academic evaluation of effectiveness (Ozer, 2007). The next section will discuss the current intervention studies that have attempted to decrease this research gap to identify how school gardens are affecting the children, schools and wider community.

1.7.1 Intervention study design

Seventeen intervention studies were identified as using a school garden to improve either children's fruit and vegetable consumption, their knowledge or attitudes towards fruit and vegetables or their willingness to taste fruit and vegetables. Eleven were non-randomised controlled trials, and six were evaluation studies (exploring pre and post intervention results). Four of the studies stated they were pilot studies (Gatto et al., 2012, Heim et al., 2009, Davis et al., 2011, Morris et al., 2001). Of the eleven studies that did include a control or comparison group, none of the studies were randomised controlled trials. Whilst, McAleese and Rankin (2007) randomly assigned two of the three schools involved in its study to receive either the control group or the nutrition program without a garden, the school which received the main intervention was selected as it had an existing garden (McAleese et al., 2007). For the studies

that did include a control school, the reasons given for not randomising were; the intervention was taught as an afterschool program and the children not enrolled in afterschool care were used as the control group (Davis et al., 2011); schools were selected based on having or not having a garden – those without a garden were used as a control school (Morris et al., 2001); constraints of the school district and characteristics such as pupil numbers (Morris et al., 2002), self-selection, the teachers were given the option to choose their condition group (Parmer et al., 2009, Morgan et al., 2010, Wang et al., 2009), or no reason given (Ratcliffe et al., 2011, Poston et al., 2005, Somerset and Markwell, 2009).

As a consequence, one of the main limitations with these trials is their study design and the use of convenience sampling with the relatively small sample size (Poston et al., 2005; O'Brien & Shoemaker, 2006; Koch et al., 2006). Furthermore, a number of the trials only had one school implementing the intervention. Small sample sizes can lead to an underestimation of the standard errors and affect the sensitivity of the tests used to determine the statistical differences between the groups. To overcome underestimation of standard errors it is recommended to have at least six clusters per condition group e.g. intervention or control (Robinson-O'Brien et al., 2009a, Murray et al., 2001). Another limitation was the lack of robust statistical analysis. The statistical methodologies used to analyse the differences between either groups or pre- and post-results were analysis of variance, t-test (paired or independent) chi-squared, correlations, or Mann-Whitney and Kruskal-Wallis tests. Only three studies (Morris and Zidenberg-Cherr., 2002; Morgan et al., 2010; & Wang, 2009) used a statistical methodology that adjusted for baseline differences - analysis of covariance and generalised estimating equations. None of the studies took into consideration the hierarchal structures of school data. These factors could compromise reliability of statistical outcomes limiting the generalisability of the results. Table 1.2 and 1.3 describe the general characteristics of each trial, including study population, age, intervention design, plants that were grown/harvested, measurement tools and results. The following overview will describe the types of gardening intervention used in these studies, then focus on the nutrition related outcomes to describe the impact of the intervention study on children's fruit and vegetable intake, knowledge, willingness to try fruit and vegetables and preferences for different types of fruit and vegetables.

Table 1.2 A summary of 6 garden based intervention studies characteristics and outcomes for Evaluation trials (pre and post)

Author (year) Location	Study population (n)	Sample age	Intervention (Duration)	Grew/harvested	Measures	Measurement tools	Results
Lineberger & Zajicek (2000) Texas, USA	Grade three to grade five children(111)	Not given	Garden activity guide for teachers to integrate gardening in the curriculum 10 lessons (10 weeks)	Not given	Pre-post: FV preferences	24-hour recall journal, questionnaires	Significant increase in children's preferences for vegetable scores ($p=0.05$), and FV snack preferences ($p<0.01$).
Koch et al. (2006) Texas, USA	Grade two to grade five children (56)	Not given	(12 weeks)	Not given	Pre-mid-post: Preference, knowledge (e.g. benefits of eating FV)and consumption of health snacks	Questionnaires and interview	No significant differences in FV preference. There was a significant improvement in healthy snack consumption and knowledge. No change found in children's attitudes towards fruit and vegetables.
Hermann et al. (2006)	Grade three to year eight children (43)	Not given	After school gardening program (duration not reported)	Corn, beans, squash, onions, peppers, tomatoes, carrots, okra, zucchini, cucumbers, lettuce & spinach.	Pre-post: Frequency of vegetable intake (e.g. daily)	Questionnaire	Significant increase in children's perceived vegetable intake between pre and post
Lautenschlager & Smith (2007) Minnesota, USA	Age 8-15 years old (66)	Mean 9-15 years old	Gardening and cooking program (10 weeks)	Not given	Pre-post: Attitudes, behaviour (intention to change) and FV intake	24-hour recall and survey	Significant difference in boys fruit and vegetables intake, no difference in girls intake.

Table 1.2 continued. A summary of 6 garden based intervention studies characteristics and outcomes for Evaluation trials (pre and post)

Author (year) Location	Study population (n)	Sample age	Intervention (Duration)	Grew/harvested	Measures	Measurement tools	Results
Heim et al. (2009, 2011) Minnesoda, USA	Grade four to grade six children (93)	10-13 years old	Trained staff intervention run at a YMCA holiday camp (12 weeks)	Beans, beets, carrots, cabbage, cucumbers, eggplant, kohlrabi, leaf lettuce, okra, onions, peppers, radishes, strawberries, Swiss chard, squash, tomatoes, zucchini, & herbs.	Pre-post: fruit and vegetable exposure, preferences, home availability asking behaviour and process measures	Questionnaires	Significant increase in: vegetable preferences, fruit and vegetable behaviour at home, and in fruit and vegetables ever tried/eaten ($p<0.001$). Significant increase in availability of fruit ($p=0.05$) and vegetables ($p=0.001$) in the home.
Wright & Rowell (2010) Wisconsin, USA	Kindergartens to grade 5 (234)	Not given	Garden program (10 weeks)	Kohlrabi, carrots, mustard greens & sunflowers	Pre-post weight of salad served at lunch time	Record of use of salad bar at lunch time	Significant increase in use of salad bar between pre and post intervention

FV= fruit and vegetables, Ed= education

Table 1.3 A summary of 11 garden based intervention studies characteristics and outcomes - Non-Randomised Controlled Trials (involves a control group)

Author (year) Location	Study groups (n)	Total (n)	Sample age	Intervention (Duration)	Grew/harvested	Measures	Measurement tools	Results
Morris et al., (2001) California, USA	Grade one children intervention (48) control (49)	(97)	Not given	Lessons integrated into the curriculum, taught by teachers (52 weeks)	Spinach, carrots, peas & broccoli	Pre-post: knowledge and attitudes of food, willingness to taste vegetables	One to one interviews	Increase in willingness to taste vegetables grown in the garden in the intervention group ($p<0.005$). No change found in children's ability to correctly name vegetables.
Morris and Zidenberg-Cherr (2002) California, USA	Grade four children Garden & nutrition ed (81) Nutrition ed(71) Control (61)	(213)	6-7 years old	Nine nutrition lessons (e.g. serving size, food pyramid) each with a gardening component taught by an investigator Activities: plant parts, indoor-outdoor seed boxes, weeding, harvesting, fertilisation (17 weeks)	Carrots, broccoli, spinach, snow peas, radish & swiss chard	Pre-post: Vegetable preferences, willingness to taste vegetables and knowledge	Questionnaires e.g. taste and rate vegetables	Preference test revealed higher preference scores for several different vegetables in the Garden/Nutrition ed group compared to the other groups Garden/nutrition ed group and nutrition ed group has significantly higher knowledge scores than the control group ($p<0.005$). No difference between the groups in willingness to taste/try vegetables.
Poston et al. (2005) Manhattan, USA	Grade three to grade five children Intervention (7) Nutrition only (11)	(18)	Not given	Junior Master Gardener programme (10-15min x 8 weeks)	Not given	Pre-post: FV preferences, knowledge, self-efficacy to consume intake	Questionnaires	No significant improvements in preference, knowledge or self-efficacy to consume.

Table 1.3 Continued. A summary of 11 garden based intervention studies characteristics and outcomes - Non-Randomised Controlled Trials (involves a control group)

Author (year) Location	Study population (n)	Total (n)	Sample age	Intervention (Duration)	Grew/harvested	Measures	Measurement tools	Results
O'Brien and Shoemaker (2006) Manhattan, USA	Grade four children Intervention (17) Control (21)	(38)	9-10 years old	Junior Master Gardener programme 8 after school lessons; F&V snack, nutrition education & gardening 30mins (80min x 8 weeks)	Not given	Pre-post: FV preferences, knowledge, self-efficacy to consume FV intake	Questionnaires	No significant difference in preference or FV knowledge score. There was an improvement in self efficacy to consumed, statistical difference not presented.
McAleese and Rankin (2007) Idaho, USA	Grade six children; Garden & nutrition ed (45) Nutrition education (25) Control (25)	(95)	10-13 years old	Nutrition in the Garden, developed by (Lineberger & Zajicek, 1998) School Garden: 25sq ft Activates: planting, weeding, watering & harvesting (12 weeks)	Strawberries, potatoes, corn, peppers, peas, beans, squash, lettuces & kohlrahi	Pre-post: FV intake	24-hour recall	Garden & Nutrition ed group consumed significantly more daily FV intake compared to nutrition ed group ($p<0.001$) Significant increase in vitamin A, C and fibre in the garden and nutrition education groups ($p<0.01$).
Parmer et al (2009) Alabama, USA	Second grade Garden (39) Nutrition ed (37) Control (39)	(115)	Mean age 7.3 (age range not given)	Health and Nutrition from the Garden. Gardening and nutrition program alternative weeks Activities: watering, weeding, & pest management (60min x 28 weeks)	Carrots, broccoli, spinach, and cabbage	Pre-post: Knowledge, preference and FV intake	Questionnaires, fruit and vegetable preference (taste and rate) and lunchtime observations	Significant increase in knowledge and taste ratings in the gardening and nutrition education groups compared to the control group ($p<0.001$). Gardening group consumed more vegetables at post-assessment than nutrition education group ($p<0.001$).

Table 1.3 Continued. A summary of 11 garden based intervention studies characteristics and outcomes - Non-Randomised Controlled Trials (involves a control group)

Author (year)	Study population (n)	Total (n)	Sample age	Intervention (Duration)	Grew/harvested	Measures	Measurement tools	Results
Somerset & Markwell (2009) Queensland Australia	Grade four to year seven male/female intervention (120) Historical control (132)	(252)	10-13 years old	Garden: 20m x 20m & greenhouse Gardening intervention with funded Gardener Activities: composting, propagation, planting, harvesting, & cooking (52 weeks)	Not given	Pre-post: Knowledge and attitude	Questionnaires	Significant improvement in knowledge/recognition of fruit and vegetables, and perceived consumption for fruit and vegetables ($p<0.05$). Decrease in interest in trying new fruits
Wang (2009) California, USA	Grades four and five High (72) Medium (32) Low(107)	(269)	Not given	High, medium and low intervention groups based on intervention development in each school (4 schools in total) Intervention consisted of school policy, gardening or cooking lessons	Not given	Pre-post: knowledge and attitudes and food intake	Questionnaire & 3-day food diary	Significant difference in fruit and vegetable consumption, knowledge & attitudes for the high intervention group ($p <0.05$). A significant decrease found in the low intervention group ($p <0.05$).
Morgan et al (2010) Newcastle, Australia	Grade 5 and 6 Nutritional education with Gardening(35) Nutritional Education (35) Control (57)	(111)	Not given	Intervention: Involved 180min per week of nutritional education, & 45 minutes of gardening Activities: planting, weeding, harvesting & cooking vegetables that were harvested. Three parental newsletters & homework tasks (180 min x 10 weeks)	Planting, weeding & harvesting; beetroot, lettuce, spring onions, spinach, potatoes, cauliflower, zucchini & rosemary	Vegetable intake & preference, fruit and vegetable knowledge Quality of school life	2 x 24hr recall & questionnaires	Both intervention groups were more willing to taste vegetables than the control group ($p=0.001$) Nutritional Ed significant improvement in identifying vegetables compared to Nutritional Ed and control group ($p=0.001$) No difference between groups was found for FV consumption

Table 1.3 Continued. A summary of 11 garden based intervention studies characteristics and outcomes - Non-Randomised Controlled Trials (involves a control group)

Author (year)	Study population (n)	Total (n)	Sample age	Intervention (Duration)	Grew/harvested	Measures	Measurement tools	Results
Ratcliffe (2011) Boston, USA	Grade six; Intervention (170) Control (150)	(330)	11-13 years old	Intervention: Health and Science program with a school garden Control: Health and Science program Activities: prepare the soil, planted seeds, transplanted starts etc & water. (60min x13 weeks)	Not given	Pre-post: Willingness to taste, knowledge, attitudes and behaviours towards vegetables	Garden Vegetable Frequency Questionnaire & Taste test	Intervention group significantly identified more vegetables than control group (p=0.002) significantly increased preferences for vegetables (p<0.02) and increased in variety of vegetables eaten compared to control group (p<0.001)
Davis (2011) Gatto (2012) California, USA	Grade four and five, Intervention group (34) Control (70)	(104)	Mean age 9.8 years old (age range not given)	Run at a community garden Garden: 10,000sq ft Activities: After-school gardening; identification of plants, seasonal crops, transplanting, recycling, composting, & irrigation Nutrition ed & Cooking (90min x 12 weeks)	Cilantro, nopales, beans, corn, & squash	Pre-post: diet, Body Mass Index & diastolic blood pressure	Block Food Screeners (food frequency screener) Anthropometrics measurements	Fibre intake increased by 22% compared to 12%; (p=0.04); decreased diastolic blood pressure 5% compared to 3%; (p=0.04) Increase in preferences for vegetables in intervention group compared to control (p=0.009)

FV = Fruit and vegetables, Ed = education

1.7.2 School Gardening Intervention Elements

The mean length of garden interventions was 12 weeks, the shortest lasting 8 weeks and the longest a whole year. On the whole, most of the studies used a professional gardener, who integrated the gardening activities into the school curriculum. Only two studies were not run in school time; Hermann et al. (2006) was an after school program, and Heim et al. (2009) was run during a summer holiday camp. Children were introduced to the basic gardening skills such as planting, watering, weeding, and harvesting (McAleese et al., 2007). The seeds that were planted were carrots, broccoli, spinach, cabbage, (Parmer et al., 2009) corn, peppers and strawberries (McAleese et al., 2007). One intervention (Lautenschlager and Smith, 2007) also included a cooking component with the gardening. Several of the studies combined nutrition lessons with a gardening component (Morris et al., 2002, McAleese and Rankin, 2007, Parmer et al., 2009, Morris et al., 2001, Lineberger and Zajicek, 2000, Poston et al., 2005).

1.7.3 Fruit and vegetable consumption

Five studies measured children's fruit and vegetable intake using standard dietary assessment methodologies (McAleese & Rankin, 2007; Parmer et al., 2009; Lautenschlager & Smith, 2007; & Wang, 2009, Morgan et al., 2010). Table 1.4 on page 31 describes the essential characteristics of these studies and the differences between groups for fruit and/ or vegetable consumption in portions (80g). In addition to these five studies, Wright and Rowell (2010) recorded the number of servings of salad provided at lunch, and Ratcliffe (2011), measured vegetable consumption by asking the children pre and post intervention whether they ate the following five vegetables at school or at home; carrots, string beans, snow peas, broccoli, or Swiss chard. The results from both of these did report a significant increase in servings of vegetables in the intervention group compared to the control group. However, due to the methodologies used by these trials their results are not presented in the analysis below. Wright and Rowell (2010) did not provide data on individual consumption, and Ratcliffe's (2011) measurement of vegetable intake was limited to only five vegetables.

Three different types of measurement tools were used to record individual intake of fruit and vegetables. Parmer et al. (2009) collated lunchtime observations to measure vegetable intake only, Mc Aleese & Rankin, (2007); Morgan (2010) and Lineberger & Zajicek, (2000) used 24-hour recalls to measure either fruit, vegetables or combined fruit and vegetables consumption, and Wang (2009) used a three day food diary. The results from these five studies were mixed, with McAlesse and Rankin (2007) and Wang (2009) showing a significant difference for fruit and vegetable intake. Lautenschlager and Smith found a difference in boys' consumption of fruit and vegetables compared to girls' fruit and vegetables consumption, and Morgan (2010)

found no differences in fruit or vegetable intake (measured separately only). Of the studies that did show an effect on fruit and vegetable intake, two used self-selection to determine which school received the intervention (Parmer et al, 2009; Wang, 2009). The teacher's willingness to teach the intervention and own beliefs in the importance of gardening could introduce bias in these results. McAlesse and Rankin's (2007) study showed the greatest change in children's fruit and vegetable intake, with an increase of 2.5 portions in the garden and nutritional education group. However, the dietary tool used was administrated by the teachers and completed by the children who might be inclined to give socially desirable answers, leading to overestimation of the intervention effect. An important geographical component to acknowledge when evaluating the success of a gardening intervention, is that all of the apparently successful interventions were located in states in the USA and Australia where fruit and vegetable can be grown all year round.

Table 1.4 A summary of gardening intervention studies exploring children's fruit and vegetable consumption

				Fruit intake (portions)				Vegetables intake (portions)				Fruit & Vegetables combined		
Author (year)	**Dietary Measurement**	**Gender**	**Intervention group**	**Baseline**	**Follow - up**	**within group diff**	**Between group diff**	**Baseline**	**Follow - up**	**within group diff**	**Between group diff**	**Baseline**	**Follow-up**	**within group diff**
Lautenschlager & Smith (2007)	24-hour recall	Boys Girls	Intervention	- -	- -	- -	- -	- -	- -	- -	- -	3.0** 2.6	3.4 2.9	0.4 ** 0.3
McAleese & Rankin (2007)	24-hour recall	Boys & Girls	Intensive Intervention	0.8	1.9	1.1	-	1.2	2.6	1.4	-	1.9	4.5	2.5**
			Low intervention	0.3	0.5	0.2	1.13*	1.8	1.7	- 0.1	1.44**	-	-	-
			Control	0.7	0.6	- 0.1	-	1.7	1.4	- 0.3	-	-	-	-
Parmer et al (2009)	Lunchroom observation	Boys & Girls	Intensive	-	-	-	-	0.7	1.0	0.3**	-	-	-	-
			Low intervention	-	-	-	-	0.6	0.6	0	-	-	-	-
			Control	-	-	-	-	0.8	0.5	- 0.3**	-	-	-	-
Wang (2009)	3 day food diary	Boys & Girls	Intensive	1.3	1.3	0.0	-	0.8	1.3	0.5	-	2.1	2.6	0.4*
			Medium	1.0	0.9	-0.1	-	1.0	1.1	0.1	-	2.0	2.0	0.0
			Intervention	1.2	1.2	0.0	-	0.8	0.8	0.0	-	2.1	2.1	0.0
			Low Intervention	1.3	0.9	-0.4	-	0.9	0.9	0.0	-	2.2	1.9	- 0.3
Morgan (2010)	2 x 24-hour recall	Boys & Girls	NE & Garden vs. control	-	-	-	0.1	-	-	-	-0.8	-	-	-
			NE & Garden vs. NE	-	-	-	-0.2	-	-	-	-0.5	-	-	-
			NE vs. control	-	-	-	-1.0	-	-	-	-0.1	-	-	-

NE=Nutrition Education; *p=0.05, **p<0.001, Diff= difference

1.7.4 Nutrition Knowledge

In addition to measuring children's intake of fruit and vegetables the primary outcome measure of these trials often explored nutrition knowledge of fruit and vegetables. Such as testing children's abilities to identify different fruit and or vegetables measured at baseline and again at follow-up (Morris & Zidenberg-Cherr 2002, Parmer et al., 2009, Morgan et al., 2010, Somerset and Markwell, 2009; Wang 2009; Ratcliffe, 2011, Morris et al., 2001, O'Brien and Shoemaker 2006, Posten et al., 2005, Koch, 2006). Out of 17 of these studies 6 identified a positive association with gardening and an increase in nutritional knowledge (Morris & Zidenberg-Cherr 2002, Parmer et al., 2009, Morgan et al., 2010, Somerset and Markwell, 2009; Wang 2009; Ratcliffe, 2011), whereas, 4 found no change in children's knowledge post intervention (Morris et al., 2001, O'Brien and Shoemaker 2006, Posten et al., 2005, Koch, 2006).

1.7.5 Self-efficacy towards fruit and vegetables

Another main outcome reported was children's willingness to try different fruit and vegetables and the improvement in fruit and vegetable preferences. Of the 17 studies, 11 also evaluated children's willingness to try fruit and vegetables or self-efficacy towards eating fruit and vegetables (Morris et al., 2001, O'Brien and Shoemaker 2006, Posten et al., 2005, Koch, 2006, Parmer et al., 2009, Morgan et al., 2010, Somerset and Markwell, 2009; Wang 2009; Ratcliffe, 2011, Lineberger & Zajicek, 2000, Morris & Zidenberg-Cherr 2002). Of these studies seven found children were more willing to try fruit and vegetables after completing the garden intervention compared to their comparison groups (O'Brien and Shoemaker 2006, Parmer et al., 2009, Morgan et al., 2010, Somerset and Markwell, 2009; Wang 2009; Ratcliffe, 2011, Lineberger & Zajicek, 2000) however, Lineberger and Zajicek (2000) and Ratclifee (2001) only found differences in preferences for vegetable, not for fruit. The methodologies used to collate this data were varied in quality. Hermann et al. (2006) used a single question to determine change in willingness to consume vegetables. They asked the children to respond either yes or no to the following question "I eat vegetables every day." Lineberger and Zajicek (2000) recorded frequency of types of fruit and vegetables recorded at follow-up, however no baseline data was given.

1.8 Barriers to implementing a school garden

From the literature search it was evident that there are some barriers to implementing a school garden programme. School gardens require long term commitment from the schools, and often need community assistance from parents if they are to be sustained (Ozer, 2005).

Another issue found was that some schools took too long to establish the school garden, affecting the period of time in the studies for plants to germinate and grown edible fruit or vegetables. Also environmental factors will play an important role in the amount of food harvested. Schools are closed over summer which is the peak harvesting season; without organising staff to water the garden and general garden maintenance the hard work during term time can be lost. The length and time spent in the interventions will also affect the chances of long term change in children's fruit and vegetable intake. It is unlikely to affect children's consumption patterns if their involvement in the actual intervention is limited.

1.9 Summary

The results from these studies provide important insight into the feasibility of school gardening. The results are promising and suggest school gardening programmes provide an interactive environment that has the potential to change children's self-efficacy and willingness to try different fruit and vegetables. These changes in attitudes towards fruit and vegetable may potentially lead to an increase in actual consumption of fruit and vegetables. The limitations of the existing research to date are the study design, evaluation tools, and lack of adequate follow-up time. With the variability in quality of study design and validated tools to measure children's nutritional intake, further research is needed to determine the potential impact gardening interventions have on children's diets.

1.10 The Royal Horticultural Society – "Campaign for School Gardening"

As the literature search has revealed, school garden programmes could potentially be an effective method of increasing children's fruit and vegetable intake. However, there are a limited number of robust studies using validated dietary assessment tools to determine if a garden intervention can improve children's overall nutritional intake, and have the long term outcome of decreasing the risk of non-communicable diseases.

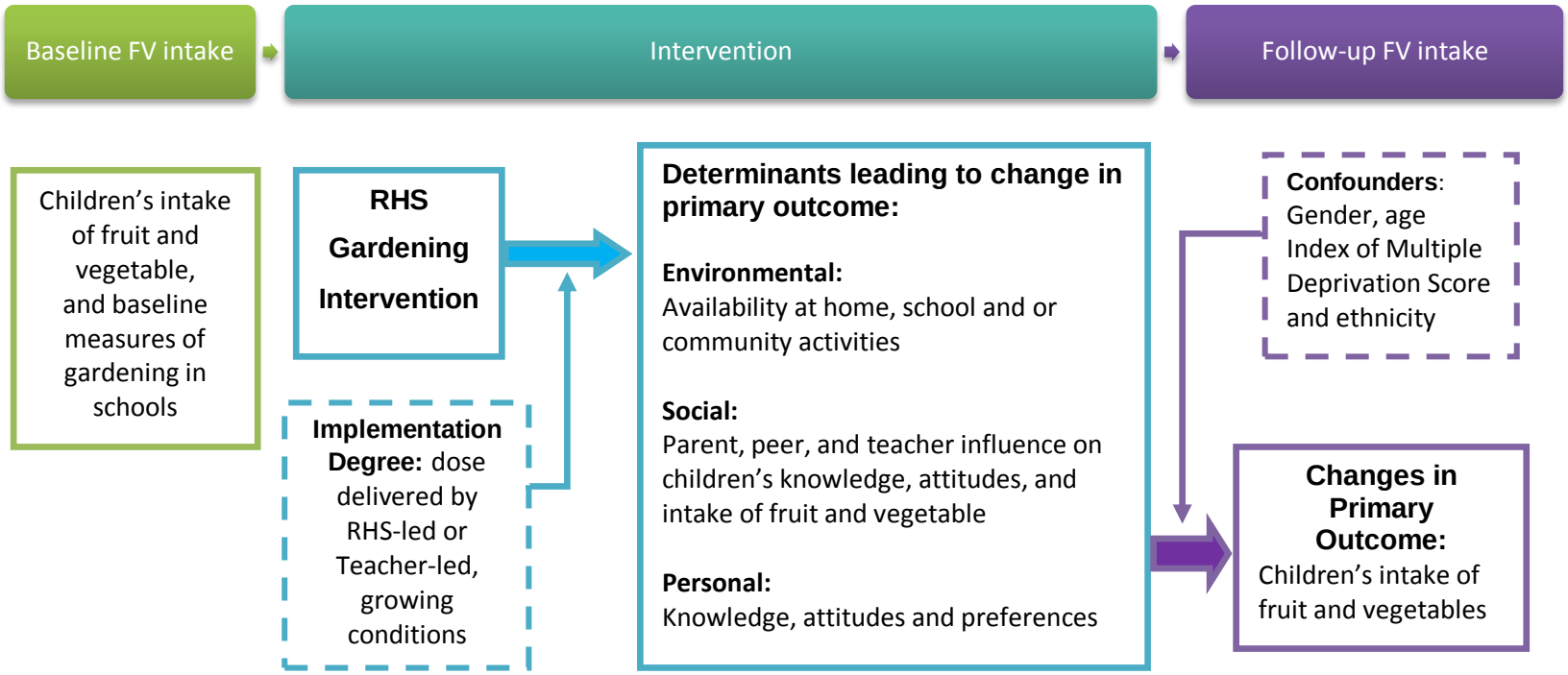
This thesis describes two randomised controlled trials designed to evaluate an existing gardening program run by the Royal Horticultural Society (RHS) in England. The RHS is the largest gardening charity in the UK and has existed for over 200 years (Royal Horticultural Society, 2010). The "Campaign for School Gardening" program was launched in 2007 and since then has recruited over 11,500 primary schools in England. The main aims of the programme are to encourage schools to be involved in growing fruit and vegetables, to enrich the

curriculum activities of the school, and to educate children with the values of gardening such as “healthy living” and “sustainability of the natural world (Royal Horticultural Society, 2010). The RHS intervention was delivered using two different approaches. The first was delivered by a trained RHS advisor, the second by the teachers, who received training from the RHS to implement the intervention.

Figure 1.1, based on the work conducted by Krølner et al., (2012), illustrates the theoretical foundation for this study. It explores some of the factors that could assist or prevent the success of the intervention on the primary outcome, highlighting important environmental, social and personal determinants that affect children’s nutritional behaviour. It is evident from the academic literature discussed so far that there are several determinants that are essential to changing a person’s health behaviour (De Bourdeaudhuij et al., 2008). Without changing a child’s environment and access and availability to fruit and vegetables, it would not be possible to change their overall intake. Watching parents, peers and teachers eating fruit and vegetables is pivotal for influencing children’s dietary habits and preferences (Patrick and Nicklas, 2005). In addition, nutrition education presented in the form of a gardening intervention should aim to increase children’s knowledge, creating the mechanisms necessary to increase overall intake (Somerset, 2009).

Nevertheless, to be able to determine the effect of the intervention it is necessary to explore the implementation of the intervention. The method by which the intervention is delivered to the schools, in this case by the RHS advisor or conducted by the teacher, can have an influence on the primary outcome. Understanding the degree of implementation of the intervention in each school is fundamental in explaining the effect of the intervention (Baranowski et al., 1998; Steckler & Linnan, 2002). Finally, information in Figure 1.1 also illustrates the possible confounders (gender, age, ethnicity and social economic status) that are associated with affecting children’s fruit and vegetable intake. Further details of the overall aims and structure of this thesis are described in the following section.

Figure 1.1 Path analysis diagram of how the intervention could change children's fruit and vegetable consumption



1.11 Structure of this thesis

The primary aim of Trial 1 is to determine whether children who participate in the RHS-led gardening intervention increase their fruit and vegetable consumption more than those participating in the Teacher-led RHS gardening intervention - Chapter 6.

The primary aim of Trial 2 is to determine whether children who participate in the low intensity RHS gardening intervention increase their mean fruit and vegetable consumption more than those in the control group – Chapter 6.

The effectiveness of either intervention will be determined by an increase in mean intake in one of the following; mean intake of fruit, mean intake of vegetables, or mean intake of fruit and vegetables at follow-up, after adjusting for baseline.

The following research questions apply to both Trial 1 and 2:

- What is the effect of the RHS Campaign on the intake of key nutrients (fat, carbohydrate, protein, vitamin C, carotene, iron, sodium, folate)? - Chapter 6.
- Can participating in a school gardening intervention improve children's ability to identify specific fruit and vegetables and attitudes towards fruit and vegetables? - Chapter 7.
- To explore if there is an association between the degree of implementation of the intervention and children's knowledge, attitudes and overall fruit and vegetable intake - Chapter 8.

1.11.1 To answer the main research questions:

- A child questionnaire and two process measures questionnaires were developed. The nutrient questionnaire Child and Diet Evaluation Tool (CADET) was modified to make it suitable for the age of this study's population. These questionnaires were piloted in primary schools from West Yorkshire before being used for the main study - Chapter 2.
- A validation study was conducted to analyse the CADET diary in children aged 8-11 years old from primary schools in West Yorkshire - Chapter 3.
- A detailed outline of the protocol for both trials was developed and approved by the Trial Steering Committee - Chapter 4.
- In addition to the main research questions a cross sectional analysis of the nutrient data collected from both trials at baseline was conducted. This analysis explores how

the home environment is associated with children's fruit and vegetable intake - Chapter 5.

1.12 Chapter Summary

This chapter has identified:

- The consequences of low fruit and vegetable intake from a public health perspective;
- The need for innovative interventions to increase children's knowledge and consumption of fruit and vegetables;
- The theory behind using gardening in schools as a tool to increase children fruit and vegetable intake, preferences for fruit and vegetables, and willingness to try different types of fruit and vegetables;
- The existing literature on garden intervention studies in primary school aged children;
- The need for a robust study methodology such as a randomised controlled trial to determine if school gardening has an effect on children's fruit and vegetable intake;
- The structure and aims of this thesis.

Chapter 2 - Development and Piloting of Questionnaires

This chapter outlines the development, modifications and piloting of the data collection tools used in this study: the dietary assessment tool and DVD, child knowledge and attitude questionnaire and the gardening process measures. It describes in detail the tools used to assess the primary and secondary outcome measures of the two trials. It also describes the pilot study conducted to confirm the suitability of language used in the questionnaires and to confirm the final data collection methodology for the trials.

The development of the data collection tools took place over two months from December 2009 until the end of January 2010. Ethics approval for the two trials was granted by the Leeds Institute of Health Sciences and the Leeds Institute of Genetics, Health and Therapeutic (LIHS/LIGHT) Joint Ethics Committee on 10th of December 2009 (ref number HSLT/09/012). The pilot study took place in two primary schools in the surrounding area of Leeds in November 2009.

2.1 Primary outcome questionnaire:

2.1.1 The Child and Diet Evaluation Tool (CADET)

The primary aim of Trial 1 and 2 is to determine whether children who participate in the RHS-led gardening intervention increase their fruit and vegetable consumption more than those participating in the Teacher-led RHS gardening intervention. The effectiveness of either intervention will be determined by an increase in mean intake in one of the following; mean intake of fruit, mean intake of vegetables, or mean intake of fruit and vegetables at follow-up, after adjusting for baseline intake. Dietary intake with a focus on fruit and vegetable intake was measured using a modified version of the Child And Diet Evaluation Tool (CADET) questionnaire (Cade et al., 2006). The main aim of the CADET diary is to collect accurate information on children's fruit and vegetable intake, whilst also collecting information on all foods the children consumed in a 24-hour period.

Part one of the CADET diary comprises a list of 115 separate food and drink types, divided into 15 categories. The categories of foods are cereal (5 items); sandwich/bread/cake/biscuit (10 items); spreads/sauces/soup (7 items); cheese/egg (6 items); chicken/turkey (3 items); meat other (9 items); fish (5 items); vegetarian (3 items); pizza/pasta/rice (8 items);

desserts/puddings (3 items); sweets/crisps (4 items); vegetables and beans (18 items); potato (2 items); fruit (13 items); drinks (9 items). Part two consists of food related questions to identify daily milk, bread, sugar, spreads, and fruit juice. It also includes general demographic questions about the family household, and questions about the children's and parent's attitude towards fruit and vegetables and the availability of fruit and vegetables at home (please see appendix page 214).

2.2 Data collection methodology

To complete the diary participants tick each item consumed under the appropriate meal time heading within the 24-hour period. In previous research with children aged 3-7 years, trained field workers filled in the CADET diary during the school day hours, and parents were asked to complete the diary for evening and morning food consumption (Ransley et al., 2007, Ransley et al., 2010). CADET has been validated for use in children aged 4-7 years old, but it has never been used in children aged 8-11 years, the age group of children in this study. After evaluation of previous studies (Ransley et al., 2007, Kitchen et al., 2009) the following modifications to the data collection methodology were made:

- The CADET diary was split into two diaries: a school diary to collect all food consumed at school and a home diary to collect all food consumed at home. These two versions of CADET were renamed School Food Diary & Home Food Diary.
- Additional demographic questions were added to explore the home food environment
- After the food recording day, the following day the fieldworker went back to the school to collect the Home Food Diary, and checked that it had been completed accurately. If a child forgot to return their Home Food Diary a retrospective recall was taken by the fieldworker to record all evening meals and breakfast.

Justification for these changes came from the response rate of a previous study "Project Tomato (Evans et al 2012b)." At baseline of Project Tomato 3159 children took part in the study. Of these children, 280 never returned the CADET diary after it was sent home to be completed by the parents. This meant the data collected during the whole day was lost, and that no data was collected on these children. An additional 170 CADET diaries sent home to be completed by parents, were returned without any of the sections completed. This reduced the sample size to 2709: a loss of 450 children or 14 percent. Furthermore, when analysing the data collected from this study, children with a total energy intake of less than 500kcal or more than 3500kcal on the day of CADET administration were excluded. This led to a further 179 children being excluded. It was anticipated that some of these errors in data collection would

be rectified after splitting the CADET diary into two diaries and having the fieldworker revisit the school to check the Home Food Diary had been completed.

2.2.1 Portion sizes for children aged 8-11 years

The dietary information from the CADET diary was transferred to an MS Access spread sheet using the established in-house software, Diet And Nutrition Tool for Evaluation (DANTE). This used standard predefined algorithms to convert food items into total daily nutrient values for each child based on the composition of foods (Royal Society of Chemistry). Whilst the CADET diary that the School and Home Food Diary were based upon was previously validated in children 3-7 years old it has not been used to collect dietary information on children 8-11 years of age. Since this study includes children aged 7-10 years old, it was necessary to change the standard portion sizes in DANTE to reflect the children's intake for each year of age, i.e. 8, 9, 10 and 11 and to account for differences in intake for boys and girls.

2.3 Methodology

2.3.1 Protocol for determining portion sizes for children aged 8, 9, 10 and 11

The portion sizes for the age groups 8, 9, 10 and 11 years, were obtained from the National Diet and Nutrition Survey of young people age 4-18 (NDNS) (Gregory et al., 2001). The NDNS was conducted to explore food consumption and nutrient intake in the general population, living in privately owned houses across Britain. The NDNS data is based on an interview, a four-day food diary as well as blood and urine samples. The NDNS data is the most detailed nutrition survey conducted across Britain. A recent up-date of the report (2008/09 – 2009/10) confirmed that the overall diet intake is similar to the previous findings. Due to the validity of this data it was decided that this data would be used to up-date the CADET portion sizes for older children (Department of Health, 2011).

From the NDNS data the mean portion size, number of participants, standard deviation, maximum and minimum values were extracted. Nearly all the food items used in the CADET were available from the NDNS data and then further broken down into each age category by gender. Whilst commonly consumed items such as apples and bananas had on average, a higher number of participants for each age group, (32 and 24 children on average per age group respectively), there were also several variables that had on average, fewer than five participants per age group. For these foods the portion had notably higher variation compared to the foods with a higher number of observations. The likelihood that these portion sizes were reflective of the general population was questionable. Furthermore, for some food

items, once these items were broken down into age/gender categories there was missing data. To improve validity of these foods with low or missing numbers the rules in the following sections were applied.

2.3.2 Missing Data

If any foods included in the CADET dairy were not available as specific codes/items on the NDNS database, then a similar food item was substituted.

2.3.3 Food Items With on Average Fewer than Five Participants per age/Gender Category

If the item had fewer than five participants on average, per age/gender category, an appropriate nutritionally similar food with an average of ten or more participants per age/gender category would be obtained. Then the average of the two means would be calculated in an attempt to reflect actual intake for each category.

An example is kiwi, which had on average only one person per age/gender category. It also had no value for females aged 11 or for males aged 10. For kiwi, an average of kiwi and peach, nectarine, plum, apricot, and mango was used to ensure a better representation of the average portion sizes for the different age groups based on gender. The aim was to smooth out the data where there were extreme values based on one person, and gain a more valid estimation of intake. For each food that was changed, a line graph was produced containing both the pre-existing food, e.g. “kiwi” and the modified food “average of kiwi and peach, nectarine, plum, apricot, mango” to visually confirm the portion sizes looked appropriate. The reason was to confirm the direction of change in consumption, as at different ages for different foods children can not only increase, but also decrease their consumption. Table 2.3 and Table 2.4 along with Figure 2.1 and Figure 2.2 below show the portion sizes for children aged three to eleven years to demonstrate the overall change in portions sizes by age in years. The calculations of portion sizes were only made for children aged eight to eleven years.

Table 2.1 Portion sizes (g) for kiwi fruit by age for girls

Food item	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11
Kiwi fruit (g) (n=8)	46	74	43	70	63	93	68	75	0
Peach, nectarine, plum, apricot, & mangon(g) (n=21)	55	86	63	109	101	79	68	78	48
Average intake of kiwi fruit & peach etc (g) (n=29)	46	74	43	70	63	86	34	37	48

Figure 2.1 Girl portion sizes (g) by age for different fruits in CADET

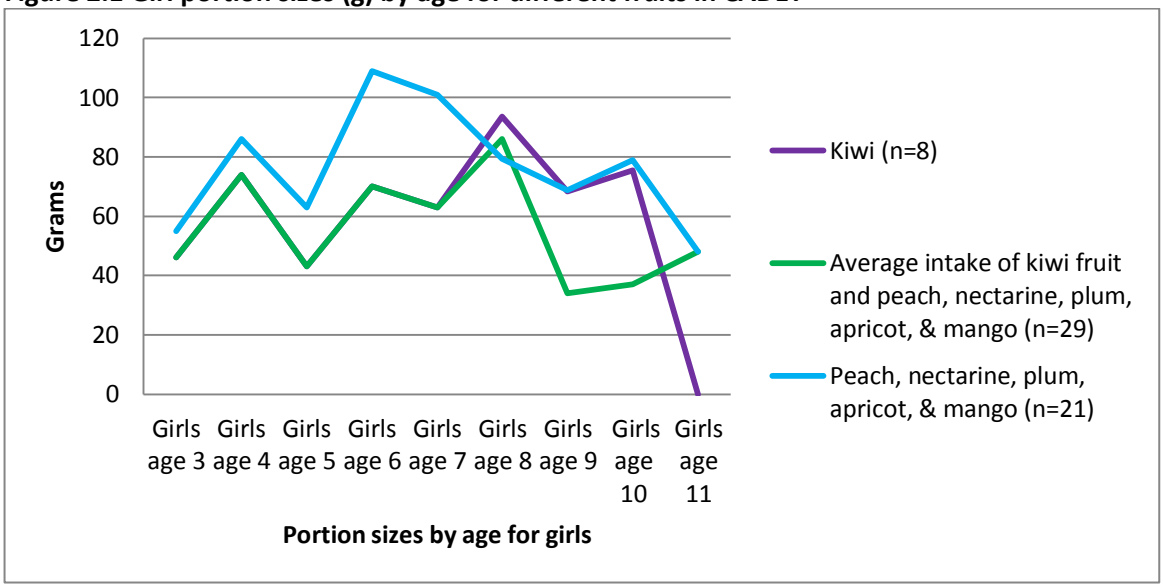
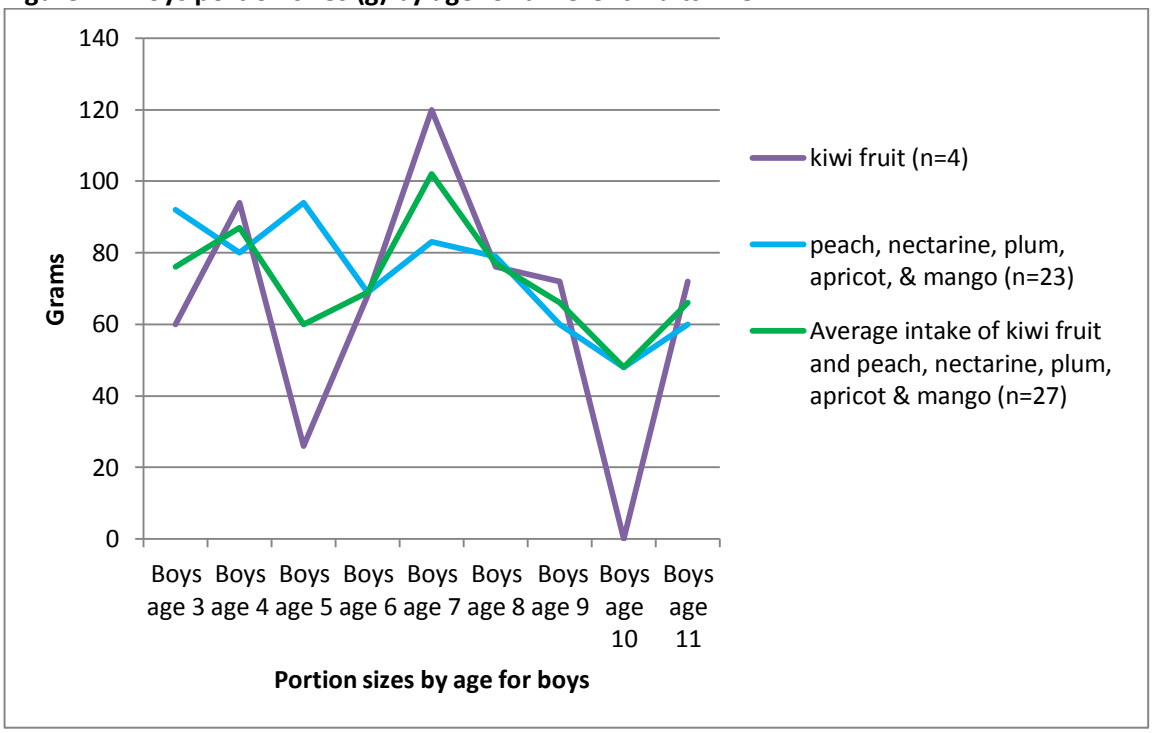


Table 2.2 Portion sizes (g) for kiwi fruit by age for boys

Food item	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11
kiwi fruit (g) (n=4)	60	94	26	68	120	76	72	0	72
peach, nectarine, plum, apricot, mango (g) (n=23)	92	80	94	69	83	79	60	48	60
Average (g) (n=27)	76	87	60	69	102	77	66	48	66

Figure 2.2 Boys portion sizes (g) by age for different fruits in CADET



2.4 Modifications

From the 115 foods in the School and Home Food Diaries, 21 had no dietary examples from the NDNS data and 16 of them had an average a sample size of fewer than five participants. Table 2.3 below, lists the food items from CADET that did not have a NDNS portion size, and the food groups used as a substitute to create an appropriate portion size. Table 2.4 lists the foods with an average of five or fewer participants per age group in the NDNS data and the food group that was used as a substitute.

Table 2.3 Foods with no portion size data from the NDNS and the food and portions (g) substituted

Food groups in CADET with no portion data in the NDNS for ages 8-11 years	Substitute food portion	Boys aged 8 years	Girls aged 8 years	Boys aged 9 years	Girls aged 9 years	Boys aged 10 years	Girls aged 10 years	Boys aged 11 years	Girls aged 11 years
Chapatti/pitta bread/wrap/ roti	Bread sticks & garlic bread/nann/parath	42	23	32	44	31	52	26	45
Cottage cheese	Cheese spread, triangles	26	22	24	22	26	23	36	25
Chicken in a creamy sauce	...stew casserole, mince, curry or keema	139	159	144	118	115	115	164	151
Vegetable pie/pasty	sausage roll, meat pie, pasty, fried dumplings	118	126	126	127	138	122	148	143
Samosa/pakora/bhajee	Vegetable pie, pasty	118	126	126	127	138	122	148	143
Quorn/veggie mince/sausages	sausage roll, meat pie, pasty, fried dumplings	66	69	64	69	77	69	82	72
Paneer (cheese curry)	...stew casserole, mince, curry or keema	139	159	144	118	115	115	167	151
Fried rice	Boiled rice	132	100	143	120	151	134	172	122
Pasta with meat/fish and sauce	Average of pasta with a cheese sauce & pasta with tomato sauce	164	155	170	231	238	160	144	185
Stir-fried vegetables	Average of carrots, cauliflower & peas	46	47	53	56	67	63	61	53
Courgettes	Average of carrots, cauliflower & peas	46	47	53	56	67	63	61	53
Spinach	Lettuces	19	16	21	35	25	22	22	28
Parsnips	Carrots	44	38	44	52	55	54	49	47
Radish	Average of peppers and salad	11	11	12	10	24	22	26	36
Leeks	Onions	15	15	15	28	26	23	35	20
Other vegetable	Average of carrots, cauliflower & peas/sweet corn	46	47	53	56	67	63	61	53
Lentils/dahl	Peas & sweetcorn	42	36	59	55	69	46	59	52
Other beans	Brussels sprouts	42	36	59	55	69	46	59	52
Pineapple	Grapes	84	58	61	105	40	90	85	90
Other fresh fruit	peach, nectarine, plum, apricot, mango & average of strawberries/grapes	100	92	111	72	88	89	71	97
Mousse/milk/rice puddings	Custard	97	91	109	105	112	80	146	104

Table 2.4. Foods with an average of fewer than five NDNS participants per age group and foods used to substitute the missing data (portion sizes g)

Food Groups with less than five participants	Substitute food	Boys aged 8 years	Girls aged 8 years	Boys aged 9 years	Girls aged 9 years	Boys aged 10 years	Girls aged 10 years	Boys aged 11 years	Girls aged 11 years
Croissants/waffles/pop tarts	Crumpets / pikelets / scotch pancakes	52	54	52	53	67	57	65	52
Nuts	Dried fruit	35	54	23	36	31	38	49	34
Quiche	Sausage roll, meat pie, pasty, fried dumplings	77	80	77	79	76	81	79	84
Corned beef, luncheon meats/salami	Ham	52	31	32	39	64	52	49	40
White fish (not fried)	Fish in breadcrumbs & fishcakes	80	78	112	81	83	79	83	62
Shellfish e.g. prawns/mussels	Tuna and other oily fish	44	33	56	50	54	54	45	47
Offal	Ham	24	18	28	27	63	47	38	39
Celery	Salad vegetables	27	8	17	33	24	22	26	36
Peppers/red/green/yellow	Salad vegetables	15	8	15	38	23	19	16	25
Strawberries/raspberries	Grapes	107	104	128	105	93	99	82	90
Pears	Apple	130	123	127	95	108	114	123	115
Melon/watermelon	Banana	199	167	138	220	171	133	102	140
Kiwi	Peach, nectarine, plum, apricot, mango	79	86	60	34	48	37	66	48
Sugar-coated cereals	Hi-fibre e.g. Bran flakes, Weetabix, Shreddies	43	40	18	36	17	38	46	46

The following Table 2.5 shows the final portion sizes for all vegetables used in DANTE for the CADET Diaries for boys and girls across the different age groups. Overall, there is a general trend for a small increase in vegetables consumption for both boys and girls. However, there is more variability between the different ages for both boys and girls in fruit intake (please see Table 2.6). Melon and watermelon portion sizes vary greatly from year group to year group; this could be a consequence of the infrequent consumption of both these fruits. It was decided not to over manipulate the data and to leave these portion sizes as they are, as the NDNS data is based on weighed intakes from a nationally representative sample.

Table 2.5 Vegetable portion sizes (g) for boys and girls age 8 to 11 years old

Food	Boys aged 8 years	Girls aged 8 years	Boys aged 9 years	Girls aged 9 years	Boys aged 10 years	Girls aged 10 years	Boys aged 11 years	Girls aged 11 years
Baked beans	95	97	112	97	113	92	104	104
Broccoli, brussels sprouts, cabbage	50	59	53	52	68	56	60	67
Carrots	42	32	40	58	54	56	41	42
Cauliflower	52	66	54	61	78	88	75	61
Celery	27	8	17	33	24	22	26	36
Coleslaw	47	44	47	35	42	38	64	42
Courgette	46	47	53	56	67	63	61	53
Cucumber	32	27	25	34	23	31	25	28
Leeks	15	15	15	28	26	23	35	20
Lentils, Dahl	42	36	59	55	69	46	59	52
Mixed vegetables	42	36	59	55	69	46	46	52
Other beans, pulses	42	36	59	55	69	46	59	52
Other salad vegetables	19	16	21	35	25	22	22	28
Other vegetables	46	47	53	56	67	63	61	53
Parsnip	44	38	44	52	55	54	49	47
Peas, sweetcorn	42	36	59	55	69	46	59	52
Peppers, red, green, yellow etc.	15	8	15	38	23	19	16	25
Radish	11	11	12	10	24	22	26	36
Spinach	19	16	21	35	25	22	22	28
Stir-fried vegetables	46	47	53	56	67	63	61	53
Tomatoes	69	75	24	64	33	69	47	41

Table 2.6 Fruit portion sizes (g) for boys and girls age 8 to 11 years old

Food	Boys aged 8 years	Girls aged 8 years	Boys aged 9 years	Girls aged 9 years	Boys aged 10 years	Girls aged 10 years	Boys aged 11 years	Girls aged 11 years
Apple	123	117	117	122	120	114	123	115
Banana	104	93	110	119	114	119	102	116
Dried fruit	35	54	23	36	31	38	49	67
Fruit salad (tinned or fresh)	107	104	128	105	93	99	82	90
Grapes	84	58	61	105	40	90	85	90
Kiwi	76	87	60	69	102	77	66	48
Melon	199	167	138	220	171	133	102	140
Orange, Satsuma etc.	132	160	117	137	105	140	84	57
Other fruit	100	92	111	72	88	89	71	97
Peach, nectarine, plum, apricot, mango	92	80	94	69	83	79	60	48
Pear	130	123	127	95	108	114	123	115
Pineapple	84	58	61	105	40	90	85	90
Spinach	19	16	21	35	25	22	22	28
Strawberry, raspberry etc	107	104	128	105	93	99	82	90

2.5 Additional Demographic Questions

There were several questions added to part two of the CADET Diary. The first set of questions explored the availability of fruit and vegetables at home, and children and parent's fruit and vegetable habits. An example question is "*do you buy specific fruit/vegetable because your child asked for it?"* The parents are presented with the response options of "*yes always, yes, most days/often, sometimes, rarely and never*." These questions were based on the existing literature (Kristjansdottir et al., 2006). This research explored the availability and accessibility of fruit and vegetables in the home environment. The reliability and validity of these questions was explored by De Bourdeauhuij et al (2005). Test-retest reliability was conducted on five different European countries: Norway, Spain, Denmark, Portugal and Belgium. The intra-class correlation coefficient was 0.6, suggesting it is a reliable tool to use in primary school aged children (De Bourdeaudhuij et al., 2005).

The second set of six questions added regarding the family's fruit and vegetable intake, were based on Bryant (2008). These questions address parents' reasons for buying fruit and vegetables for their family and the importance of buying fruit and vegetables. One such question addresses the "*price of fruit and vegetables*" - parents were provided with the options of either "*very important, important, neither unimportant or important, unimportant, very unimportant."*

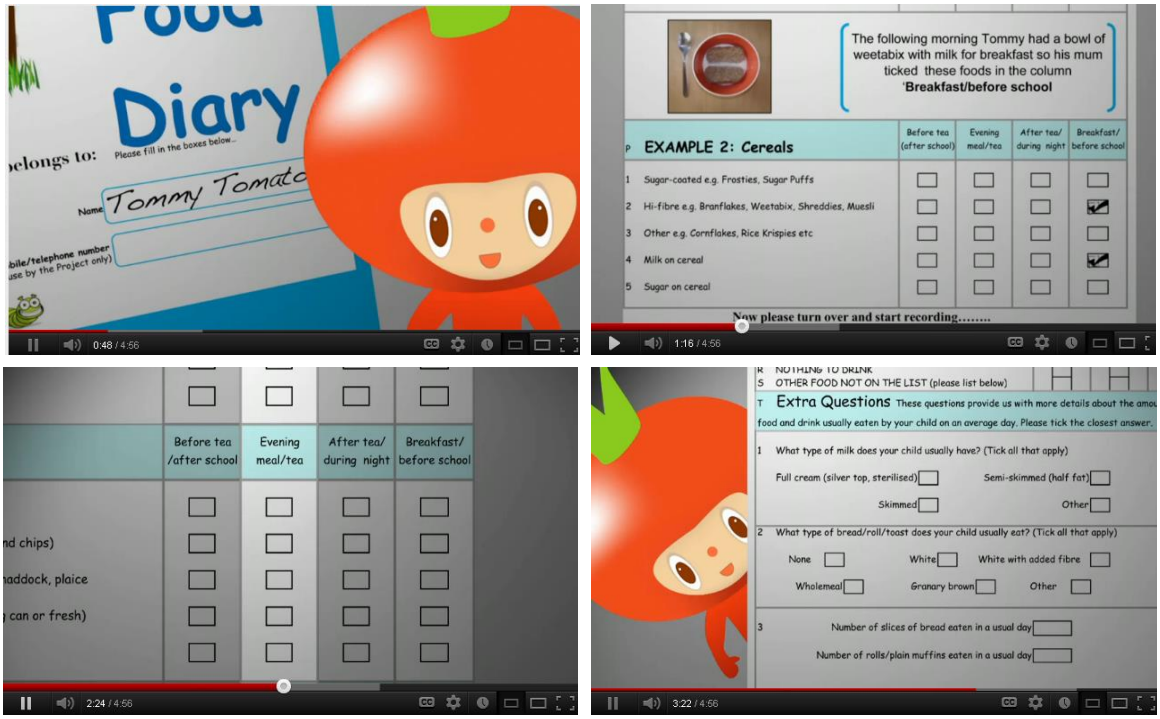
The third and final question that was added to the home food diary was a request for an inventory of fruit and vegetables currently in the house on the evening the diary was administered. This question lists common fruit and vegetables consumed and asked the parents to tick any of them that are currently in their food cupboards or fridge. There is also a section of "other" a particular item was not listed.

These questions in section two were included to provide some understanding of the home food environment, providing us with insight into the availability of fruit and vegetables, and parent's attitudes toward fruit and vegetables. This insight is pivotal, as the home food environment is a key influence on children's food intake (Bryant et al., 2008, Ogden et al., 2006).

2.6 Development of the Home Food Diary Instruction DVD

Previous studies that have implemented the CADET diary to measure dietary intake have identified that parents and children with low literacy ability or English as a second language struggle to complete the diary (Ransley JK et al., 2010). Whilst the CADET diary had two pages of simple instructions on how to complete the diary, it was evident some participants still did not understand what was required of them. Sometimes children or parents would complete the diary, ticking every item in the diary that the child liked, rather than only those foods the child had eaten that day. Some did not complete the CADET at all, and simply did not return it to school, despite several reminders. To improve accuracy and completion of the Home Food Diary, the concept of creating an instructional DVD for parents and children to watch was developed.

Figure 2.3 Images from the CADET DVD



The DVD script was written with the aim of children and parents watching the DVD together, it used a cartoon character to explain each step of the diary, whilst showing the actual diary on the screen for parents and children to follow. The script was written by MSC with input from the PhD supervisors, with the aim of introducing the study to the audience and explaining how to complete the Home Food Diary step by step. The main aims of the script were to introduce the study, remind the children to make sure their parents were watching, demonstrate how to complete each meal, explain what “part two” questions consisted of, and to return the diary

back to school the next day. It also provided a contact number for parents to ring if they had any queries.

It was decided that a cartoon character would be the narrator and resemble the characters used by the Wii console. The cartoon character was a tomato called Tom the Tomato, and had the head of a tomato with a red body, alive in a plant pot. The concept behind using a cartoon character was to make the DVD child friendly so hopefully children and parents would find it interesting. To construct the DVD Leeds Media Service were contracted. It was decided that the voice of Tom the Tomato would be a child's voice and Emily Cade who was 16 years of age was recruited as she had a clear speaking voice with very little regional accent. The total length of the instruction DVD is 5 minutes. The end product is a useful tool for anyone completing the Home Food Diary questionnaire as it both "verbally tells you" and "visually shows you" how to complete the Home Food Diary (www.youtube.com/watch?v=AIbzqaJiHq0).

2.7 Secondary outcome questionnaires:

2.7.1 Development of the Knowledge and Attitudes towards fruit and vegetables questionnaire

One of the secondary outcome measures was "Can participating in a school gardening intervention improve children's ability to identify specific fruit and vegetables and attitudes towards fruit and vegetables?"

Since the RHS gardening intervention is an educational resource that teaches children about fruit and vegetables through gardening, it has the potential to have an impact on children's general knowledge of fruit and vegetables. Therefore, one of the other main aims of this study was to explore change in children's knowledge and attitudes towards fruit and vegetables, to see if there was a difference from baseline to follow-up. A short questionnaire was developed to identify children's knowledge and attitude towards fruit and vegetable consumption, and assess gardening activity levels (please see page 226 in the appendix). The knowledge questions assessed children's ability to recognise different fruit and vegetables. Children were presented with a list of 13 fruit and a list of 17 vegetables (and 1 herb), with a colour picture for each, and asked to draw a line connecting the name with the right picture. The attitude questions were based on previously validated research (Somerset and Markwell, 2009). Children were asked if they agreed or disagreed with these ideas about fruit and vegetables, and were presented with a list of ten questions, five about fruit, and five about vegetables. An example is "I enjoy eating fruit." The children had to circle one of the four options, "agree a

lot, agree a little, disagree a lot, and disagree a little." Images of smiley faces, neutral or sad were presented above each statement for the children to help work out their response.

The gardening questions assessed the children's gardening experience: what they have grown and what they have tasted. The children were asked to confirm yes or no if they had done any gardening, then write in the space provided if they had grown any fruit or vegetables. They were then asked to confirm "yes or no" if they had tasted any of the fruit or vegetables they had grown, and write down what they had tasted.

To assist with the varying levels of reading ability this questionnaire was read out to the children as a class, to help them with any difficult words. Furthermore, the teachers and teaching assistants were encouraged to help the children that might struggle with this task, and children were encouraged to put their hand up if they had any questions.

2.7.2 Process Measures Questionnaires

There were two process measures components for this study; the first was a gardening telephone interview, to identify current level of gardening activities within the school (please see appendix page 228). The second was the gardening activity process measure questionnaire to identify the gardening activities that had taken place in each academic year in each school.

2.7.2.1 School Gardening Questionnaire

The School Gardening questionnaire was a telephone interview. It was designed to identify the school's baseline gardening level. This questionnaire was based on the RHS benchmarking scheme which ranks the schools in the following categories: (1) planning, (2) getting started, (3) growing and diversifying, (4) sharing best practice and (5) celebrating with the wider community. The schools were asked a series of questions to identify different aspects of gardening currently occurring in their school garden. The questions were focused on the following aspects of gardening in schools: school culture and ethos, the school garden, teaching and learning, and community. Within each of these areas there were several questions that reflect different levels of development within school gardening that relate to the five categories, describing the different stages of developing a school garden. These questions were adapted to simple yes or no questions to be used in a telephone interview. The interviewee was the school staff member who was most involved in the school garden within each school. The questions were structured according to the five categories.

2.7.2.2 Gardening Activity Process Measure Questionnaire

The aim of the gardening activity questionnaire was to identify the level of adherence to the intervention for the schools involved in the intervention, and to identify any gardening activities that are being undertaken by the control schools. The main aim of the process evaluations is to capture what fruit and vegetables each school grows and harvests. It is also to identify which year groups have been involved in the garden that year, if they have started a growing or environmental club, and to find out if the schools had any success or failure stories around the school garden. This information was captured via email in September 2010 for trial years one and two, and again in September 2011 for both trials.

For the schools involved in the RHS intervention more in-depth information about their intervention activities was captured by the regional advisor and was used by him to outline changes in school gardening. From this, the level of involvement of the intervention for each school and their adherence to the intervention was identified, as well as success and failure stories reported by the regional advisor himself and via the process measures email.

For Trial 2 intervention schools, there was another process measure that was captured, which is level of involvement in the twilight sessions, whereby the regional advisor kept a record of teacher's attendance. With this type of intervention, schools were expected to tailor the intervention to their individual needs. By monitoring what activities are undertaken in the school garden aspects of the intervention that could be associated with dietary change were identified.

2.8 Discussion

Accurately measuring children's energy and nutrient intake is challenging, especially in a large trial such as this as there are always benefits and limitations with any nutritional assessment tool. Research suggests that children are aware of what they consume from around 8 years old (Livingstone and Robson, 2000). With primary school aged children, parents are often used to collect the dietary information as children are considered too young to collect accurate dietary data. However, dietary analysis is prone to many forms of measurement error (Cade et al., 2002). CADET has been validated in an ethnically diverse population (Cade et al., 2006) and has been used to evaluate large intervention studies. Such as the national free school fruit scheme in primary school children (Ransley et al., 2007) and in a large national RCT of an intervention to maintain fruit and vegetables eating in year 3 children once they are no longer eligible for free fruit (Evans et al., 2011, Christian et al., 2011). The style of CADET using a simple tick box

list is considered an appropriate tool for people with low literacy who struggle to record or weigh what they eat. The main benefit of using a 24-hour tool is that it is easy to complete in a large sample at a relatively low cost (Gibney et al., 2006). This style of nutrition analysis will capture the mean intake of a population, and is the standard method used for intervention evaluation. The disadvantage with 24-hour data is that it cannot be used to analyse individual intake, as the instrument is not sensitive enough to identify individual differences in dietary patterns (Evans, 2010, Gibney et al., 2006). Nevertheless, the CADET tool has been proven to be a valid tool for evaluating intervention studies in trials (Ransley JK et al., 2010, Cade et al., 2006, Christian MS, 2011) and is an effective way to capture fruit and vegetable intake in children. The strengths and limitations of the CADET Diary will be discussed in Chapter 3.

2.9 Questionnaire development summary

The main aim of the dietary assessment tool is to collect information on children's fruit and vegetable intake, whilst also collecting information on all the food the children consumed in one 24-hour period. Whilst previously one 24-hour food diary has been used, for this study CADET was changed and modified into a School Food Diary and a Home Food Diary, to improve the response rate of the Home Food Diary. Furthermore, the portion sizes used to analyse the children's food intake were changed to reflect the age and gender related portion sizes of the sample. A DVD was also designed to help parents and children understand how to complete the Home Food Diary. The final modification was a change in the administration of the diaries, with the field workers returning to each school the day after collection, to collate and check the diaries and to identify any that had not been completed properly. The additional step was to collect a recall from home intake from children who had not returned their diaries that day.

To ensure that these portion sizes reflected actual dietary intake it was necessary to test this instrument - the Home and School Food Diary, against an appropriate reference measurement such as a one day weighed record in the relevant aged children in years 3, 4, 5 and 6 (Nelson et al., 2007, Molag et al., 2007). Chapter 3 describes the validation study that was undertaken as part of this project, and provides a more detailed discussion about using a 24-hour recall for nutritional intervention work.

Additional questionnaires were designed to measure the secondary outcomes measures for this study:

- Child knowledge and attitude questionnaire
- Gardening telephone interview questionnaire

- Gardening in schools process measure questionnaire

These questionnaires were designed to capture important information to evaluate the effectiveness of the RHS gardening intervention, through evaluating children's learning and knowledge with a focus on fruit and vegetables, capturing change in schools gardening involvement based on RHS gardening levels and implementation of the intervention or other gardening activities in schools.

2.10 Piloting Baseline materials

Due to the changes in the original CADET diary, the collection method and the development of the new questionnaires, including the Child Knowledge and Attitude Questionnaire as well as the instruction DVD it was necessary to pilot these materials. Two primary schools in West Yorkshire were recruited to be involved in a pilot study of the collection procedure and the new materials; School and Home Food Diary, the Child Gardening questionnaire and the instructional DVD.

The aims and objectives of the pilot study were:

- To determine if the DVD should be shown to the children in the classroom at school, or if it should be sent home with the children for them and their parents to watch together.
- To confirm that the questionnaire is age appropriate in terms of language used and layout and to identify whether there were any questions children struggled to answer.
- To test the new data collection protocol and explore the potential benefits of the field workers checking the Home Food Diary the following day.

2.11 Methodology

2.11.1 Study population

A total of 74 year 3 and 4 children from two local primary schools in Leeds (mean age 8.4 years) participated in the pilot study. This involved three different class groups, one year three, one year four and a mixed year three and four class. To evaluate whether the DVD should be sent home or viewed in school, one class was allocated to receive the DVD to watch in class, another was allocated to be given the DVD to take home, and the third class was allocated not to receive the DVD at all.

Nutrition Masters students were recruited and trained to administer the CADET diaries and the child attitude and knowledge questionnaire. The students were asked to record everything the children ate at school by completing the School Food Dairy, then go through the child attitude and knowledge questionnaire as a class. At the end of the school day, one class of children was given the home food diary, one class was asked to watch the DVD before they were given the home food diary; and the final class was given the DVD and the Home Food Diary and asked to watch the DVD with their parents.

2.12 Results

A total of 74 children were invited to participate in the pilot study and 62 parents agreed to let their children participate. The results from this study are presented in Table 2.7.

Table 2.7 Pilot study results

	Received the DVD to take home (N=33)	Watched DVD at School (N=22)	No DVD given (N=19)
Response rate (%)	30 (90)	15(68)	17 (89)
Boys (%)	13 (43)	9 (60)	10 (59)
Year level	3 & 4	3	4
Returned the Home Diary (%)	25 (84)	11 (73)	8 (47)
Home food diary recalls	5 (16)	4 (27)	9 (53)
5 A DAY "correct" answer	19 (63)	8 (16)	9 (53)

2.12.1 Home Food Diary and Instruction DVD

One of the aims of the pilot study was to evaluate whether the DVD should be shown to the children in the classroom at school, or whether it should be sent home with the children for their parents to watch together; there were concerns about children forgetting to return the DVD's back to school the next day, and losing the DVD. The results indicated that children who received the DVD to take home and watch with their parents had a higher return rate (84%) compared to the children who watched the DVD in class (73%) and or did not receive the DVD (52%). Of those parents who confirmed they watched the DVD, all of them completed the Home Food Diary correctly. Therefore, it was decided that all children should receive the DVD to take home and watch with their parents to improve the quality of the data collected.

2.12.2 School Food Diary

The field workers were also required to complete the school food diary for all the children in the pilot study. It was brought to our attention that Yorkshire pudding was not included on the School Food Diary, as one school had them as part of their school dinners – it was then added to both School and Home Food Diaries. There was also a comment from one of the parents

about the Home Food Diary. They stated that they would prefer their ethnicity to be classified as "British Asian" rather than "Asian British." This was rectified.

2.12.3 Data collection protocol

On the second day of data collection, the field workers had two tasks: 1) to check the Home Food Diary was completed properly and 2) to check if the home diary was completed and if the children did not return the Home Food Diaries, the field workers had to complete a diet recall. These results reveal that 25% of the total sample did not return the Home Food Diary. Of the children who were allocated to watch the DVD with their parents only 16% of that class needed a diet recall taken, compared to 28% who watched the DVD at school and 48% who did not receive the DVD.

2.12.4 Knowledge and Attitude Questionnaire Results

To assist with the psychological questions and the variability in children's reading ability, the knowledge and attitude questionnaire was read aloud to the children and completed together as a class. School teachers were encouraged to assist any children they thought might struggle completing the questionnaire.

Administration of the questionnaires was successfully completed. There were six different sections on the child questionnaire. There was only one section which children struggled to complete, this was section 4 containing psychological questions about gardening and fruit and vegetable self-efficacy. Children were asked to respond either *"agree a lot, agree a little, disagree a little, or disagree a lot"* to each of these questions (presented in Table 2.8). Due to the feedback from the fieldworkers, five of the questions were removed. Furthermore, a smiley face or sad face was added under the different options (agree a little etc.) to help children choose how to respond to each of these questions.

The results also revealed that on average, when asked how many fruit and vegetables you should eat every day to stay healthy, 52% of the children were not aware they should consume at least 5 fruit and vegetables a day.

Table 2.8 Psychological questions included on the Child Knowledge and Attitude Questionnaire

Questions	Questions removed
I like trying new fruits.	No
I like trying new vegetables.	No
Eating fruit and vegetables every day keeps me healthy.	No
Most fruit tastes bad.	Yes
We have veg with dinner most nights.	Yes
There's usually lots of fruit and vegetable snacks at home.	Yes
I'm good at preparing fruit and vegetables.	No
I like raw vegetables.	Yes
We grow fruit or vegetables at home.	Yes
My parents encourage me to eat fruit and vegetables	No
I enjoy eating fruit.	No
I enjoy eating vegetables.	No
I try to eat lots of fruit.	No
I try to eat lots of vegetables.	No
I find it easy to eat lots of fruit.	No
I find it easy to eat lots of vegetables.	No

2.13 Discussion

There were three main aims of this pilot study. The first was to determine whether the children should take the DVD home to watch, or watch at school. The results revealed that children and parents watched the DVD together had a higher response rate than children who just watched the DVD at home, or did not watch the DVD at all. The second aim was to test the Child Knowledge and Attitude Questionnaire, to confirm that the questionnaire was age appropriate in terms of language used to identify whether there were any questions children struggled to answer. This identified that children struggled with some of the psychological questions such as *"We have veg with dinner most nights*" and "*there's usually lots of fruit and veg snacks at home"* therefore these questions were removed. The final aim of the pilot study was to test the new protocol methodology. On the second day of data collection, 18 children (25%) of the children did not bring back a Home Food Diary; if the field workers had not conducted a recall, then 25% of the sample diet data would have been lost. The fieldworkers also provided positive comments regarding conducting the diet recall. This is supported by other research that states children are aware of what they consume from around 8 years old, the mean age of the trial children (Lillegaard et al., 2007).

Overall, the aims of the pilot study were achieved, and the results were able to provide important feedback in the development of the necessary tools needed to evaluate the RHS gardening intervention.

2.14 Chapter Summary

This chapter has discussed the methodology used in designing the data collection tools for this study. It also discussed the pilot study conducted in Leeds and the changes made as a consequence of this process.

The pilot study revealed it was beneficial for parents to watch the DVD at home with their children, when compared to children who watched the DVD at school or not at all. It also highlights some of the psychological questions that children in year 3 and 4 struggled to understand, and some minor changes in the Food Diaries. These changes and additions to the collection methodology aim to improve the overall response rate and quality of the data collected.

Chapter 3 - Measuring fruit and vegetable intake in primary school children: validation of the CADET Diary in children aged 8-11 years

The primary aim of the two trials is to explore the difference in children's fruit and vegetable intake between intervention and comparison groups. The Child And Diet Evaluation Tool (CADET) diary designed by the Nutritional Epidemiology Group at the University of Leeds is a 24-hour food diary that measures the nutrition intake of children aged 3-7 years old, with a focus on fruit and vegetable consumption. CADET has never been used to measure nutrient intake of children aged 8 to 11 years old. As discussed in the previous chapter, portion sizes data based on gender and age (eight, nine, ten and eleven) were generated from the National Diet and Nutrition Survey (NDNS) study conducted in 2004 so the CADET diary could be used for the two RHS trials. This chapter outlines the validation of the CADET diary in a sample of 67 children from West Yorkshire aged 7-11 years old. To ensure that these portion sizes reflect actual dietary intake, participants were asked to complete the CADET diary (i.e. the School and Home Food Diary) concurrently with a one day weighed record diary (Nelson et al., 2007, Molag et al., 2007). Total fruit and vegetable intake in grams and other nutrients were extracted to compare the mean intakes from the CADET diary and Weighed Food Dairy using t-tests and Pearson's r correlations. Bland-Altman analysis was also conducted to assess the agreement between these two methods, to determine whether the CADET diary was suitable for measuring the primary outcome of the two RHS trials.

3.1 Introduction

Dietary assessment attempts to accurately estimate habitual intake for the group of individuals of interest. Nevertheless, measuring food intake is difficult due to the wide variation that can occur daily, weekly, or even seasonally (Cade et al., 2002). The importance of accurately measuring food intake in children is a concern, as dietary habits formed in early life can have a serious impact on long term health status (Berenson, 2002). Measuring food and nutrient intake in children is more challenging than in adults. Until children are eight years or older, they are not aware of the food they are consuming or do not have the cognitive abilities to identify their own food intake (Livingstone, 2003). This means parents play a vital role in reporting their child's food intake. Epidemiological research involving primary school age children tends to rely on parents or field workers to report children's food intake. Evidence suggests that parents can be reliable reporters of their child's food intake using either dietary

recalls or 24-hour food diaries in the home environment (Klesges et al 1987, Baranowski et al 1991). This reliability is strengthened when both parents are involved in the reporting process (Livingstone, 2000). Food eaten outside the home is less reliable, and often a major area for possible bias. When children are absent from their parent's care for four or more hours of the day, their parents ability to accurately recall their child's nutrient intake dramatically decreases (Baranowski et al., 1991). Therefore using field workers to complete the children's recall at school reduces this risk of bias. Another area of measurement error is portion sizes; in both adult and children studies accurately measuring portion sizes is a large source of error. There are mixed views as to whether children can estimate the quantities of food they have consumed. Some studies state children aged 8-15 years can estimate within ten percent the food they actually consumed when measures such as household items are used to help aid quantification (Lytle et al., 1993). It is accepted that there is no perfect way of measuring habitual intake in children (Frobisher and Maxwell, 2003). For large population studies it is essential that the dietary assessment method be easy to complete.

When validating a dietary assessment method it is important to look at the daily energy intake between the two methods; it is also necessary to explore differences in nutrient intake; e.g protein, carbohydrates, total saturated fat, monounsaturated fat, polyunsaturated fat, fibre, calcium, iron, carotene, folate and vitamin C. Generally speaking variability in nutrient intake is low for those nutrients regularly found ubiquitously in the diet e.g. protein, carbohydrates, and higher for nutrients concentrated in a small range of foods such as carotene, retinol, folic acid, and unsaturated fatty acids (Livingstone and Robson, 2000).

For children, the validity of a 24-hour recall compared to a more complex food diary has been shown to accurately reflect energy intake of the sample population, however, they are generally not precise enough to accurately measure individual intake (Johnson et al., 2006). The most likely cause of overestimation or underestimation of energy intake is associated with the portion sizes assigned to different foods. Misreporting in dietary questionnaires is a major problem in adult studies let alone in paediatric populations that rely on information from parents and children. It is vital that all studies build in validation methods to critically examine evidence of measurement error in the reporting.

Whilst the CADET diary has been previously validated in children aged 3-7 years, this study involves children aged 8-11 years (Cade et al., 2006). Using the age specific portion sizes based on research from the children's NDNS (Wenlock and Farron, 2000), the CADET diary was up-dated for children aged 8-11. This study aims to evaluate whether a modified version of CADET

has the potential to measure the diet of children aged 8-11 years by validating it against a reference method. A sample of primary school children was asked to complete the CADET diary whilst at the same time completing a weighed food diary (Nelson et al., 2007b, Molag et al., 2007).

3.2 Method

3.2.1 Subjects

Eight schools surrounding the Leeds and the West Yorkshire area were asked to participate in the study. Five schools were recruited, and a total of 67 children from years 3-6 (aged 8-11 years old) agreed to take part in the study.

3.2.2 Design

Data collection was carried out between November 2010 and June 2012. The children received a consent letter to take home to their parents a week before the data collection day. All parents who gave consent attended an information session at the end of the school day.

3.2.3 Dietary Assessment Method: CADET

For this trial, diet was assessed using a modified version of the validated Child And Diet Evaluation Tool (CADET) questionnaire (Cade et al., 2006). The CADET uses age and gender specific food portion sizes to calculate food and nutrient intake for children aged 3 to 11 years old. The CADET diary comprises a list of 115 separate food and drink types, divided into 15 categories. The categories of foods are cereals (5 items); sandwich/bread/cake/biscuit (10 items); spreads/sauces/soup (7 items); cheese/egg (6 items); chicken/turkey (3 items); meat other (9 items); fish (5 items); vegetarian (3 items); pizza/pasta/rice (8 items); desserts/puddings (3 items); sweets/crisps (4 items); vegetables and beans (18 items); potato (2 items); fruit (13 items); and drinks (9 items). The CADET diary for this study was split into a School Food Diary and a Home Food Diary. Both diaries included the same food items, with different meal time options. The School Food Diary had the meal time options of morning break, lunch time, afternoon break, whereas the Home Food Diary had the following options: after school/before tea, evening meal/tea, after tea/during night, and breakfast/before school. To complete the School and Home Food diary participants tick each item consumed, under the appropriate meal time heading within the 24-hour period.

The School Food Diary was completed by a trained fieldworker at school for all school time meals, whilst the children were given the Home Food Diary to take home for their home food,

their evening snacks and meals, as well as breakfast the next day. The following day the fieldworker would go back to the school to collect the Home Food Diary, and check that it had been completed accurately. If a child forgot to return their Home Food Diary the fieldworker took a retrospective recall was taken for all after school snacks, evening meals and breakfast.

3.2.4 Comparison Method: Weighed Food Diary

The method used for comparison with the School and Home Food Diaries was a semi-weighed food diary. This diary is again a prospective food diary, administrated on the same day as the School and Home Food Diaries. Similar to the School and Home Food Diaries it involves two sections, one to be completed by field workers at school, the other to be taken home to be completed by the parents.

Researchers asked the parents to weigh all food their child ate using standard kitchen scales. Children who brought a packed lunch to school had their food weighed in the morning, and then their left-overs were collected at the end of lunchtime, weighed and recorded again. For children who received a school meal, the administrator recorded on a tick list what the children consumed from the food provided, then used the standardised portion sizes provided by the school kitchen to weigh and record the food consumed.

Parents were asked to weigh and record all food consumed after school as well as the left-overs from each meal. They were also required to weigh and record the breakfast that the child consumed the next day. The scales were provided if the parents required them. The diaries and scales were then returned to the fieldworker the following day, and checked for completeness.

3.2.5 Data Coding

The dietary information from the School and Home Food Diaries was converted to an MS Access spreadsheet using the established in-house software, based on the composition of foods (Holland et al., 2002) and using standard predefined algorithms to convert weights of composite foods into total daily nutrient values for each child. The weighed food diary data were entered using the MS Access spreadsheet based on the DANTE software.

3.2.6 Ethical Approval

Ethical approval was obtained through the Leeds Institute of Health Sciences and Leeds Institute of Genetics, Health and Therapeutic Joint Ethics Committee (Reference number: 09/012).

3.3 Statistical Analysis

All statistical analysis was performed using Stata IC version 12 (StataCorp, 2005). The results from the two methods were compared using Bland-Altman plots, Pearson's correlation coefficients, and paired t-test or Wilcoxon signed rank test for non-parametric data to identify any significant difference between the two methods (Cade et al., 2006).

Correlation coefficients (r) determine any significant correlations between the CADET tick list and weighed food diary. Correlation coefficients measure the strength of the relationship between the two dietary methods (Bland & Altman., 1986). Paired t-tests were used to assess significant differences between the two methods of assessment.

To examine the agreement between the school and home diary and the weighed food dairy Bland-Altman plots were reviewed. For this the mean values of nutrients from the two diaries are plotted against the differences between the diaries. The differences between the methods were also checked for normality of distribution before attempting the Bland-Altman plots.

There are issues with using correlations as the primary method to determine differences between two assessment measures, in this case dietary intake. Correlation coefficients measure the association between the two methods. High correlation scores do not necessarily mean high agreement between the two methods. As Bland-Altman (1990) states it is expected that the two methods should produce high correlations as they were designed to measure the same thing. However, there have been cases that have produced high correlation scores, but the agreement between the methods is low. An example often used in the literature is the (Serfontein and Jaroszewicz, 1978) analysis of two measures of gestational age which produced high correlations (0.85); however, the gestational age range were quite different, with one measurement of gestational age between 35 and 36 weeks and the other between 34 and 39.5 weeks (Bland & Altman., 1986). The aim of a validation study should be to explore how different the measures are from each other, rather than focussing on the similarities. When possible the statistical analysis should state the anticipated differences between the two methods before proceeding with the analysis. The first step for this analysis is to plot the

differences between the two methodologies against the mean. This provides the information to explore the relationship between measurement error and the true value.

A sub-analysis exploring the mean differences between fruit and vegetables was conducted to explore whether a particular fruit or vegetable was affecting the overall accuracy of the CADET diary. Paired t-tests were used to determine whether there was a significant difference between individual fruit and vegetables.

3.4 Results

The total sample consisted of 67 children who completed the questionnaires, with a mean age of 9.3 years old (SD: +/- 1.4) also of 51% whom were girls. Table 3.1 shows number of children from each year group.

Table 3.1 The number of children from each year group

Year	Number of children (%)
3 (age 8)	18 (27)
4 (age 9)	15 (22)
5 (age 10)	22 (33)
6 (age 11)	12 (18)

3.4.1 Accuracy of the CADET Diaries compared to the Weighed Food Diary

Table 3.2 shows the mean and standard deviation of the daily intake of fruit (g), vegetables (g) fruit and vegetables combined (g) and key nutrient intakes as recorded by the CADET Food Diaries and the Weighed Food Diary. As the outcome for this data was found to be normally distributed, paired t-tests were conducted, which show no significant statistical differences for protein, carbohydrates, fibre, and sodium. However, there was a statistically significant difference between the CADET Diaries and the Weighed Food Diaries for combined fruit and vegetable intake, vegetable intake, fat calcium vitamin C and sugar. The CADET Diaries recorded higher fruit and vegetable intake and macronutrient intake values than the Weighed Food Diary. The CADET diary correlates well with the Weighed Food Diary for fruit, vegetables and combined fruit and vegetable intake. However, for the micronutrient intake it has poor correlation results between the CADET Diary and the Weighed Food Diary.

Table 3.2 CADET Diary vs. weighted food diary (n=56)

	School & Home Food Diaries		Weighed Food Diary		Difference CADET –Weighed Food Diary			Difference (P-value)	Correlation coefficient between CADET and weighed food diary		
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**95% CI**		**R**	**95% CI**	**P-value**
Fruit (g)	**169**	166.9	**148**	145.1	**21**	116.9	-10, 54	0.6	**0.7**	0.5, 0.8	<0.001
Vegetables (g)	**83**	85.8	**51**	61.7	**32**	61.3	15, 49	0.001	**0.7**	0.5, 0.8	<0.001
Fruit & Vegetables (g)	**253**	202.5	**199**	161.9	**53**	19.5	14, 93	0.008	**0.7**	0.5, 0.8	<0.001
Energy (kcal)	**2061**	598.6	**1869**	752.4	**191**	861.9	-45, 462	0.06	**0.2**	-0.2, 0.4	0.07
Protein (g)	**69**	29.3	**65**	25.3	**4**	34.3	-5, 14	0.2	**0.2**	-0.1, 0.4	0.06
Carbohydrate (g)	**275**	68.7	**259**	134.4	**27**	134.7	-7, 61	0.1	**0.3**	0.1, 0.5	0.02
Fat (g)	**83**	37.0	**65**	27.9	**18**	38.1	7, 28	0.001	**0.3**	0.1, 0.5	0.02
Fibre, Englyst (g)	**12**	4.9	**12**	9.7	**0.5**	10.2	-2, 3	0.3	**0.3**	-0.1, 0.4	0.2
Calcium (mg)	**912**	368	**749**	350.0	**162**	316.4	75, 249	0.001	**0.6**	0.4, 0.8	<0.001
Total sugar (g)	**143**	49.8	**117**	81.4	**25**	83.2	3, 49	0.006	**0.3**	0.1, 0.5	0.007
Sodium (µg)	**2629**	1193	**2629**	1307.7	**87**	1558.9	-341, 517	0.4	**0.2**	-0.0, 0.5	0.05
Vitamin C (mg)*	**97**	91	**65**	89	**-32**	375.5	-123, 69	0.003	**0.4**	0.2, 0.6	<0.001

*Median and Interquartile range presented. Differences tested using the Wilcoxon signed rank

3.4.2 Agreement between the two methods

Figure 3.1 to 3.6 shows the Bland-Altman plot for the agreement between the CADET Diary and the Weighed Food Diary (WFD) for fruit intake, vegetable intake, total fruit and vegetable intake combined, total fat intake, energy intake (in kcal) and vitamin C. This area increases in size when the mean difference between the methods increases. The large cluster on the scatter plots for fruit and vegetable intake represent the number of children who had no fruit or no vegetable intake. From the sample of 67 children 5 did not consume any vegetables and 14 did not consume any fruit.

Figure 3.1 Differences between CADET Diary and Weighed Food Diary mean fruit intake (g).

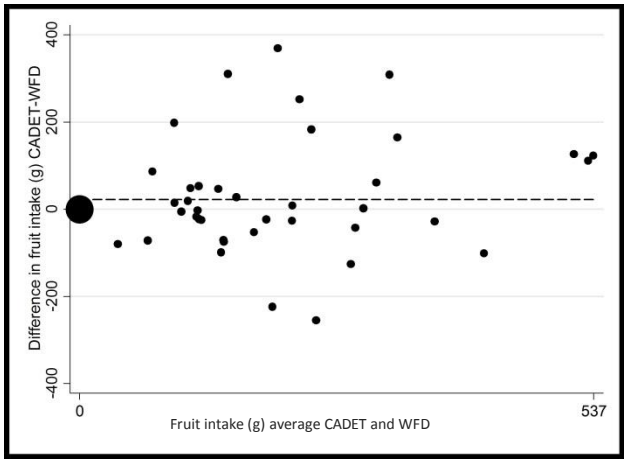


Figure 3.2 Differences between CADET Diary and Weighed Food Diary mean vegetable intake (g).

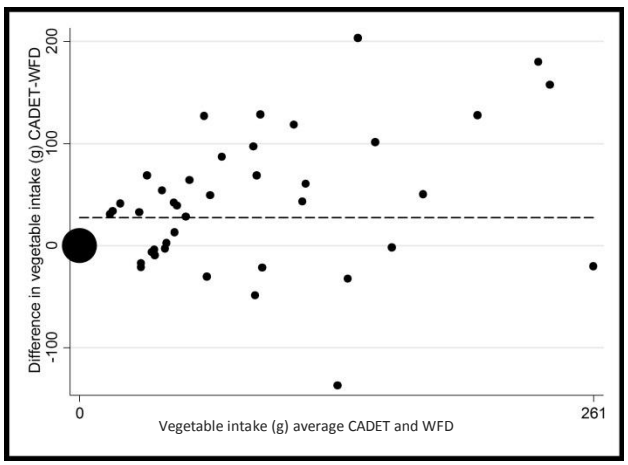


Figure 3.3 Differences between CADET Diary and Weighed Food Diary mean total fruit and vegetable intake (g).

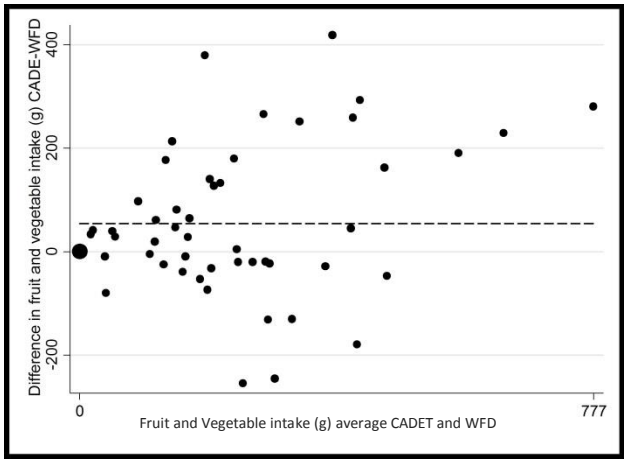


Figure 3.4 Differences between CADET Diary and Weighed Food Diary mean energy intake (kcal).

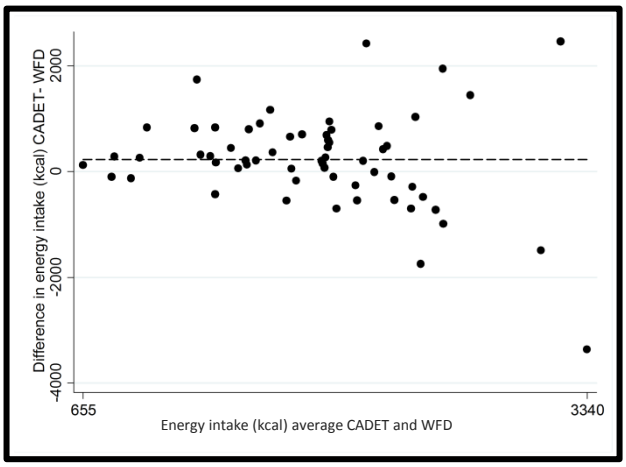


Figure 3.5 Differences between CADET Diary and Weighed Food Diary mean fat intake (g).

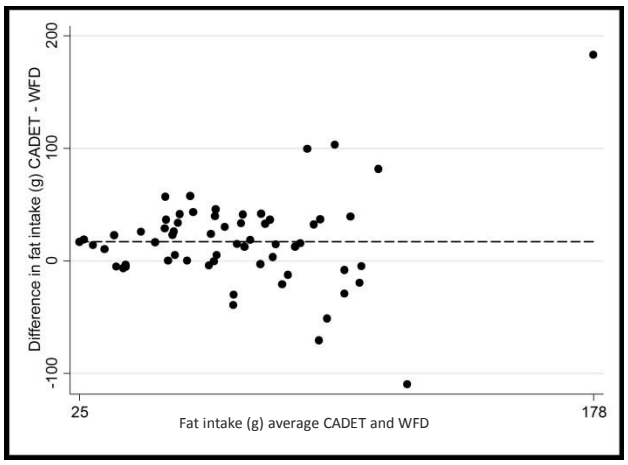
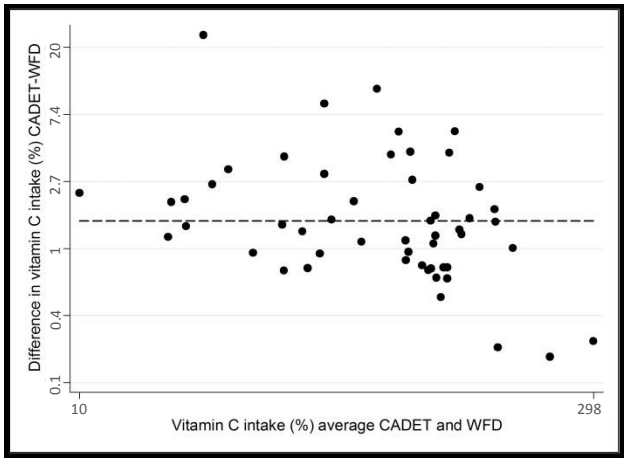


Figure 3.6 Differences between CADET Diary and Weighed Food Diary the ratio of vitamin C intake (%).



The results of the Bland-Altman analyses for figures 4 to 9 are summarised in Table 3.3. The difference between the CADET Diary and Weighed Food Diary are relatively small for fruit (22g) and vegetable (32g) intake measured separately. However, when combined it does increase the mean differences between the two methods to 54g which is over half a portion. There is a mean difference of 191 kcal in the two methods for energy intake. The mean differences for fat intake and vitamin C were relatively small. The 95% limits of agreement were moderately wide for fruit and vegetable intake. The 95% limits of agreement for fat intake were much smaller at -63 g to 99 g and ratio of vitamin C from 0.2 to 9 (%). However, there was more variation in the 95% limits of agreement for energy intake from -1497 to 1881 kcal.

Table 3.3 Results of the Bland Altman analyses comparing the agreement between CADET and the Weighed Food Diary.

Food & Nutrients	Mean difference	Lower limit	Upper limit
Fruit intake (g)	22	-207	250
Vegetable intake (g)	32	-88	152
Total fruit and vegetable intake (g)	54	-226	333
Energy intake (kcal)	191	-1497	1881
Fat intake (g)	18	-63	99
Ratio of vitamin C intake(%)	1.5	0.2	9

3.4.3 Sub-analysis of fruit and vegetables – reviewing age/gender portion sizes

There were significant differences in the mean intake of fruit and vegetables between recordings taken with CADET and those with the Weighed Food Diary; to explore the possible causes for these results a sub-analysis assessing the mean differences for individual fruit and vegetable was conducted. From conducting this analysis it was evident that compared to the weighed food diary more fruit and vegetables were ticked on the CADET diaries. There were

only 90 individual fruit and vegetable items listed in the food weighed diaries, whereas 215 items were ticked in the CADET diaries. This is a substantial difference. One of the primary reasons for this difference was parents listing combinations of fruit or vegetables in one weighed portion and ticking each item on the CADET diary, rather than selecting fruit salad, or mixed vegetables. From the 90 foods recorded in the weighed food diary these items were broken down into the list of fruit and vegetables (see Table 3.4). Paired t-tests were conducted to explore which particular fruit and vegetables were contributing to the significant differences between the two dietary measurements.

The results revealed small non-significant differences for apples (mean difference 9 g, 95%CI: -24, 6); bananas (mean difference -22 g, 95%CI: -30, 75); strawberries (mean difference 1 g, 95%CI: -76, 77); oranges and satsuma (mean difference 7 g, 95%CI: -60, 75); peaches, plums, nectarines and apricot (mean difference -3 g, 95%CI: -31, 24).

Whilst for grapes the paired t-tests revealed there was no significant differences in grapes portion sizes the mean difference was 47 g (95%CI: -24, 6). Melon and watermelon on the other hand did have a significant difference in the mean weight for the weighed food diary and the CADET diaries with the mean difference of 104 g (95%CI: 33, 175) - suggesting that the portion sizes for melon and watermelon might be reducing the accuracy of the CADET diary to measure fruit intake.

For vegetables there was no significant differences between mean intake for carrots (mean difference 3 g, 95%CI: -26, 33), cucumber (mean difference -4 g 95%CI: -16, 8). However, there were significant differences between peas and sweetcorn (mean difference 23 g, 95%CI 10, 36) and broccoli, brussels sprouts and cabbage (mean difference 25 g, 95%CI: 18,33). Again these differences in these vegetables items might be reducing the accuracy of the CADET diary to measure vegetable intake.

Paired t-tests were also conducted for combined fruit and vegetable intake and sub-analysed by school and home. The results show a reduced mean difference in combined fruit and vegetable intake from the previous analysis of only 12 g (95%CI: 3, 21) compared to 19 g in the main analysis (see Table 3.4). It also revealed small mean intakes for combined fruit and vegetable intake at school of 17 g (95%CI: 2, 32) and for home intake of 8 g (95%CI: -3, 19).

It was noted that melon and watermelon, peas and sweetcorn, broccoli, brussels sprouts and cabbage were all consumed at both home and at school. To explore how these items were

affecting the mean differences they were removed from the analysis and paired t-tests were conducted again on combined fruit and vegetable intake. These results revealed that after removing the above mentioned items the mean differences between combined fruit and vegetable intake was only 4 g (95%CI: -5, 14), for school intake 5 g (95%CI: -10, 20) and for home intake 4 g (-9, 17).

Table 3.4 CADET Diary vs. Weighed food diary by fruit and vegetables

		School & Home Food Diaries		Weighed Food Diary		CADET –Weighed Food Diary			
	Frequency of consumption	Mean	SD	Mean	SD	Mean	SD	95% CI	Diff P-value
Apples	11	**116**	10	**107**	17	**9**	22	-24, 6	0.2
Banana	7	**127**	44	**150**	29	**-22**	57	-30, 75	0.3
Grapes	4	**109**	47	**62**	49	**47**	49	-17, 141	0.2
Strawberries	4	**107**	15	**106**	50	**1**	48	-76, 77	0.9
Melon, watermelon	4	**193**	30	**88**	44	**104**	44	33, 175	0.01
Oranges, satsuma	6	**127**	17	**120**	73	**7**	64	-60, 75	0.8
Peaches, Plums, nectarines, apricot	8	**81**	9	**84**	31	**-3**	33	-31, 24	0.8
Carrots	5	**50**	8	**47**	18	**3**	24	-26, 33	0.8
Peas, sweetcorn	4	**54**	11	**30**	12	**23**	8	10, 36	0.001
Broccoli, brussels sprouts, cabbage	11	**57**	6	**31**	10	**25**	11	18, 33	<0.001
Cucumber	10	**28**	5	**32**	13	**-4**	17	-16, 8	0.5
Fruit & vegetables combined	87	**86**	46	**74**	50	**12**	41	3, 21	0.001
School Fruit & vegetables	37	**77**	43	**60**	49	**17**	44	2, 32	0.02
Home Fruit & vegetables	50	**93**	7	**85**	48	**8**	39	-3, 19	0.1
Refined fruit & vegetables combined	66	**86**	42	**81**	51	**4**	39	-5, 14	0.4
Refined School Fruit & vegetables	26	**76**	37	**71**	54	**5**	37	-10, 20	0.5
Refined Home Fruit & vegetables	40	**92**	45	**88**	48	**4**	40	-9, 17	0.6

3.5 Discussion

The CADET is one of the few 24-hour measurement tools that can provide a reliable and valid nutrient analysis on children's diets. The simple tick box style of CADET is considered an appropriate tool for people with low literacy that struggle to record or weigh what they eat. CADET is aimed at capturing mean intake of a population as the instrument is not sensitive enough to identify individual differences in dietary patterns (Evans, 2010, Gibney et al., 2006). The primary aim of the CADET tool has been to measure fruit and vegetable intake in children, and this analysis has demonstrated that for children aged 3-11 years old CADET is an effective method of capturing fruit and vegetable intake.

3.5.1 Fruit and vegetables intake combined

From the sample of 67 children 5 did not consume any vegetables and 14 did not consume any fruit. The mean daily intake in the CADET Diary 253 g and in the Weighed Food Diary 119 g, with the CADET measuring similar intake to the NDNS (2008/9 – 2010/11) of 2.8 portions for boys and 3 portions for girls. The CADET Diary generally reported higher values than the Weighed Food Diary for mean fruit, vegetables and total fruit and vegetables consumption. The Bland-Altman plot showed that the mean difference for combined fruit intake was 53 g. Overall the Bland-Altman plots had fairly wide 95% limits of agreement. The mean difference in fruit and vegetable intake was larger for the age group 8-11 years than in the previous validation study which reported a difference of 42 g (Cade et al., 2006). This indicates that the CADET diary overestimates intake compared to the Weighed Food Diary, a common problem with tick list food frequency questionnaires. The correlation coefficients were strong for fruit and vegetable intake, all equalling 0.7 and were statistically significant. Compared to the previous validation of CADET (Cade, et al., 2006), overall the results from this study have slightly higher r correlations for combined fruit and vegetable intake, and vegetables and fruit intake measured separately. As the tool is often used to investigate trials that have a primary outcome of fruit and vegetable intake, these results indicate it is a valid method for fruit and vegetable intake, one of the fundamental aims of the questionnaire. Suggesting, that the CADET tool is suitable to measure children's fruit and vegetable intake.

3.5.2 Sub-analysis exploring portions sizes for fruit and vegetables

The additional analysis exploring individual fruit and vegetables revealed that the portion sizes for peas and sweetcorn, broccoli and other green vegetables, and in particular melon and watermelon had significant differences between the mean intakes of the two diary methods. None of the children actually consumed watermelon, which might be affecting the portion size

of other melon intake such as cantaloupe. Whilst there was a significant difference in peas, sweetcorn and broccoli intake children's portions sizes do vary, more so than consuming a piece of fruit such as an apple. These differences in consumption patterns reduce the chances of accurately measuring intake in these items. Nevertheless unlike melon which was found to have 104 grams mean difference intake between the dietary methods, the vegetable intake was only 23 to 25 grams differences, which is a considerably smaller difference. Further work should be conducted to reduce the error in this reporting method by modifying the CADET portions slightly for these commonly consumed fruits and vegetables. Of course a limitation of this analysis is it is only using small frequency of consumption per fruit or vegetables, however, these numbers are similar to those used in the NDNS data.

3.5.3 Nutrients

The comparison between the CADET Diary and the Weighed Food Diary for nutrient intake shows a similar trend. The CADET diary had higher means for every nutrient (kcal, protein, carbohydrate, fat fibre, calcium total sugar and sodium) compared to the weighed intake, apart from vitamin C intake, with correlation results 0.2 to 0.6, equivalent to other food frequency recall questionnaires (Cade et al., 2002, Cade et al., 2006). There were however three nutrients that did have statistically significant results for the correlations; these were kcal, protein and fibre. The Bland-Altman plots showed that the mean difference for kcal, vitamin C and total fat were small with reasonably small 95% limits of agreement, demonstrating the CADET diary can provide valid nutrient data for the whole diet.

3.5.4 Validity of tick list questionnaires to assessment of children's dietary intake

The use portion size data provided by the NDNS (Department of Health, 2011) enabled the CADET diary algorithms to be adjusted so it was suitable for older children in this study. NDNS portions sizes are based on a representative sample from the UK. However, with such a vast amount of nutrient data from different foods in CADET it meant using portion sizes based on relatively small samples for each food. Whilst the methodology discussed in Chapter 2 used to determine the portion sizes attempts to rectify this issue through merging portion sizes from small groups of children, such as five or lower, with an average of similar foods with a larger sample size, ten or more, this means the CADET diary could overestimate or underestimate children's consumption. It is a limitation of not only this measurement tool, but also most food frequency questionnaires (Noethlings, 2003). CADET does, however, provide good estimation between combined fruit and vegetable intake, the primary outcome of these two RHS trials. This is due to assigning age and gender portion sizes for all foods and drinks. Another

limitation is using a one day tick list to measure intake which is unlikely to reflect true long term intake. Since the sample size for this study was small with only 67 children, and likely to be underpowered for certain comparisons, as according to best-practice recommendations, a sample size of 100 is sufficient to assess the validity of a dietary assessment method (Serra-Majem, 2009). Undertaking a one day weighed diary alongside the CADET diary can be time consuming, and this may have reduced our potential sample size and the generalisability of these validation study results. Furthermore, this study was done as an addition to evaluating the two RHS trials, impacting on time and funding dedicated to this analysis.

Nevertheless, the CADET diary does avoid the issues with child self-reported food intake, and is less of a burden on the participants than the most commonly used alternative, a weighed 4 day food diary (Hachett et al., 2002). Also, academic research suggests that a one day food frequency questionnaire can be as useful as a multiple day food diary (Blom et al., 1989; Clapp et al., 1991; & Rocket et al., 1997). Furthermore, the CADET has been used in large intervention trials where measuring food intake is a difficult task in terms of time, funding and resources (Evans et al., 2012b). The sub-analysis which explores individual items on the CADET also revealed that parents ticked more items on the CADET diary than they entered in the weighed food diary. This could be partly due to combining mixed vegetables or fruit salad being recorded as one item in the weighed food dairy, but as separate items in the CADET diary. It also supports the contention that completing a food frequency questionnaire is easier therefore more items are recorded. With the additional development of the DVD to help explain how to complete CADET to parents, CADET is one of the few diary assessment tools that can be quickly implemented by non-professionals.

3.6 Conclusion

The results from this validation study concluded that the CADET diary is a valuable nutritional epidemiological tool for measuring children's diets from age 3 to 11 years. It is easy to implement in large studies, and only requires a basic level of literacy to complete. Whilst it does tend to overestimate children's intake, this is a limitation of all tick list food based questionnaires. The modest differences between the two methods indicate it is possible to use the CADET diary for any primary school children up to 11 years old. This analysis confirms that it is a suitable measurement tool to assess the primary outcome of the two RHS trials.

3.7 Chapter summary

The aim of this chapter was to validate the CADET against a Weighed Food Diary to confirm that the portion sizes assigned to the different items within the CADET diary are suitable. A small study was conducted in six primary schools in Leeds with a total of 67 children from years 3-6 (age 8-11 years old) participating. Children's intake at school was recorded in the CADET tool by trained fieldworkers and intake at home was recorded by parents/carers. This data was compared against a 24-hour Weighed Food Diary obtained on the same day. The macronutrients of the two methods were compared using Bland-Altman plots, Pearson correlation coefficients, and paired t-tests or Wilcoxon signed rank tests to identify any significant difference between the two methods. Overall, the results show that the CADET tool can be used to estimate children's food intake. It is possible to get parents to provide dietary data for their young children using a simple tick list questionnaire format. The results from this chapter confirm that the CADET Diary is a suitable tool for primary school children up to 11 years old, therefore it is an appropriate tool for measuring children's food and nutrient intake for the two RHS trials.

Chapter 4 - Methodology

This chapter outlines the general methodological components that applied to both trials. It will discuss:

- Sampling and recruitment of schools (inclusion and exclusion criteria)
- Sample size calculation
- Randomisation methodology
- Training of field workers to collect the baseline and follow-up data.
- The two interventions: RHS-led and Teacher-led
- Data cleaning methodology

It should also be noted that this chapter is based on the published protocol written by MSC, as stated on page 3.

4.1 Sampling and recruitment of schools

Addresses of all schools were supplied by the Local Education Authority from the nominated London boroughs for each trial, and they were sent a recruitment letter (example provided on page 233 of the appendix). Schools were then asked to reply providing information on their gardening activities. These responses from the schools were checked by both the University of Leeds Team and the RHS Campaign for School Gardening manager before randomising to either interventions or the allocation group.

4.1.1 Trial 1 – RHS-led intervention vs. Teacher-led intervention

The RHS established their Campaign for School Gardening to schools in the London region in the autumn of 2009. The RHS Campaign provided intensive support in each region to 10 schools through support from an RHS School Gardening Regional Advisor (the RHS-led intervention). The remaining schools had access to support through twilight training sessions for staff and other activities (the Teacher-led intervention). A sample size of 10 schools received the RHS-led intervention, as this was the maximum number of schools one Regional Advisor could work with. Further details of the intervention components are discussed in section 4.3 on page 84.

Twenty-six schools, from four boroughs in London: Wandsworth; Tower Hamlets; Greenwich; and Sutton were recruited for Trial 1. Of the 26 schools; 10 were randomly allocated to receive

the RHS-led and 16 schools were allocated to receive the Teacher-led intervention. The allocation sequence was generated using Stata. All schools were allocated at the same time.

4.1.2 Rationale for Trial 2

In Trial 1 it was not possible to randomise schools to receive no intervention at all (control/comparison group) as it is RHS policy to provide support to all schools who register an interest in the Campaign. As a consequence of this, the second set of schools were recruited into a linked trial, Trial 2, to provide a no intervention arm - comparison group.

4.1.3 Trial 2 – Teacher-led vs. Delayed Intervention

Thirty-two schools from the following neighbouring Trial 1 boroughs in London: Lewisham; Lambeth; Merton and Newham were recruited for Trial 2. Of these schools, 16 were randomly allocated to receive the Teacher-led intervention and 16 schools were used as comparison schools. The comparison schools received no active intervention during the trial. However, they were informed that once the study had ended follow-up collection in February 2012 they would be able to attend the Twilight sessions offered to the Teacher-led schools.

It was not possible to blind the schools to their intervention group due to the nature of the intervention. The fieldworkers were blinded to the allocation of schools to the intervention (RHS-led or Teacher-led) and comparison arms of the study.

4.2 Study Population

4.2.1 Trial 1 inclusion criteria

All non-fee paying primary schools within the following London boroughs: Wandsworth; Tower Hamlets; Greenwich; and Sutton with classes in key stage 2 (years 3-6) were invited to take part in the study.

4.2.2 Trial 2 inclusion criteria

All non-fee paying primary schools within the following London boroughs: Lewisham; Lambeth; Merton and Newham with classes in key stage 2 (years 3-6) were invited to take part in the study.

4.2.3 Exclusion Criteria for Trial 1 and 2

Independent schools, special schools and schools without all 4 year groups in key stage 2 at primary school (years 3-6) and small schools with fewer than 15 pupils per year group were excluded.

4.2.4 Proposed Sample Size

From the previous school based trial, Project Tomato (Kitchen, 2009), the standard deviation for daily vegetable consumption in this age group was estimated to be 85 g and 143 g for fruit, with an associated intraclass correlation coefficient of 12.5% for vegetables and 11.4% for fruit. With the proposed sample of one year 3 class and one year 4 class from each school the proposed sample size needed to detect 0.5 portion of a difference in vegetable intake with 90% power then there would need to be 627 children per group, approximately 13 schools (Cade, 2009). The Project Tomato research identified that approximately 75% of participants completed the dietary questionnaire at baseline and follow-up, therefore to allow for possible withdrawals and children changing schools, it was decided that 16 schools would be allocated to each group, except for the "RHS-led intervention" where the sample size requirements were determined by the staffing levels at the RHS. As a consequence, the RHS-led schools group had a sample size of 10 schools only.

4.2.5 Discontinuation criteria

Analysis followed the principle of intention-to-treat. Therefore included in the analyses are all schools and children initially randomised, to their original group for analysis purposes in the intervention group originally allocated to them. All reasonable and ethical steps were taken to ensure completeness of follow-up of outcome measures.

4.2.6 School withdrawal

If a school wished to withdraw from the trial, the study team would post a data collection form to the head/class teacher along with a freepost envelope. The data collection form would record the following: reasons for withdrawal; whether anything could have been done to make taking part in the study easier; if they no longer wanted to take part in the intervention and receive information/training/materials and if they still allowed us to use data collected to date and to collect data at round two i.e. follow-up collection in October 2011.

4.2.7 Child withdrawal

If a parent requested to remove their child from the trial. It was anticipated that this request would go either to the school, the RHS or the study team at the University of Leeds. Whoever was the first point of contact with the parent was required to inform the other relevant groups (school/RHS/University of Leeds) by telephone, letter, or email. Record of any child withdrawals was recorded in the database. On receipt of this information the study team would send a letter to inform the class teacher that the child was to be withdrawn from the study. A data collection form and freepost envelope would be sent via the class teacher to the parent. A covering letter would make it clear to the parent that while the child would not receive any self-study or home based materials, the child would not be left out of whole class activities as to do so would involve taking the child out of the class whilst these activities were occurring. The parent would be asked to complete the data collection form and post it back to the Nutritional Epidemiology Group in the freepost envelope.

4.2.8 Assessment of harm

On rare occasions, children or schools may need to discontinue the randomised intervention. This may, in most cases, be only a temporary withdrawal, for example, if a child injures themselves with a spade. Minor adverse reactions were not considered grounds for discontinuing. However, these events were captured either the by the RHS Regional Advisor for the RHS-led schools, or by the Nutritional Epidemiology Group (NEG) team through the process measures email for the Teacher-led schools. All adverse events were reported to the Trial Steering Committee. However, the same notification procedures would apply as for school or individual withdrawal detailed in section 4.2.6-7 above.

4.2.9 Interim analysis and stopping rules

No interim analyses of trial outcomes were planned.

4.2.10 Randomisation

Cluster randomisation with school location and borough to identify each “cluster” was used to randomise the schools. The schools were randomised by geographic location of their London borough and using Stata (StataCorp, 2005). From each primary school one year three class and one year four class was asked to consent to be part of the trial. These classes were randomly selected if there was more than one class in that particular year group.

4.2.11 General considerations

All data collected from these two trials has been reported and presented according to the revised CONSORT statement in the results chapter 6 (Schulz et al., 2010).

4.2.12 Ethical Approval

Ethical approval was obtained through the University of Leeds Research Ethics Committee in 2009. Written informed consent from all schools was obtained first and then obtained from all parents whose children were in the classes chosen to participate in the trial data collection. Schools and parents were informed about the potential risks and benefits of participating in the trial through the information sheet. Participant's parents were given informed consent, with the opportunity to "opt-out" of the study if they did not wish their child to take part. If the parents wished their child not to participate in the study, their child was still able to take part in the growing activities in the class; however their food intake and child attitude and knowledge questionnaire were not recorded.

In addition, to the main trials ethical approval; the validation study and the weighed food diary was approved by the Leeds Institute of Health Sciences and the Leeds Institute of Genetics, health and Therapeutic (LIHS/LIGHT) joint ethics committee in November 2010.

4.3 The Intervention: The RHS Campaign for School Gardening

4.3.1 Intervention definitions

RHS-led intervention: these schools received an intervention delivered by the RHS Regional advisor.

Teacher-led intervention: staff from these schools attended twilight sessions of the garden programme at a nearby participating school. The twilight sessions were run by the RHS regional advisor.

The Campaign for School Gardening aims to:

- Inspire and empower schools to get growing and to give children the chance to grow and create gardens
- Demonstrate the value of gardening in enriching the curriculum, teaching life skills, and contributing to children's mental and physical health
- Convince everyone involved with education in schools of the value of gardening in developing active citizens and carers for the environment

- Understand the importance of plants and show how gardening can contribute to a sustainable environment

4.3.2 The RHS-led Intervention

The RHS Campaign for School Gardening consisted of two programmes. The RHS-led intervention schools received the following:

- A day visit from the RHS regional advisor each half term to work in the garden with teachers and children (Summer Term 2010 to Summer Term 2011 inclusive).
- Follow up visits to aid lead teachers with planning (Autumn Term 2011 to Autumn Term 2012)
- General on going advice on the school garden, free seeds and tools
- 1 twilight teacher training session each term (Summer term 2010 to Summer term 2011 inclusive), based on seasonal tasks in the school garden (open to RHS-led school teachers and others from local schools)
- Free access to a wide range of teacher resources at www.rhs.org.uk/schoolgardening/

The role of the regional advisor was to assist the schools to develop a successful garden, through working directly with teachers/pupils to give them support and practical advice. They were also expected to help schools overcome barriers to developing gardening within schools. The regional advisor had the expertise and experience to tie in gardening and growing activities with the National Curriculum and to run staff training sessions for teachers. The key task of the regional advisor was:

- Deliver advice and support to schools in setting up school gardens and growing projects
- Promote the RHS Campaign for School Gardening by contacting schools, LEA's, local authorities and partner organisations and give talks and demonstrations
- Train teachers in the practical skills to grow plants and harvest crops
- Build community links and recruit volunteers to enable the wider community to support and get involved in school growing projects
- Contact, advise and support schools within the region by visits, e-mails and phone calls
- Make links with partner organisations and recruit volunteers to support schools in setting up school gardens and growing plants.
- Run termly twilight training sessions courses at 10 school venues throughout the year

There are standard skills and qualifications necessary to qualify as a regional advisor for the RHS. All regional advisors must have "relevant Horticultural qualifications" e.g. Wisley Diploma in Practical Horticulture, RHS Diploma and Advanced Certificates and or Edexcel Level 3 National Award in Horticulture. They must also possess a high level of practical experience in training and running horticultural workshops. In addition, they are expected to have strong teaching and presentation skills to inspire and enthuse their audience, and also the ability to vary their training style depending on the audience and their initial levels of understanding and willingness to learn.

Figure 4.1 The RHS regional advisor seed sowing at one of the RHS-led schools

An example of some of the work conducted in one of the RHS-led schools is described below.

- To embed gardening into the school and attain all the benefits which that brings (e.g. most pupils never have access to growing, as they don't have gardens themselves)
- To have a community garden which helps to deal with some of the difficult issues faced in the 'forgotten estate' (Initial targets 13/05/10)
- Re-develop the school garden (to be used for class growing).
- Simple beds, paths, a fence, and later possibly a greenhouse.
- Digging pit for the nursery to prevent the raised bed being 'Dug'.
- Clear the Community Allotment Garden (secret Garden), and cover to prepare for development. The community garden is to be used for project work, teaching (such as life cycles in a wildlife area), and community beds and for use by Learning Mentors to work with children who have learning difficulties and/or behavioural issues.

The two images below demonstrate the before and after effect of the RHS-led intervention in one of the 10 RHS-led schools.

Figure 4.2 Before and after images of the development of the school garden from a RHS-led school

4.3.3 The Teacher-led Intervention "Teacher-led schools"

The Teacher-led intervention schools worked with the RHS by attending termly twilight training at their nearby RHS-led school, to help support them in developing and using their school garden. Unlike the RHS-led schools the Teacher-led schools did not have direct support from the regional advisor. The regional advisor ran these twilight sessions for them and provided the Teacher-led schools with advice as needed for their school garden. Here is an example of some of the topics taught in the twilight sessions.

Summer term 2010:

- Planning your school garden
- What and when to grow for the school term
- Watering in the school garden
- Introduction to garden pests

Autumn term 2010:

- Garden site assessment and plans
- Bulb planting (including practical with free bulbs supplied)
- School garden risk assessment templates
- Soil types and texture

Spring term 2011:

- Safe Tool Use
- Seed Sowing
- Growing for the school years
- Composting

Summer term 2011:

- Watering
- Pricking out
- Garden tours

Trial 1 consisted of schools participating in both intervention groups mentioned above, whereas for Trial 2 schools were involved in the Teacher-led intervention and a comparison group of schools were included. The comparison group did not receive any support from the regional advisor during the period of the trial. However, the comparison schools were able to receive the twilight sessions for the summer of 2012 once the study had completed follow-up data collection.

4.4 Data Collection Methods

4.4.1 Data Sources

The data used in this study came from the following sources:

Child Level Data

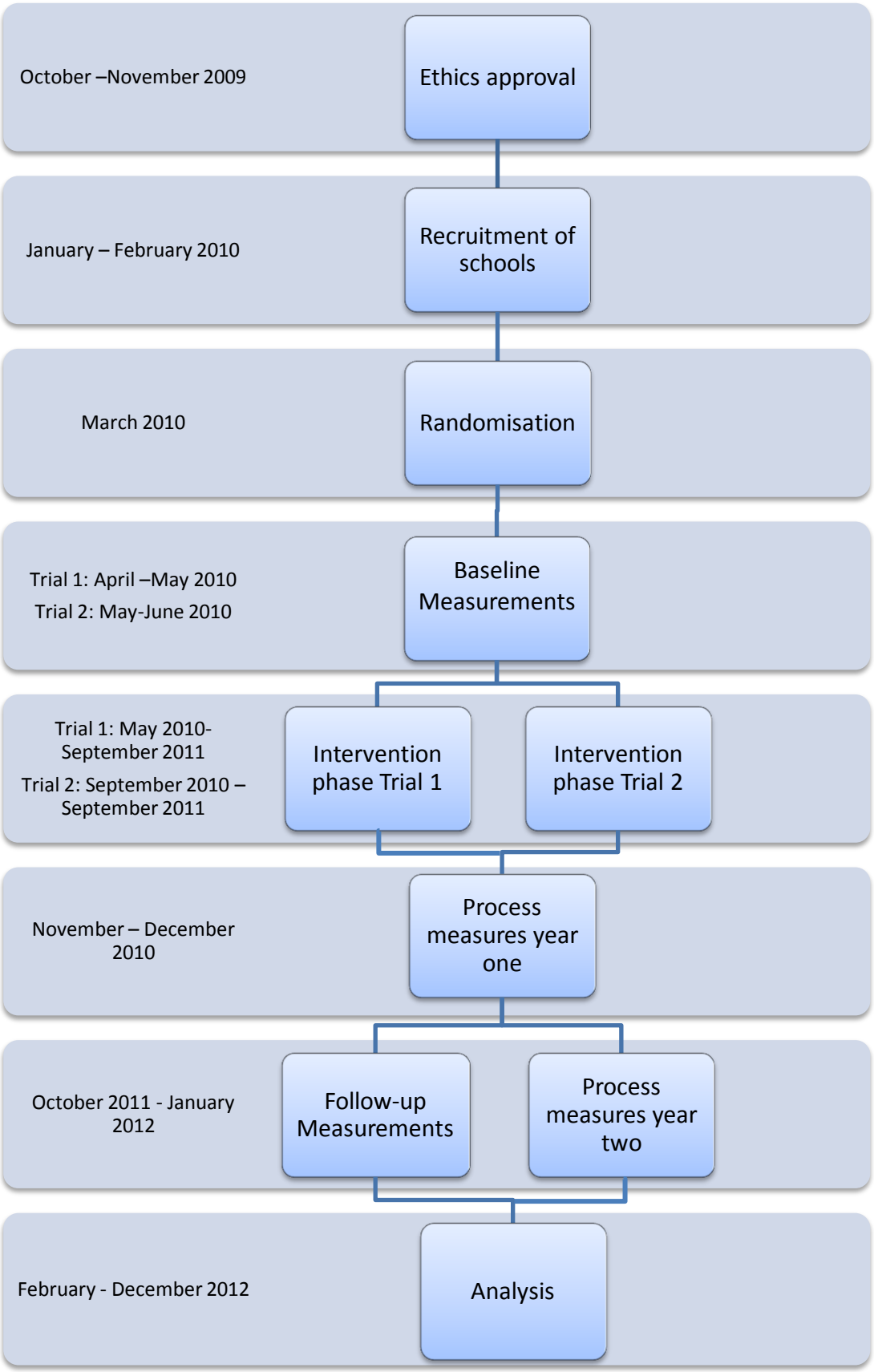
- School Food Diary
- Home Food Diary
- Child knowledge and attitude questionnaire

School level Data

- School Gardening Level Questionnaire
- Gardening in schools - process measures email
- Information collated from the RHS advisor on school gardening in the intervention schools

The main outcome measurements were collected at baseline in May-June 2010 when the children were in years 3 and 4 aged 7-8 years old. With the process measures email collected in October 2010. The follow-up measurements were collected in October 2011 - January 2012 when the children were in years 5 and 6 aged 9-11 years old. A breakdown of the different phases of these two trials is illustrated in Figure 4.3.

Figure 4.3 Trial Phases.



4.4.2 Training the Fieldworkers - Nutrition students

The primary schools were spread throughout London therefore a large sample of nutrition undergraduate or master's students were recruited to undertake baseline collection. Training sessions were designed and led by MSC with assistance from one of the research assistants on the trial. The students were recruited from Kings College London, Kingston, Westminster and Roehampton University. The students were offered £70 pounds payment per school and were informed that in order to participate it would be necessary for them to attend one of the two training sessions offered in London. The first training session was at Roehampton University on the 9th of April 2010, the second was at Kings College London on the 12th of April 2010. Baseline collection took place from mid-April to July 2010.

Most of the students who registered an interest in the study were dietetic students, who had little data collection experience. In order to ensure that a high consistent standard of data was collected, training was provided to the students to teach them how to complete not only the School and Home Food Diary, but the Child knowledge and attitude questionnaire as well.

One of the vital qualities needed to work with children is presentation skills, the ability to speak confidently in a room full of young children. To assess the students on their ability to complete the baseline collection, the first part of the training was for them to introduce themselves and explain how to play one of their favourite childhood games.

The next component of the training was a presentation by MSC introducing the students to the study, and what exactly their tasks would be if they were involved in the data collection. This was the first time the students had seen the questionnaires, so each section was explained to them in detail to help them familiarise themselves with the questionnaires. They were also shown the instructional DVD. The main part of the training consisted of two activities which are explained in detail below.

4.4.3 Sample diet exercise

This exercise involved giving the students examples of children's food intake for the whole day. The aim was for the students to correctly code each food and categorise it in the right section of either the School Food Diary or the Home Food Diary. An example of a child's diet is presented in Table 4.1 Example diets and Correct Answers are shown with the correct School Food Diary codes. There were always some difficult food items included that are typical for children to eat, but not for adults such as the Dairylea Lunchables and Dunkers Ham Wrap.

Table 4.1 Example diets and Correct Answers

Breakfast	Morning break	Lunchtime	Before tea	Evening meal	After tea
white bread toasted (C1)* with Utterly Butterly (D1); Glass of apple juice(A6)	fruit and nut bar (B3)	tropical flavoured spring water (A4); cheese and onion crisps(B1); Dairylea Lunchables – ham (E2, B5, G5)	Satsuma(M5)	chicken nuggets(F2); chips(L2) tomato ketchup(D2) salt vinegar	Jaffa cakes(N5); white bread(C1) toasted with Utterly Butterly(D1)

**food group and number on the CADET Diary*

4.4.4 Right or Wrong

In the second activity the students were presented with 10 completed Home Food Diaries, and they had to identify if the diaries had been completed by the parents correctly or incorrectly. The aim of this exercise was to show the students what to expect on day two of the baseline collection, and to identify when it is necessary to take a recall from the child due to serious errors in the Home Food Diary.

At the end of the session the students had the opportunity to ask questions and queries about completing the different questionnaires and the overall structure of the data collection process.

4.5 Baseline Collection

Baseline collection of the School Food Diary, Home Food Diary, child questionnaire, and School Gardening Telephone Interview took place between April and July 2010. The baseline process measures emails were sent out in November 2010 with reminders sent in December 2010.

The sample consisted of 52 schools with a possibility of up to 2731 children being surveyed. The actual number of children that participated in the baseline collection for Trial 1 was 1163 and for Trial 2 was 1417, giving the total number of children as 2580. Two schools withdrew from the study: one due to teaching problems and the other was concerned about CRB checks despite the fact that the students who were assigned to visit this school had been checked. The length of the baseline collection was longer than anticipated due to a volcanic eruption in Iceland delaying flights during the Easter break, leaving many schools understaffed. The undergraduate students trained to collect the data were efficient, though a small number

withdrew from collecting data from a school at late notice. To prevent this occurring at follow-up the students were asked to sign a contract outlining their expectations in writing.

4.6 Follow-up Collection

Follow-up collection of the School Food Diary, Home Food Diary and child questionnaire, School Gardening Telephone Interview took place from October 2011-January 2012. The same process from baseline for recruiting students was conducted for follow-up collection. All students who participated in follow-up collection attended a training session.

The Follow-up process measures emails were sent out in December 2011 and a reminder was sent in January 2012. A number of the students who participated in baseline collection also participated in follow-up.

4.7 Data handling

4.7.1 Blinding of the statistician

The PhD supervisor (CELE) allocated a random code for the different intervention groups and control group involved in both trials. This was done to blind MSC to the intervention allocation whilst she was conducting the data cleaning and initial primary analysis, to confirm there was no bias in the data cleaning method. Once the primary analysis was completed, the project statistician informed MSC of the code, so she could finalise the secondary outcomes, and final results. The details of school allocation for both trials were sealed in an envelope and kept in the principal investigators office.

4.7.2 Food and nutrient data

Data from baseline and follow-up home and school food diaries based on the Child and Diet Evaluation Tool (CADET), were entered by Swift Research Ltd. The dietary information in the diaries was converted to an MS Access spread sheet providing the number of portions of 95 food types at each of 7 possible meal/snack events (breakfast, morning break, lunch, afternoon break, tea and after tea). For example, on the diary a child could tick sugary cereals at breakfast time. The Database Manager used pre-determined age related portion sizes to estimate the weight of all food types consumed. The Database Manger then used established in-house software, named DANTE, based on the composition of foods (Royal Society of Chemistry), and using standard predefined algorithms to convert weights of foods into total daily nutrient values for each child. The 42 nutrients included, total energy intake, macronutrients, vitamins and minerals, of which only those associated with fruit and vegetable

intake were analysed further. These included total energy, fats, sugars, carbohydrate, fibre (NSP), carotene, vitamin C, folate, zinc and iron. The 115 food types were reduced further to 14 categories, one of which was fruit (group M) and one of which was vegetables excluding potato (group L). Fruit juice is categorised as one category of group A (drinks). The weights of all types of fruit were summed to give the total weight for fruit, in addition to the total number of portions of fruit (one portion =80 g). The weights of all types of vegetables were summed to give the total weight for vegetables in addition to the total number of portions of vegetables. The data on nutrients and weights of foods was saved in an excel spread sheet and converted to a Stata spread sheet by MSC. When combining the data in Stata, a third variable was used to cross check that the merge had been successful. A copy of this data set was stored securely in the RHS analysis folder, under RHS Stata files. This folder was password protected. No changes were made to the original Stata dataset, instead all changes as a result of data cleaning and generating new variables were stored in the Stata "do file." Therefore, each time the file was used, the do file was re-run to apply the cleaning process and further analysis. Each child was given a unique identification code containing information the on school and child. Follow-up and baseline data were combined using the unique id for the children and therefore, no names or identifying information were included. The database was password protected so only the database manager NH, MSC and CN, and CW could access the data. Any excel spread sheets with children's names included (needed to identify the children for follow-up collection) also contained a password. Only MSC, CN and CL had access to this password.

4.7.3 Data cleaning

Values for non-dietary data collected at the follow-up phase were checked to ensure all values were within plausible pre-determined ranges. Out of range values were checked against original data to identify data entry errors. Errors due to data collection methods were recorded as missing.

Baseline and follow-up data was checked for completeness. Missing data for participants such as date of birth, and gender were obtained from schools where possible by NEG (Clerical Assistant). If these details were not available, children who were missing age data, were given the mean age of that year group e.g. year 3, 4, 5 or 6. When gender data was missing, they were given mean portion sizes, based on an average of boys and girls for that particular age group. Where both age and gender was missing, then both steps above were applied.

The school and home food diaries were entirely tick box based and were scanned; therefore free of data entry errors. However, it was possible that there were scanning errors, such as

diaries scanned the wrong way round or not lined up properly or random marks mistaken for ticked boxes. Accurate scanning of diaries was initially checked by Swift Research Ltd. On arrival to the NEG department, a random sample of the scanned diaries (approximately 10% of Home Diaries and 10% of School diaries) was inspected by MSC to provide a further check that the scanning process was accurate. Based on previous research into children's diet diaries that have mean energy and or total fruit and vegetable intake ± 3 times the standard deviation were identified as outliers and excluded.

Also, it was noticed from inspecting the baseline data that when a child ate fruit salad there were also several others types of fruit (more than three) ticked for that particular meal time. It was decided to clean this data so only fruit salad was recorded, as the fruit intake for that particular meal, was considered too high for the majority of children.

4.8 Chapter Summary

This chapter has described the general methodological aspects that apply to the both trials. It has explored how the schools were recruited and randomised, identified when the different data was collected, described the interventions and outlined the methods used to collate and both baseline and follow-up data. Further descriptions of the statistical analysis will be described in detail in the relevant results chapters' 5-8.

Chapter 5 - Baseline Food and Nutrient Characteristics

The first half of this chapter aims to explore the nutrient and food data from the Home and School Questionnaire for all children in Trial 1 and 2 combined from baseline. It will also explore children's fruit and vegetable intake broken down by meal event, lunch type (packed or school meal) and the differences between boys and girls for key nutrients and food. The second half of this chapter will explore how the home food environment and parental attitudes and values affect children's fruit and vegetable intake. This chapter continues to explore the baseline diaries; however a proportion (36%) of the parents did not complete the additional questions in the CADET diary; of these 23% did not return the Home Food Diary, reducing the effective sample size to 1516 children for the analysis of the home food environment questions. This work was also published in the Journal of Epidemiology and Community health as stated on page 3 (Christian et al., 2012).

5.1 Background to regression analysis

5.1.1 Linear regression analysis

Linear regression analysis explores the dependency of one variable in this case total fruit and vegetable consumed, on one or more other variables such as gender (Jull and Frydenberg, 2010), by fitting a linear equation to the observed data. Whilst the fundamental principles of regression remain the same, due to the sampling technique used to select the participants - clustered (randomisation), multilevel regression methodology should be applied for all statistical analysis (Juul and Frydenberg, 2010).

5.1.2 Clustered multilevel regression analysis

Multilevel regression analysis is often used for education based data as it takes into consideration the hierarchal structure of school data (Snijders and Bosker, 2012). In this study level one is the individual child, and level two is the school. Level one, the individual level is considered to be nested within the higher level, the schools. It is based on the theory that children's food consumption within a school is similar; for example children who eat a school meal will all have the same options or choice on any given day at that particular school and are therefore more likely to consume similar foods. The benefit of this technique is that the means and confidence intervals for the different foods and nutrients will be more accurate, if there is variation at school level. As the children's food consumption within a school is more similar to

each other there will be less variability within the sample of each school compared to a random sample from the whole population (Rasbash et al., 2004). Also multilevel modelling is not focused on the individual schools within the sample, but on estimating the patterns of variation within the population of schools (Rasbash et al., 2004). If a single level model was used instead for this analysis which ignored the hierarchal structures within the data, this would lead to inaccurate or misleading results. The confidence intervals would be too narrow, leading to different conclusions (Rasbash et al., 2004).

5.2 Methods

5.2.1 Study population

This study includes baseline measurements from two trials: in total, 2393 children completed the baseline data collection from 52 primary schools from the following London boroughs; Wandsworth, Tower Hamlets, Greenwich, Sutton, Lewisham, Lambeth, Merton and Newham.

5.3 Statistical Analysis

All statistical analysis was performed using Stata IC version 12 (StataCorp, 2005). The descriptive statistics were performed for all key nutrients, foods, fruit and vegetable by meal event and demographic characteristics.

Analysis was then performed using clustered multilevel regression models to explore the differences between boys and girls for nutrients and food items. These models were first conducted unadjusted, and then the primary analysis adjusted for the possible confounders on children, food and nutrient intake, ethnicity and Index of Multiple Deprivation Score (IMDS). The output generated for the primary analysis was effect size, standard deviation, 95 percent confidence internals and p-values, with a p-value of less than 0.05 taken to represent statistical significance for all of the analyses.

An additional variable based on the NHS 5 A Day guidelines was created to explore how many children were achieving the UK government's fruit and vegetable target. This variable included all fruits and vegetables consumed, a portion (80 g) if pure fruit juice was consumed and a portion (80 g) if baked beans were consumed.

The model fit was assessed by checking skewness, kurtosis (sktest), and q-normal probability plots and residuals. The sktest explores the skewness and kurtosis of the variables against the null hypothesis that the variable is normally distributed (Pevalin and Robson, 2011). The

skewness statistic and the kurtosis statistics which describes the shape of the distribution, with a score of 3 indicating the variable is normally distributed, a score less than 3 indicates the distribution is flatter than a normal distribution and a score greater than 3 indicates that the distribution is high-pitched than a normal distribution.

5.4 Results

The majority of the nutrients had a slightly skewed distribution; therefore in an attempt to correct this, a natural log-transformed variable was created. Using a logarithmic transformation on the data can decrease the level of skewness, meeting the assumptions for a regression model. Due to the little improvement in the logarithmic transformed data, it was considered more appropriate to use the original format for ease of interpretation, and seems to be common practice in this area of research. The regression assumptions were checked using histogram of residuals, kurtosis (sktest), q-normal probability plots, and scatter plot of the residuals.

5.4.1 Basic characteristics

A total of 2579 children were asked to participate in the study from 52 schools. After excluding children who did not complete both a Home and School Food Diary the final sample size was 2393, and the response rate was 92 percent. Sixty-nine children had a total energy intake and/or total fruit and vegetable intake more than three times the standard deviation of the mean and were excluded from the study. The mean age of the children was 8.3 years (1188 girls and 1205 boys). Twenty-nine percent of the children received free school meals and 33 percent of the sample ate a packed lunch. English was spoken as an additional language by 46 percent of the sample. Fifty-nine percent of children had a member of the family educated to degree level or higher. These results are presented in Table 5.1.

Table 5.1 Sample characteristics of 2393 children participating in the RHS campaign for school gardening

Baseline characteristics	N	Mean or %	SD	95%CI
Age (years)	2393	8.3	0.7	8.2, 8.3
Boys (%)	1205	50		
Received free school meals (%)	693	29		
Ate packed lunch (%)	781	33		
Spoke English as an additional language (%)	1147	46		
Family member with degree (%)	1410	59		
Ethnicity (%)				
White	575	24		
Mixed	200	8		
Asian or British Asian	317	13		
Black or Black British	419	18		
Chinese or other ethnic group	72	3		
Prefer not to say	810	34		

5.4.2 Children's nutrient intake

The mean, standard error and 95% confidence intervals for key nutrient intakes for the whole sample are presented in Table 5.2. The only nutrient not above the recommended mean was vitamin A, which was 100µg lower than the recommended intake (mean 406, 95%CI: 388, 424). The mean intake of kcal for all children was 2018 (95%CI: 1990, 2047). Total fat was 13g higher than the recommended intake (mean 81, 95%CI: 79, 83), and sodium was 1508mg higher than the recommended intake in this age group (mean 2658, 95%CI: 2604, 2711).

Table 5.2 Dietary intake of 2393 children enrolled in the RHS School gardening campaign

				Estimated average requirements/Recommended nutrient intake*	
Nutrients	**Mean**	**SE**	**95% CI**	**Girls**	**Boys**
Energy (kcal)	2018	14.5	1990, 2047	1740	1970
Energy (KJ)	8488	60.9	8369, 8608	7280	8245
Protein (g)	73	0.6	72, 74	28	28
Carbohydrate (g)	264	1.7	260, 267	265	322
Fibre (Englyst) (g)	12	0.1	12, 12	18	18
Fat (g)	81	0.8	79, 83	68	77
Total sugars (g)	130	1.0	128, 132	123	140
Iron (mg)	11	0.1	10, 11	8.7	8.7
Calcium (mg)	853	7.7	838, 868	1000	1000
Potassium (mg)	2727	20.3	2687, 2767	2200	2200
Sodium (mg)	2658	27.3	2604, 2711	1200	1200
Folate (µg)	226	1.9	222, 230	300	300
Carotene (µg)	2077	35.4	2007, 2146	1700	1700
Vitamin A (retinol equiv) (µg)	406	9.3	388, 424	500	500
Vitamin C (mg)	111	1.4	108, 114	30	30

*FAO/WHO/UNU, 1985, Department of Health 1991, NHMRC, 2006

5.4.3 Children's key food and drink intake

The mean, standard error, and 95% confidence intervals for key foods from the whole sample are presented in table 5.3. Children on average consumed 94g of vegetables and 200g of fruit, with a combined mean of 295g of fruit and vegetables at baseline. Table 5.3 also shows the number (%) of children who consumed different foods and the mean intake from this sub-sample. From this analysis it is evident that 84 percent of the sample consumed some vegetables on the day of collection, and 80 percent of children consumed some fruit; with 95 percent of the children eating either fruit or vegetables. Consumption of dried fruit was particularly high at 79 percent of all children. The other most commonly consumed items were drinks: fizzy pop/squash 53 percent, fruit juice 51 percent and milk 43 percent.

5.4.4 Fruit and vegetable intake by meal event

Further analysis was conducted to explore fruit and vegetable consumption by meal event. These results are presented in table Table 5.3 for the whole sample, and consumers only. The most common times to consume fruit was lunchtime and before tea/after school, with the largest proportion of children, 38% consuming fruit at lunchtime. Lunch was also one of the most common meal times to consume for vegetables, with the largest proportion of children, 58% consuming vegetables with their evening meal.

5.4.5 Difference in fruit and vegetables between packed lunch and school meals

For lunchtime, children can either have a school meal (provided by the school) or a packed lunch (provided by the parents). Table 5.4 displays the breakdown of fruit and vegetables based on lunch type. These results show that fruit intake was on average 42g higher in children who had packed lunch meals compared to children who had school meals, and vegetable intake was 33g higher in children who had school meals compared to children who had a packed lunch.

Table 5.3 Dietary intake of 2393 children enrolled in the RHS School gardening campaign

	Total sample			Consumers only				
Food	**Mean**	**SE**	**95% CI**	**n**	**%**	**Mean**	**SE**	**95% CI**
Total vegetables (non-pulse, bean, lentil, dahl or seed)(g)	94	1.7	91, 98	2006	84	113	1.7	109, 116
pulses, beans, seeds (g)	16	0.8	14, 17	455	19	85	2.4	73, 86
Total fruit (g)	200	3.5	193, 206	1909	80	251		244, 257
Fruit (non-dried) (g)	199	3.4	192, 206	1900	79	251	3.5	244, 258
Dried fruit (g)	2	0.2	1.3, 2	103	4	38	1.7	35, 41
Total fruit & vegetables (excluding pulses & beans) (g)	295	4.1	286, 303	2269	95	311	4.1	303, 319
5 A Day portions (80g)	4	0.1	4, 4	2336	98	4	4.3	4, 4
Sweets, toffees, mints (g)	4	0.2	3, 4	380	16	26	0.5	25, 27
Chocolate bars, Mars etc. (g)	7	0.3	6, 8	446	18	39	0.6	38, 40
Crisps, savoury snacks (g)	11	0.3	10, 12	916	38	30	0.3	29, 30
Nuts (g)	1	0.1	1.1, 1.8	93	4	37	1.6	34, 40
Milk or milky drink (g)	108	2.9	102, 114	1028	43	253	3.6	146, 260
Fizzy pop, squash, fruit drink (g)	185	4.5	176, 194	1259	53	352	5.2	342, 362
Fruit juice (pure) (g)	123	3.0	117, 129	1222	51	241	3.5	235, 248

Table 5.4 Fruit and vegetable intake (g) by Lunch Meal of 2343 children enrolled in the RHS School gardening campaign

	Whole sample				Mean consumption - Consumers only				
	n	Mean	SE	95% CI	n	%	Mean	SE	95% CI
Fruit intake									
School Meal	1571	189	4.1	218, 243	1396	58	243	4.2	234, 251
Packed Lunch	772	231	6.4	218, 243	567	24	267	6.3	255, 280
Vegetable intake									
School Meal	1571	106	2.1	102, 110	1208	50	119	2.2	115, 123
Packed Lunch	772	73	2.7	67, 78	665	28	99	3.0	93, 105

5.4.6 Differences in key nutrient intake between boys and girls

Multilevel regression analysis was conducted to explore the differences between boys and girls in this sample. Table 5.5 displays the means, standard deviation/standard error for boys and girls, and the unadjusted and adjusted regression results. These results identified there is a significant difference between boys and girls for fibre, potassium, sodium, carotene, and vitamin C, after adjusting for ethnicity and IMDS.

5.4.7 Differences in key food and drink intake between boys and girls

Further analysis was conducted on only boys and girls who consumed the particular foods or drinks (see Table 5.6). Girls on average consumed 20 g (95%CI: 12, 25) more vegetables; 14 g (95%CI: 10, 17) more dried fruit; 37 g more total fruit and vegetables (excluding pulses and beans) (95%CI: 20, 54); 19 g more nuts (13, 25) and 11mls more fruit juice (95%CI: -3, 25). Whereas boys on averaged consumed 5 g more sweets (95%CI: 8, 3) and 63 mls more fizzy pop (81, 45) than girls.

5.4.8 Differences in fruit and vegetable intake by meal event between boys and girls

The differences between boys and girls who consumed fruit and vegetables by meal events are presented in Table 5.7. On average, girls consumed 7 g (95%CI: 3, 11) more vegetables at lunchtime and 10 g more vegetables from their evening meal than boys, after adjusting for ethnicity and IMDS.

Table 5.5 Dietary intake of 2393 children enrolled in the RHS School gardening campaign

	Girls (n=1189)			Boys (n=1205)			Unadjusted		Adjusted for ethnicity IMD score			
	Mean	SE	95% CI	Mean	SE	95% CI	Mean diff	SE	Mean diff	SE	95%CI	P-value
Energy (kcal)	2015	19.2	1977, 2052	2023	21.8	1980, 2066	-8	30	-13.2	28	-70, 43	0.6
Energy (KJ)	8472	80.6	8314, 8630	8506	91.2	8326, 8685	-34	129	-55	118	-292, 182	0.6
Protein (g)	73	0.8	72, 75	74	1.0	72, 76	-1	1	-1	1	-4, 2	0.3
Carbohydrate (g)	265	2.4	261, 270	263	2.4	258, 268	2	4	1	5	-6, 8	0.8
Fibre (Englyst) (g)	13	0.2	13, 13	12	0.2	12, 13	1	0	1	0	0, 1	<0.001
Fat (g)	81	1.0	79, 83	82	1.4	80, 85	-1	2	1	2	-4, 8	0.3
Total sugars (g)	132	1.4	129, 134	130	1.5	127, 133	2	2	1	2	-4, 5	0.7
Iron (mg)	11	0.1	11, 11	11	0.1	11, 11	0	0	0	0	0, 0	0.7
Calcium (mg)	865	10.3	845, 886	843	11.4	820, 865	23	16	19	16	-12, 51	0.2
Potassium (mg)	2809	28.5	2753, 2864	2648	28.8	2591, 2704	161	44	147	43	61, 234	0.001
Sodium (mg)	2592	30.4	2532, 2651	2724	45.1	2636, 2813	-133	56	-131	53	-238, -24	0.01
Folate (µg)	228	2.5	223, 233	225	2.9	219, 230	3	4	2	4	-6, 11	0.5
Carotene (µg)	2250	54.2	2153, 2366	1898	45.0	1809, 1986	362	89	345	90	164, 526	<0.001
Vitamin A (retinol equiv) (µg)	389	10.4	368, 409	424	15.2	394, 453	-35	18	-29	17	-63, 4	0.08
Vitamin C (mg)	119	2.0	116, 123	104	1.9	100, 107	16	3	15	3	8, 20	<0.001

Table 5.6 Dietary intake of children who consumed the following food items

	Girls			Boys			Unadjusted		Adjusted Ethnicity IMD score			
	Mean	SE	95% CI	Mean	SE	95% CI	Mean diff	SE	Mean diff	SE	95% CI	P-value
Total vegetables (nonpulse, bean, lentil, dahl or seed)(g)	105	2.5	100, 110	85	2.3	80, 89.4	20	4	20	4	12, 25	<0.001
Pulses, beans, seeds (g)	80	3.3	74, 867	92	3.5	85, 98.6	-12	5	-11	5	-20, -2	0.02
Total fruit (g)	211	4.9	201, 221	190	4.9	180, 199	21	6	18	7	4, 32	0.01
Fruit (non-dried) (g)	254	4.9	244, 263	249	5.1	239, 258	5	5	3	6	-9, 15	0.6
Dried fruit (g)	44	2.3	39, 48	29	1.1	27, 31	14	2	14	2	10, 17	<0.001
Total fruit & vegetables (excluding pulses & beans) (g)	316	5.8	305, 327	274	5.8	263, 286	41	8	37	9	20, 54	<0.001
5 A Day portions (80g)	4.6	0.08	4.5, 4.8	4.1	0.08	3.9, 4.3	0.5	0	0.5	0	0.2, 0.7	<0.001
Sweets, toffees, mints (g)	25	0.8	22, 26	30	0.6	28, 31	-5	1	-5	1	-8, -3	<0.001
Chocolate bars, Mars etc. (g)	38	0.9	38, 41	39	0.8	37, 41	0.9	1.0	1.1	1.1	-1.0,3.3	0.3
Crisps, savoury snacks (g)	31	0.5	30, 32	29	0.4	29, 30	2	1	2	1	1, 3	0.004
Nuts (g)	48	2.4	43, 52	29	0.9	26, 30	20	3	19	3	13, 25	<0.001
Milk or milky drink (g)	251	4.8	242, 260	256	5.3	245, 266	-5	7	-3	7	-17, 10	0.6
Fizzy pop, squash, fruit drink (g)	318	6.4	305, 330	382	7.7	366, 397	-63	10	-63	9	-81, 45	<0.001
Fruit juice (pure) (g)	248	5.0	238, 257	235	4.8	226, 245	12	7	11	7	-3, 25	0.1

Table 5.7 Fruit and vegetable intake (g) by meal time of children enrolled in the RHS School gardening campaign[1]

	Girls				Boys				Unadjusted		Adjusted for Ethnicity and IMDS			
	n	Mean	SE	95% CI	n	Mean	SE	95% CI	Mean diff	SE	Mean diff	SE	95%CI	P-value
Fruit intake by meal time														
Breakfast	202	134	4.9	125, 144	158	130	5.4	120, 141	3.6	7.6	14	7.6	14, 17	0.8
Morning break	244	110	2.5	105, 115	189	112	2.5	107, 117	-2.0	4.0	-1.3	3.9	-9, 7	0.7
Lunch (all children)	461	132	3.0	126, 138	444	126	2.6	121, 131	5.7	3.6	6.3	3.4	-1, 13	0.07
Afternoon break	27	179	19.5	139, 219	28	182	21.8	138, 227	-3.3	30.5	-2.9	32.5	-70, 64	0.9
Before tea/after school	415	145	4.3	136, 154	366	155	4.9	145, 165	-9.6	5.5	-10.9	5.6	-22, 1	0.05
Evening meal	264	133	4.7	124, 142	259	136	4.6	127, 145	-3.4	7.0	-2.5	7.2	-16, 51	0.7
After tea	278	136	4.5	127, 144	239	141	5.2	131, 152	-5.6	6.4	-7.5	6.5	-20, 5	0.2
Vegetable intake by meal time														
Breakfast	25	61	8.3	44, 79	31	44	3.7	36, 51	17.7	7.0	16.3	6.3	3, 29	0.01
Morning break	21	78	9.5	31, 126	14	78	22.0	31, 126	-8.8	34.1	-19.8	38.3	-102, 62	0.6
Lunch (all children)	724	66	37.7	64, 69	661	60	34.5	57, 62	6.9	2.1	7.2	2.1	3, 11	0.001
Afternoon break	12	87	26.1	30, 145	11	103	30.9	34, 172	-15.6	33.1	-76.5	30.0	-143, -10	0.02
Before tea/after school	141	61	3.4	55, 68	124	64	5.1	54, 74	-2.2	6.5	-1.6	6.5	-14, 11	0.8
Evening meal	736	83	2.0	80, 87	655	74	2.0	70, 78	9.5	2.6	9.5	2.8	4, 15	0.001
After tea	64	62	5.5	51, 74	59	57	3.8	50, 64	5.3	5.6	5.4	5.7	-6, 17	0.01

5.5 Family meals can help children reach their 5 A Day: Further analysis of the baseline data

Epidemiological evidence indicates that a diet rich in fruit and vegetables can decrease the risk of developing cardiovascular disease, stroke, hypertension, type 2 diabetes mellitus, obesity and several forms of cancer (WHO, 2009, World Cancer Research Fund, 2007, Bazzano LA, 2002, Boffetta P, 2010, Ness AR, 1997, Harding AH, 2008). A diet low in fruit and vegetable intake is one of the top ten risk factors for global mortality (Magarey, 2005). Of particular public health concern is the rise of obesity in children (Reilly et al., 2006). One in ten children aged 2-10 is obese in the UK (National Centre for Social Research, 2005). Diet plays a fundamental role in weight management. Having a healthy diet rich in fruit and vegetables, which are low energy density foods, could potentially help tackle this epidemic. In the last 4 years the Department of Health has spent over £3.3million on the 5 A Day campaign and £75 million on the Change 4 Life campaign to rectify poor diets (NHS, 2012). However, these campaigns do not directly address family meal time behaviour. With the average child in UK consuming less than the recommended intake of fruit and vegetable, it is important to identify influential factors associated with improving children's overall nutrition.

There is evidence that dietary habits are developed in childhood and persist throughout life; therefore it is vital that children at a young age consume adequate levels of fruit and vegetables (Singer et al., 1995, Skinner et al., 2002). Parents are the most influential factor on the quality of a child's diet (Cooke, 2007, Jones et al., 2010). Parent's attitudes and beliefs determine what food is offered to their children. Several studies have also indicated that children's fruit and vegetable intake is positively associated with their parents' intake (Fisher, 2002 , Gibson et al., 1998). Part of the influence parents have on their children's food intake is through modelling. Modelling is an important way for children to learn about eating; watching the way their parents eat and the different types of food they eat is pivotal in creating their own food habits and preferences (Patrick and Nicklas, 2005) Children need to see adults eating fruit and vegetables, to help demonstrate positive behaviour (French and Stables, 2003). However, there are few studies conducted in the UK that explore how the provision of fruit and vegetables in the home environment affects children's overall intake. Using a large sample of children from London, this study aims to further explore and identify characteristics of the home food environment associated with children's fruit and vegetable intake.

5.6 Methods

5.6.1 Variables

Below is a list of the questions in Section two of the Home Food Diary which ask about the child's fruit and vegetable intake and home environment. The responses were completed by the parent or carer. These questions explored fruit and vegetable habits in the family home:

- Do you have different kinds of fruit/vegetables at home
- Do you buy specific fruit/vegetables because your child asks for it?
- Do you cut up fruit/vegetables for your child to eat?
- Do you (parents) eat fruit/vegetables every day?
- Do you eat fruit/vegetables together with your child?
- Do you have to ask your child to eat their fruit or vegetables?
- Do you allow your child to eat as much fruit/veg as she/he likes?

The responses to these questions were collected as yes/ always, yes most days/often, sometimes, rarely, never. General summary statistics, including box plots and histograms of the different categories, were first analysed to identify the best method to code the data. Based on the frequency of responses to these questions they were then categorised never/rarely, sometimes, or always.

Four questions were designed to identify the factors associated with consumption habits of the family (Bryant et al., 2008):

- The money I have available to spend on fruit and vegetables
- The price of fruit and vegetables
- The time I have available to prepare fruit and vegetables
- Likes and dislikes of my family for fruit and vegetables

The responses to these questions were collected as: very important, important, neither important or/unimportant, unimportant, very unimportant. Correlation tests indicated that these questions were highly correlated. These were re-coded into a scale of 1-not important at all, to 5-very important.

In addition to these questions the following home inventory question "Please tick if you have any of the following fruit or vegetables in your fridge/freezer or cupboards" was collected to identify the variety of fruit and vegetable in the home. As well as the following question "How many nights a week does your family eat together at a table?" was asked to explore how the family meal habits are associated with children's fruit and vegetable intake. As the responses

to this question can only be 0-7 it is considered a multinomial variable, therefore it cannot be treated as a continuous variable. Total fruit and vegetable intake by the 8 possible responses was explored, due to the similarity in total fruit and vegetable intake in g for people who ate together at a table 1-6 nights a week. The data was re-coded into the following: never (0 nights a week), sometimes (1-6 nights a week), and always, (7 nights a week).

5.7 Statistical Analysis

Statistical analysis was performed using Stata IC version 11 (StataCorp, 2005). The analysis was performed using clustered multilevel regression models with total fruit and vegetables as the primary outcome. Multilevel models take into consideration the hierarchical structure of the data, caused by randomising by cluster such as by school (Kitchen et al., 2009). The multilevel regression model was used to explore the difference in fruit and vegetable intake. These models were first conducted unadjusted, and then adjusted for gender, ethnicity and Index of Multiple Deprivation Score (IMDS). The output generated for the primary analysis was effect size, standard error, 95 percent confidence internals and p-values, with a p-value of less than 0.05 taken to represent statistical significance for all of the analysis. The same statistical methodology was applied to explore how home environment habits and children's mean nutrient intake.

5.8 Results

5.8.1 Children's fruit and vegetable consumption and the home food environment

Clustered (by school) multilevel regression models with total fruit and vegetables as the primary outcome were conducted to explore the home food environment and children's fruit and vegetable intake. Table 5.8 displays the results unadjusted and adjusted for children's gender, ethnicity and IMDS.

5.8.2 Meal time behaviour

Children from families who reported "always" eating a family meal together at a table, consumed on average, 125 g (95%CI: 92, 157) more fruit and vegetables, than those families who reported "never" eating a meal together. Children from families who reported "sometimes" eating a family meal together, had on average 95 g (95%CI: 57, 133) of fruit and vegetables more than those children who never ate a family meal together at a table.

Table 5.8 The association between the home food environment and children's fruit & vegetable intake

How often do you eat together as a family at a table?	N	Unadjusted Model Grams	P-diff	P-trend	Adjusted Model* Grams	95%CI	P-diff	P-trend
Reference category: Never	92	1			1			
Sometimes	768	96	<0.001		95	57, 133	<0.001	
Always	656	126	<0.001	<0.001	125	92, 157	<0.001	<0.001
Do you cut up F&V for your child to eat? Reference category: Never/rarely	255	1			1			
Sometimes	495	28	0.04		21	-6, 49	0.1	
Always	820	55	<0.001	<0.001	44	18, 71	0.001	<0.001
Do you eat F&V together with your child? Reference category: Never/rarely	109	1			1			
Sometimes	439	8	0.7		10	-36, 57	0.6	
Always	1018	42	0.05	<0.001	39	-2.5, 80	0.04	0.03
Do you (parent/carer) eat F&V every day? Reference category: Never/rarely	58	1			1			
Sometimes	258	48	0.1		43	-14, 99	0.1	
Always	1260	93	<0.001	<0.001	87	37, 138	0.001	<0.001
Do you have different kinds of F&V at home? Reference category: Never/rarely	28	1			1			
Sometimes	214	36	0.3		24	-54, 101	0.5	
Always	1368	75	0.03	0.01	66	-2, 135	0.05	0.01
Do you buy specific F&V because your child asks for it? Reference category: Never/rarely	166	1			1			
Sometimes	542	21	0.3		15	-24, 53	0.4	
Always	873	27	0.1	0.3	20	-17, 57	0.2	0.5
Do you have to ask your child to eat their F&V? Reference category: Never/rarely	582	1			1			
Sometimes	477	-12	0.4		-12	-43, 19	0.4	
Always	513	-21	0.1	0.4	-27	-57, 5	0.09	0.2
Do you allow your child to eat as much F&V as they like? Reference category: Never/rarely	78	1			1			
Sometimes	180	12	0.6		5	-52, 62	0.8	
Always	1324	34	0.1	0.2	24	-25, 73	0.3	0.4

*Adjusted for gender, ethnicity and Index of Multiple Deprivation Score

5.8.3 Parental role modeling and fruit and vegetable consumption

The children of parents who ate fruit and vegetables every day had on average 87g (95%CI: 37, 138) more fruit and vegetables than children whose parents never/rarely eat fruit and vegetables. Having different types of fruit and vegetables at home was also associated with increased fruit and vegetable intake. Having to ask your child "always" to eat their fruit and vegetables had a non-significant inverse relationship with children's overall intake.

5.8.4 Provision of fruit and vegetables

Children whose parents always cut up fruit and vegetables for them, consumed on average, half a portion more fruit and vegetables (44 g, 95%CI: 18, 71) and children with parents who sometimes cut up fruit and vegetables (10 g, 95%CI: -36, 57) more than children of parents who never cut up their fruit and vegetables. There were no significant differences in fruit and vegetable consumption if parents bought specific fruit and vegetables for their children.

Clustered (by school) multilevel regression models with total fruit and vegetables as the primary outcome were conducted to explore the association of the number of different types of fruit and vegetables people had in their households on the questionnaire completion day. The results indicated that for every additional different type of fruit or vegetable in the house, children's fruit and vegetable intake increased by 5 g, after adjusting for sex, ethnicity and IMD score (95%CI: 4, 6, $p<0.001$). Further analysis was conducted to explore if there was an association with preparation time and cost of fruit and vegetables on a scale of 1-unimportant to 10-very important. The models showed that there were no significant differences (preparation time: 3 g, 95%CI 0, 6, $p=0.9$; cost: 3 g, 95%CI -1, 6, $p=0.9$).

5.8.5 Children's nutrient intake and key foods

Multilevel modelling was conducted to explore if there was a difference in mean nutrient intake and frequency of family meal time behaviour. These results are presented in Table 5.9. The results show there was a significant difference in mean carbohydrates, fibre, sugar, folate, carotene, vitamin C, fruit and vegetable intake, and 5 A Day portions with higher intake in a family who report always eating together. For families who reported always eating together at a table, children met the government recommendations for 5 A Day (5.0 portions, 95%CI: 4.8, 5.2), compared with families who reported sometimes eating together, (4.6 portions, 95%CI: 4.5, 4.8) and families that never reported eating together at a table, 3.3 portions (95%CI: 2.8, 3.8).

Table 5.9 Mean nutrient and food intake by frequency of eating a family meal together at a table.

Frequency of eating together as a family at a table	Never n=92			Sometimes n=768			Always n= 656			P-trend*	All children N=2389		
Nutrients	**Mean**	**SE**	**95%CI**	**Mean**	**SE**	**95%CI**	**Mean**	**SE**	**95%CI**		**Mean**	**SE**	**95%CI**
Energy (kcal)	1960	75.5	1810, 2110	2078	25.9	2027, 2129	2115	27.6	2061, 2170	0.1	2019	14.5	1990, 2047
Energy (KJ)	8240	316.2	7612, 8868	8740	108.5	8526, 8953	8896	115.5	8669, 9123	0.1	8489	60.8	8370, 8608
Protein (g)	72	3.9	65, 80	75	1.1	73, 77	77	1.2	75, 80	0.1	74	0.6	72, 75
Carbohydrate (g)	250	7.5	235, 265	273	3.0	267, 278	279	3.2	273, 285	<0.001	264	1.7	261, 267
Fibre (Englyst) (g)	11	0.5	10, 12	13	0.2	12, 14	14	0.2	13, 15	0.6	13	0.1	12, 13
Fat (g)	82	4.6	73, 91	84	1.5	81, 87	85	1.6	82, 88	0.01	82	0.8	80, 83
Total sugars (g)	120	5.0	110, 130	137	1.9	133, 141	140	2.0	136, 144	0.01	131	1.0	129, 133
Iron (mg)	11	0.5	9, 12	11	0.2	11, 12	12	0.2	11, 12	0.1	11	0.09	10, 11
Folate (µg)	217	10.6	196, 238	236	3.5	229, 243	246	3.7	238, 253	0.02	226	2.0	222, 230
Carotene (µg)	1744	181.4	1384, 2104	2139	63.2	2014, 2263	2412	70.5	2274, 2551	<0.001	2077	35.2	2008, 2147
Vitamin C (mg)	97	6.0	85, 109	119	2.6	114, 124	125	2.7	111, 130	<0.001	111	1.4	109, 114
Food													
Total vegetables (non-pulse, beans, lentils or seeds) (g)	68	7.1	54, 82	99	3.1	93, 105	113	3.5	106, 119	<0.001	95	1.7	92, 98
Pulses, beans, seeds (g)	15	4.0	7, 23	17	1.3	14, 19	20	1.8	17, 24	0.2	86	2.4	81, 91
Total fruit (g)	148	14.7	119, 177	213	6.4	200, 226	229	6.8	216, 242	<0.001	200	3.5	193, 207
Dried fruit (g)	35	8.4	7, 61	41	2.8	36, 47	36	2.6	31, 41	0.5	39	17.2	35, 42
Total fruit & vegetables (excluding pulses & beans)	3.3	0.2	2.3, 3.1	3.9	0.1	3.7, 4.1	4.3	0.1	4.1, 4.5	<0.001	3.7	0.1	3.6, 3.8
Portions 80g													
5 A Day (portions 80g)	3.3	0.2	2.8, 3.8	4.6	0.9	4.5, 4.8	5.0	0.1	4.8, 5.2	<0.001	4.3	0.1	4.3, 4.5
Fruit juice, pure (ml)	112	14.2	84, 140	138	5.7	126, 149.2	138	6.0	126, 149	0.2	124	3.0	117, 130

*Adjusted for gender, ethnicity and Index of Multiple Deprivation Score

5.9 Discussion

The first half of this chapter described the energy and nutrient intake for all children from the RHS baseline collection. It also explored the differences between boys and girls in this sample. Overall, the nutrient levels of all children in this sample were adequate, when compared to the DOH recommendations (DOH, 1991), with children's mean iron, folate and carotene levels, all meeting the recommendations (Cullen, 2000). Children's mean fat intake and sodium intake was above the recommended levels. With the obesity epidemic in children (Reilly et al., 1999), consumption of high energy dense foods needs to be decreased. Diet plays a fundamental role in weight management; having a healthy diet consisting of high levels of low energy density foods could help tackle this epidemic (Miller, 1981 ., Fogarty et al., 2007). These results mirror those found in the 1999-2000 NDNS analysis (Gregory & Lows, 2000), and work conducted by Glynn et al., (2005). These studies also stated children's fat and iron intake was above the maximum requirements set by the Scientific Advisory Committee on Nutrition (SACN, 2003).

Nevertheless, the overall energy levels were appropriate for children from this age group. These results identified that there were some differences between boys and girls for fibre, potassium, sodium, carotene, and vitamin C, after adjusting for ethnicity and IMDS. There was also a difference found in the types of food boys and girls consumed. On average girls consumed more vegetables, dried fruit and fruit juice than boys; whereas boys consumed on average, more sweets and fizzy drinks. Furthermore, girls tended to consume more fruit and vegetables than boys in the lunchtime meal and their evening meal. This difference remained significant after adjusting for ethnicity and IMDS. These gender differences in fruit and vegetable consumption have also been found in previous research conducted in the same age group (Glynn et al., 2005). With dietary patterns established in childhood tending to be persist throughout adulthood (Singer et al., 1995, Skinner et al., 2002), this dietary pattern of girls consuming more fruit and vegetables can also be seen in a teenage population (Inchley et al., 2001) and in the adult population (Gregory et al., 2001). This difference in fruit and vegetable intake between boys and girls needs to be addressed in future public health interventions. More research should be conducted to try and identify ways of encouraging boys to consume more fruit and vegetables.

The second half of this chapter explored the association between primary school children's fruit and vegetable intake and their home food environment. This is the first large survey of London children to explore this association. It found that eating a family meal together at a table had the biggest association on children's fruit and vegetable intake. Children in families

who stated they ate together every day had 1 ½ more portions of fruit and vegetables daily than families who reported never eating together at a table, after adjusting for possible confounders. It also found that sometimes eating at a table together increased children's fruit and vegetable consumption by more than a portion. The importance of the family meal is supported by previous research in preschool children (Gibson et al., 1998) and primary school children (Rockett, 2007, Cullen et al., 2001, Christian MS, 2011). The majority of literature conducted in this area is from the USA (Gribble et al., 2003, Cullen et al., 2001, Fitzpatrick et al., 2007, Fulkerson et al., 2008, Robinson-O'Brien et al., 2009a, McIntosh et al., 2010, Rockett, 2007). There is one study exploring this association in the UK (Christian MS, 2011), a relatively small study with only 102 participants. This study does however support our findings here, reporting that frequency of family meals can increase children's fruit and vegetable consumption.

Not only does the family meal time behaviour have an association with fruit and vegetable intake, it may also be a predictor of the general quality of a child's diet (Matheson DM, 2004). McIntosh et al., (2010) explored mother's planning behaviour around cooking and attitudes towards the family meal identifying that mother's belief in the family meal determined the frequency of this behaviour. Also, mothers who have a higher belief in the importance of eating a meal together were more likely to be motivated to plan their food shopping around cooking for a family meal. These results are similar to Jones et al., (2010) who found that maternal intake was a predictor of children's fruit and vegetable intake. Regularity of parent's fruit and vegetable consumption, and availability of fruit and vegetables in the home (Gibson et al., 1998, Kratt et al., 2000, Kelder et al., 1994) are considered important predictors of children's intake (Cullen et al., 2001, Kitchen et al., 2009). There has also been research in older children (age 9 to 14 years old) that found eating a family meal together was inversely associated with obesity in children in the USA (Taveras et al., 2005).

There are benefits other than the family's nutritional status to having a family meal together. They provide conversational time for families (Christian MS, 2011), incentives to plan a meal (Cullen et al., 2001), and an ideal environment for parents to model appropriate mealtime behaviour. Since dietary habits are established in childhood the importance of promoting the family meal needs to be utilised in public health campaigns such as the "Every Contact Counts" campaign, raising health consciousness using brief interventions.

This research also supports previous studies on preschool age children that parental intake is strongly associated with children's intake (Wind et al., 2008, Blanchette and Brug, 2005). The more frequently parents stated they consumed fruit and vegetables was associated with higher consumption in their children. Parents eating fruit and vegetables with their children was also associated with higher consumption. The relationship between parental intake and child's intake can be explained through modelling, and the child's simple desire to imitate their parents (Patrick and Nicklas, 2005, Robinson-O'Brien et al., 2009a, McIntosh et al., 2010). Increased availability would increase children's familiarisation with different fruits and vegetables, which is considered to be a key determinant in children's consumption (Timperio et al., 2008, Nelson et al., 2007). Availability of different types of fruit and vegetables in the home could simply be providing children with the visual cue to eat a piece of fruit or vegetables (Jago et al., 2007, Timperio et al., 2008). Future interventions could be tailored towards improving parental intake of fruit and vegetables, to facilitate their children's intake.

Another important, but simple to implement public health message, is that cutting up fruit and vegetables facilitates children's intake. If children have access to prepared fruit and vegetables at home, they are more likely to eat them. Research has been conducted in older children supporting this finding (Cullen, 2000, Wind et al., 2006). Wind et al., (2010) also found cutting up vegetables correlated to children's intake. This study is the first study conducted in primary school children in the UK to support such findings.

The importance of a family eating together at a table becomes evident when exploring the differences between the key foods, with the mean intake for families who always ate an evening meal at a table reaching the governments guidelines of five portions (Department of Health, 1991). The 5 A Day definition includes one portion of fruit juice and one portion of beans, as well as any fruit or vegetables consumed. A third of the children in this sample report achieving this target. It is evident that eating a family meal together plays a vital role in improving children diets. There were also several macronutrients which were significantly higher in the families that always ate together at a table, such as folate, carotene, vitamin C and iron, all found in fruit and vegetables. Gillman et al., (2010) also found frequency of family meals was associated with higher intakes of, folate, vitamin C, and fibre in children.

5.9.1 Strengths and limitations

There were some limitations of this analysis. There were 887 parents (36%) who did not complete the additional questions, of these 23% did not return the Home Food Diary; therefore the results are potentially subject to response bias. However no differences were found when analysing with or without the missing participants. The CADET questionnaire was completed by trained fieldworkers in school hours and parents for the evening meal and breakfast. Parents and children might be inclined to give socially desirable responses, leading to an overestimation of the association of the home food environment on children's fruit and vegetable intake. This type of dietary assessment has limitations; the portion size assumed for each item in CADET is based on weighed intakes from UK children. A one-day tick list may not reflect true nutrient intake in the longer term.

Nevertheless, this study is unique as its population is from London, a highly diverse population in terms of ethnicity and socio-economic groups. The dietary data was collected using the previously validated 24-hour food tick list CADET. The strength of the CADET diary is that it uses age and gender specific food portion sizes to calculate food and nutrient intake. A one-day tick list is an economically effective way of gathering nutrient information from children. Furthermore, all the results were conducted using multilevel analysis. The benefit of this technique is that the means and confidence intervals for the different foods and nutrients will be more accurate, as the children's food consumption within a school is more similar to each other, with less variability within the sample compared to a random sample from the whole population (Rasbash et al., 2004, Aiken and West, 1991). In addition to previous research using this tool, a DVD with instructions for completing the questionnaire was sent home for parents/carers and children to watch, and a trained fieldworker reviewed the diary with the children to improve the home food data quality.

5.10 Conclusion

In conclusion, the results from this study illustrate a positive public health message for parents, which not only could improve their own dietary habits, but also their children's. The key message from this research is for families to eat fruit and vegetables together at a mealtime. Cutting up fruit or vegetables for children facilitates their intake. Eating fruit and or vegetables with children will increase their consumption, and could help them achieve the national recommendation. Successful public health interventions are needed to improve family food related behaviour.

5.11 Chapter Summary

The CADET tool found that children consumed on average 293g fruit and vegetables (95%CI: 287, 303) per day. The first half of this chapter described the energy and nutrient intake for all children from the RHS baseline collection. It also explored the differences between boys and girls in this sample. The second half of this chapter used explore the home environment and children's fruit and vegetable intake. Children of families who reported "always" eating a family meal together at a table, had 125 g more fruit and vegetables, than families who never ate a meal together. Daily consumption of fruit and vegetables by parents was associated with higher fruit and vegetables, 87 g intake in children compared to rarely/never consumption of fruit and vegetables by parents. Cutting up fruit and vegetables for children was associated with higher consumption. Families who reported always cutting up fruit and vegetables for their children had 44 g more fruit and vegetables than families who reporting never cut up fruit and vegetables. This chapter identified that cutting up fruit and vegetables and family meal consumption of fruit and vegetables facilitates children's intake. Eating a family meal together regularly could increase a child's fruit and vegetables intake and help them achieve the recommended intake.

Chapter 6 - Evaluation of a randomised controlled trial of a school gardening intervention and children's fruit and vegetable intake

Current academic literature showed promising results suggesting school gardening programmes provide an interactive environment that seems to change children's self-efficacy and willingness to try different fruit and vegetables. These changes in attitudes towards fruit and vegetable may potentially lead to an increase in actual consumption of fruit and vegetables. However, the limitation of the current research to date was the study design, evaluation tools, and lack of adequate follow-up time. With the variability in quality of study design and validated tools to measure children's nutritional intake, it was evident that further research is needed to determine the potential impact gardening interventions have on children's diets. This study used a robust methodology for two randomised controlled trials to explore how two different gardening interventions affect children's fruit and vegetable consumption. Chapter 6 addresses the primary outcome for both trials and the following aims for Trial 1 and 2:

Primary aims

- Can the RHS Campaign lead to increases in vegetable and fruit intake in children aged 8-9 years?

The effectiveness of the RHS-led intervention compared to the Teacher-led intervention (Trial 1) or the Teacher-led intervention compared to the comparison group (Trial 2) would be determined by an increase in mean intake in one of the following; mean intake of fruit, mean intake of vegetables, or mean intake of fruit and vegetables at follow-up after adjusting for baseline.

Secondary aims

- What is the effect of the RHS-led intervention compared to the Teacher-led intervention or Teacher-led intervention compared to the comparison schools on intake of key nutrients (fat, carbohydrate, protein, vitamin C, carotene, iron, sodium, folate)?
- Is there an interaction between gender and the intervention?

6.1 Background to multilevel modelling

The primary analysis for these trials was performed using clustered multilevel regression models. This section will outline the statistical theory behind multilevel analysis using the combined data from the two trials as an example. The multilevel model formula for the main analysis for these two trials was (Leckie, 2010):

$$\mathbf{change}_{ij} = \beta_0 + u_{0j} + e_{ij}$$

The word $\mathbf{change}_{ij}$ represents the mean change in children's fruit and vegetable intake from follow-up to baseline of ***i*** pupil from that particular school ***j***, β_0 represents the overall mean from all the schools in the model, u_{0j} represents the school or level 2 residuals, and finally e_{ij} stands for the pupil level residual (Leckie, 2010). For this study the command used to fit this multilevel model in stata was **xtmixed**.

An example of the line stata code is:

xtmixed change || schoolid:, mle variance

The variable **change** is the difference between combined fruit and vegetable at follow-up and the combined fruit and vegetable intake at baseline. This is a basic model and does not include any explanatory variables, therefore it only contains an intercept (Leckie, 2010). The level 2 aspect of the code is the variable **schoolid.** The **mle** command stands for maximum likelihood estimation, and **variance** reports the variance of the intercept and coeffcients within the model (Leckie, 2010). An example of the Stata output for this type of model is presented in Figure 6.1

Figure 6.1 Example of the multilevel modelling output from Stata.

```
xtmixed change  || schoolid:, mle variance
Performing EM optimization:
Performing gradient-based optimization:
Iteration 0:   log likelihood = -10820.415
Iteration 1:   log likelihood = -10820.415
Computing standard errors:
Mixed-effects ML regression                     Number of obs      =      1554
Group variable: schoolid                        Number of groups   =        49

                                                Obs per group: min =         5
                                                               avg =      31.7
                                                               max =        55
                                                Wald chi2(0)       =         .
Log likelihood = -10820.415                     Prob > chi2        =         .

------------------------------------------------------------------------------
      change |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       _cons |   7.173113   10.66486     0.67   0.501    -13.72964    28.07586
------------------------------------------------------------------------------
------------------------------------------------------------------------------
  Random-effects Parameters  |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
schoolid: Identity           |
                  var(_cons) |    3434.85   1133.471      1798.947    6558.388
-----------------------------+------------------------------------------------
               var(Residual) |    63391.6   2311.201      59019.79    68087.25
------------------------------------------------------------------------------
LR test vs. linear regression: chibar2(01) =    31.51 Prob >= chibar2 = 0.0000
```

The between-school (level 2) variance is presented by the **var(_cons)** line in the model output e.g. 3434. The within-school between-pupil (level 1) variance is presented by the **var(Residuals)** line in the model e.g. 63391. To work out the total variance in the model the two numbers are combined e.g. 66825. The variance partition coefficient for the above model is calculated by dividing the between-school variance by the within school between-pupil variance e.g. 0.05. This indicates that 5% of the variance in change in mean fruit and vegetables can be attributed to the differences between schools. School effect (residuals) or $\hat{u}_{0j}$ and their standard errors can be calculated through generating a caterpillar plot of the school effect (and 95% confidence intervals) in rank order and is presented in Figure 6.2 (Rabe-Hesketh and Skrondal, 2008).

Figure 6.2 Plots of the school residuals for change in fruit and vegetable intake in ascending order with their 95% confidence limit

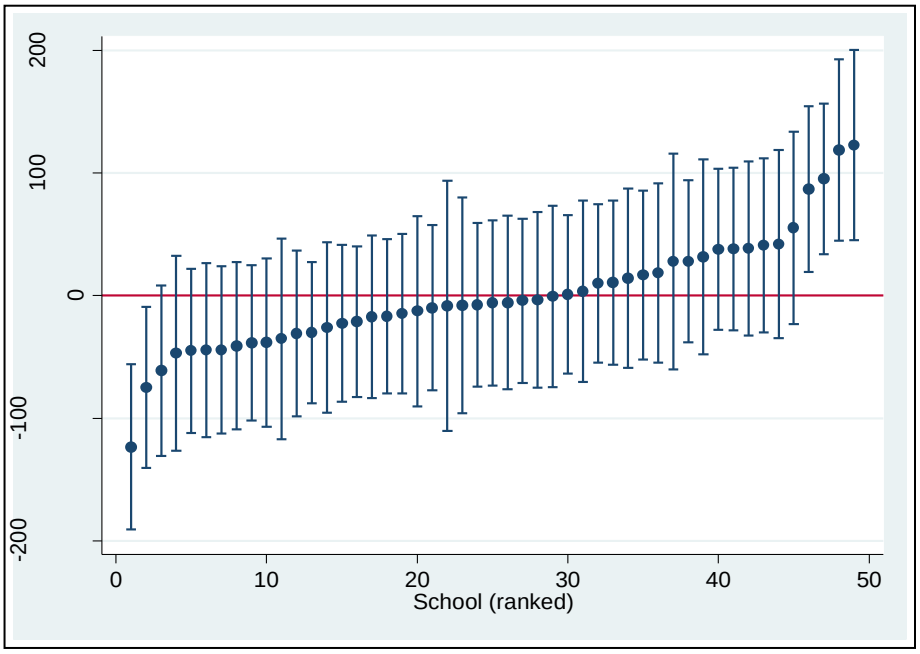


Figure 6.2 illustrates the school residual's departure from the overall average line predicted by a fixed parameter. From the plot it is evident that a few of the school's confidence intervals do not pass through zero at each end of the plot. However, this was only for a few schools, whereas the majority of the schools do pass through zero, indicating that the schools do not differ significantly from the average line at the 5% level. Therefore random slope analysis was not carried out on this data.

6.2 Methodology

Details regarding the sampling methodology, ethics, data collection tools, randomisation, data cleaning and the interventions are described in detail in chapter 4 –Methodology on page 77.

6.2.1 Study population

Trial 1 includes 23 schools from the following London boroughs: Wandsworth; Tower Hamlets; Greenwich. Trial 2 includes 31 schools from the following London boroughs: Lewisham; Lambeth; Merton and Newham.

6.2.2 Sample size

The proposed sample size for this study to have 90% power to detect a 0.5 portion difference in vegetable intake, is 627 per group, i.e. about 13 schools using 2 classes from each school. To

have 90% power to detect a 1 portion difference in fruit intake, 482 per group are required, i.e. about 10 schools.

6.3 Statistical Analysis

6.3.1 Variables

The primary objective of the trials was to evaluate the RHS school gardening intervention by measuring the change in mean intake of the following: daily portions of fruit and vegetable intake; daily portions of fruit intake and daily portions of vegetable intake derived from the school and home food diaries.

- All three variables are continuous and derived from the nutrient software dietary nutrition tool for evaluation (DANTE).
- These measurements were taken at baseline (April 2010) and again at follow-up (15 months later).

Secondary aims measures

Nutrient:

- Total energy intake (MJ/day)
- Fat intake (g/day)
- Saturated fat (g/day)
- Salt intake (g/day)
- Sugars (g/day) including non-milk extrinsic sugars
- Carotene intake (mg/day)
- Vitamin C intake (mg/day)
- Vitamin D intake (mg/day)
- Iron (µg/day)
- Fibre, non-starch polysaccharides (g/day)
- Zinc (µg/day)
- Carbohydrates (g/day)
- Folate (µg/day)

Foods:

- High in fat, salt or sugar and sugar sweetened beverages

General participant descriptive and summary of primary and secondary outcomes/aims measures were tabled for each intervention/control group within the two trials. Summaries of continuous variables comprised of the number of observations presenting the following: the

mean, standard deviation, 95% confidence intervals. Summaries of categorical variables comprised of the number of observations and percentage of observations for each category.

6.3.2 Comparison of intervention type and control groups at baseline

School level baseline characteristics were compared between intervention and control groups for Trial 1 and Trial 2 separately. This was performed to confirm that randomisation has resulted in broadly similar groups in terms of weights of foods and nutrients and individual and school level characteristics. Balance of school/class and child-level variables between the two intervention groups was assessed using the following variables:

School/class level:

- % children with English as an additional language
- % non-white children
- % children with free school meals eligibility

Child level:

- Sex
- Age

6.3.3 Primary outcome analysis of the trial

The variability between the schools determined which type of model should be used for this analysis. The main analysis used a random effects model with total fruit and vegetables as the primary outcome to explore the study aims and objectives; results were reported both as unadjusted and adjusted for baseline intake. Analyses using random effects models were used to determine any differences between schools. This analysis was based on the theory of intention-to-treat (ITT) analysis, where all participants are analysed based on their randomised condition at baseline. The output that was generated for the primary analysis was effect size, standard error, 95 percent confidence intervals and p values, with a p-value of less than 5% taken to represent statistical significance.

6.3.4 Description of means of food types and nutrients by intervention status

Following comparison of baseline variables, the mean weight (g) of fruit and vegetables consumed on the follow up CADET data collection day with standard error and 95% confidence

intervals was analysed for all children. This was reported with no adjustment for baseline levels and also adjusted for baseline fruit and vegetable levels.

6.3.5 Secondary outcome analysis of the trial

A p-value of 0.01 was used to take into account multiple testing. These analyses answer plausibility questions, i.e. that the effect of the intervention differs by gender.

6.3.6 Sensitivity analysis

This is an epidemiological based RCT and therefore it is typical that drop out would occur. Reasons why participants have dropped out was described in chapter 4. Sensitivity analyses were carried out using baseline data brought forward to explore the effect of reducing drop outs on the primary outcome.

6.4 Results

6.4.1 Sample size

Our sample size at baseline for both trials (2590 children) was originally less than the original aim of 2900 children. The final sample size reduced to 1557, with only 641 children in total completing Trial 1 (RHS-led: 312, Teacher-led: 329); similar results were found in Trial 2 with 916 children in total completing the trial (Teacher-led: 488, Control: 428). The response rate at follow-up for the two combined was 60%. This reduced the average group size to approximately 388, which was 94 children less per group than proposed sample size of 482 (calculated in chapter 4 methodology). This has reduced the power to detect the difference of 1 portion to fruit and vegetables to 83 percent.

Figure 6.3 Trial 1 RHS Gardening CONSORT Flowchart of schools

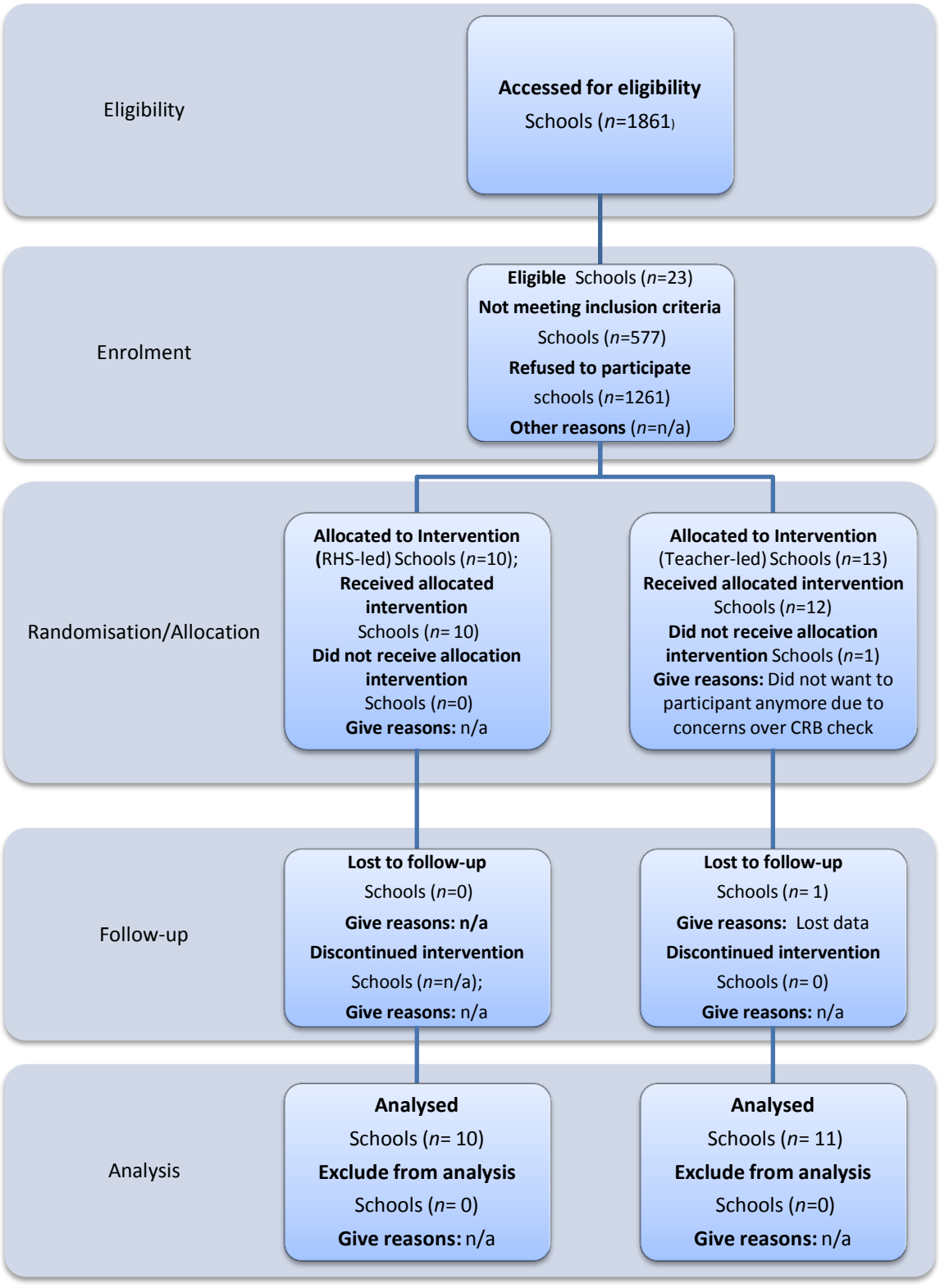


Figure 6.4 Trial 1 RHS Gardening CONSORT Flowchart of children

Figure 6.5 Trial 2 RHS Gardening CONSORT Flowchart of schools

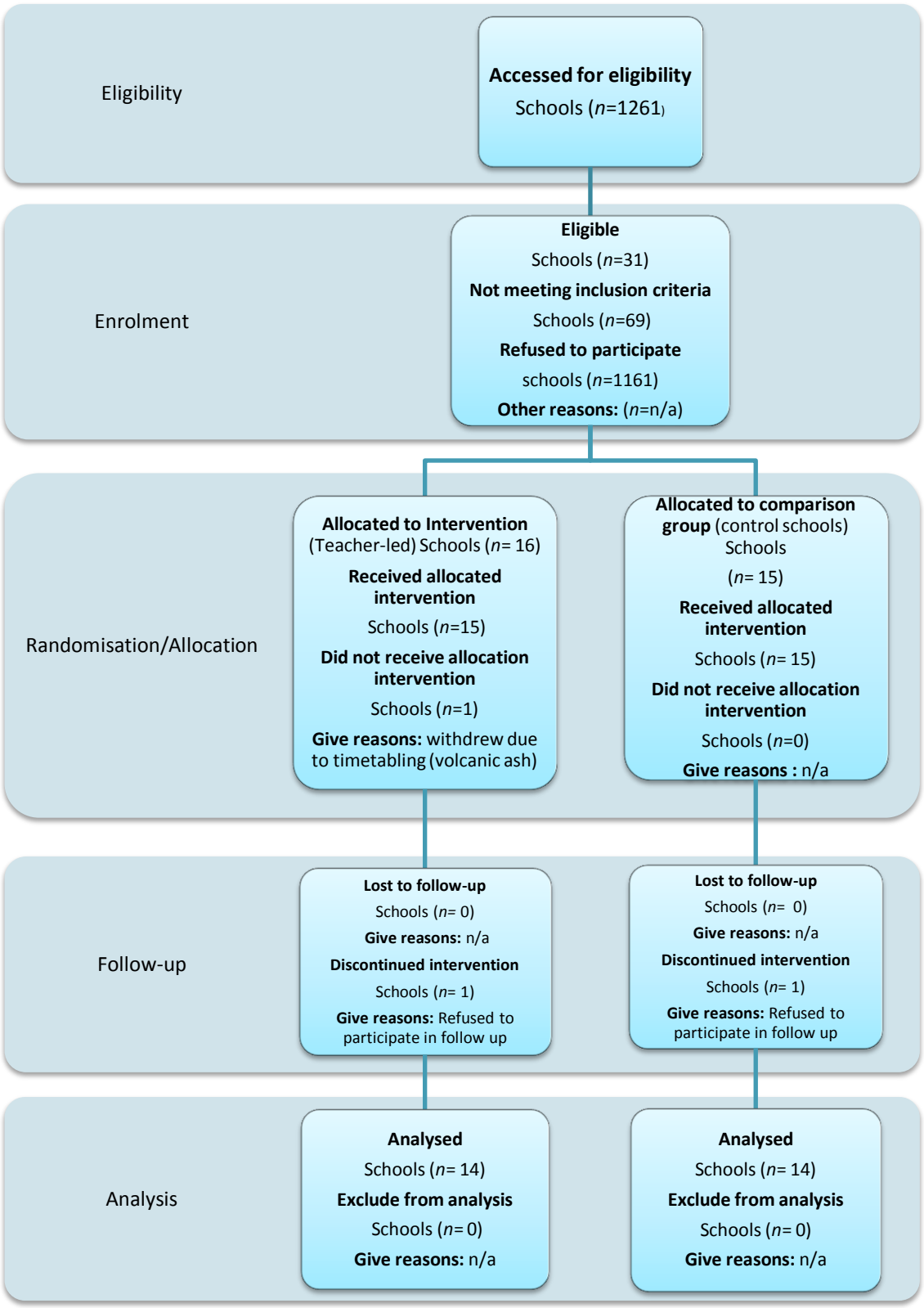
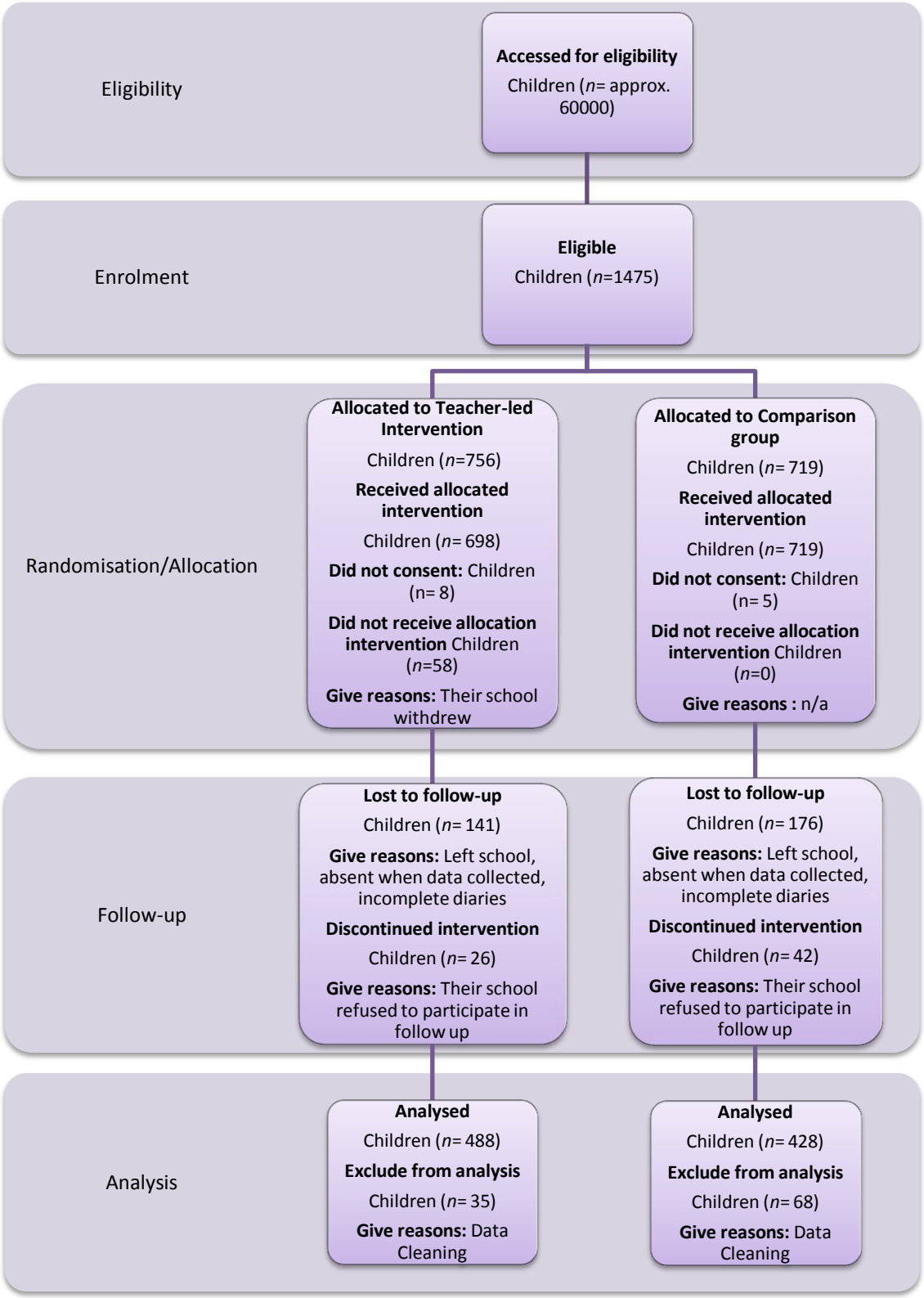


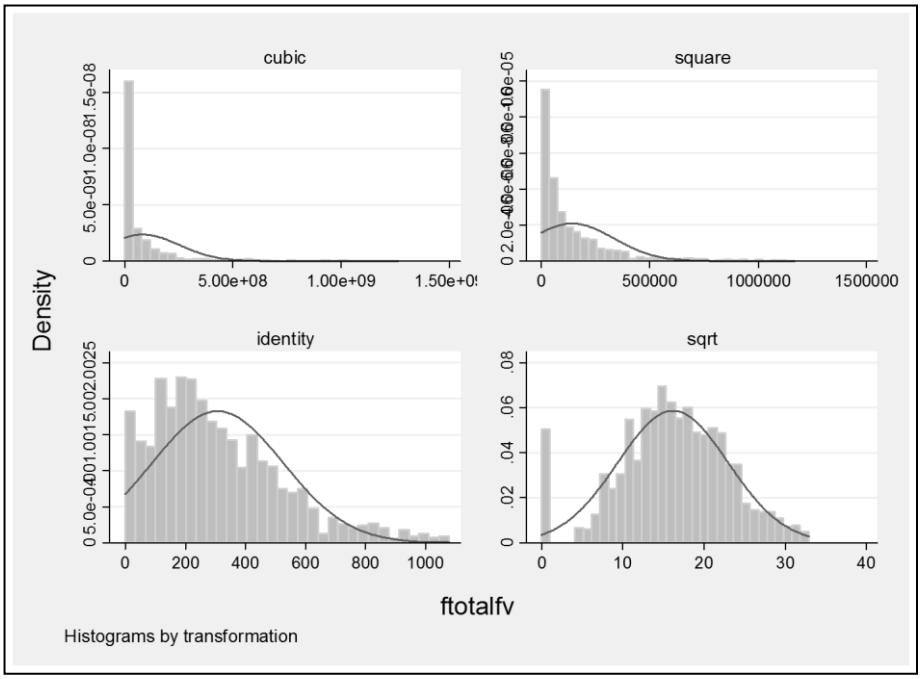
Figure 6.6 Trial 2 RHS Gardening CONSORT Flowchart of children



6.4.2 Regression assumptions

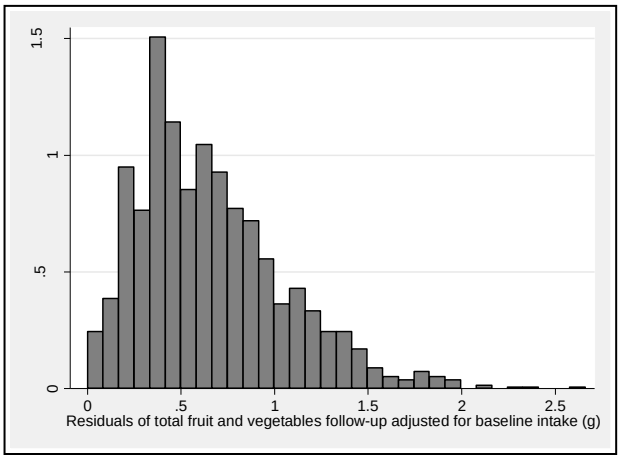
The primary analysis for this trial is exploring fruit and vegetable intake in the trials using multilevel regression analysis which requires the primary outcome and the residuals of the regression to be normally distributed. For children, fruit and vegetable intake is rarely normally distributed as often a percentage of children do not consume any fruit or vegetables on a particular day. This leads to a negatively skewed distribution. Figure 6.7 shows the possible transformations that might improve the distribution of combined fruit and vegetable intake at follow-up. It is evident from the transformation options that none of these transformations improve the general distribution of follow-up fruit and vegetable intake. Please note that the histogram labelled identity is the distribution without any transformation.

Figure 6.7 Output exploring transformations for follow-up total fruit and vegetable intake (ftotalfv).



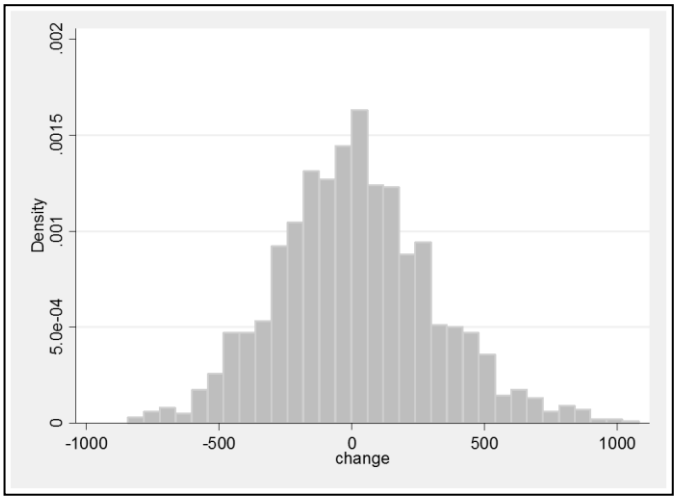
In addition to exploring the histogram of the distribution of follow-up fruit and vegetable intake, a plot of the residuals was explored to determine if it would be appropriate to use follow-up fruit and vegetable intake, adjusted for baseline fruit and vegetable intake in the analysis. Figure 6.8 displays the plot of the residuals for follow-up fruit and vegetable intake from the primary multilevel regression analysis. From the figure it is evident that the distribution is skewed. Therefore if the analysis was conducted using follow-up fruit and vegetable intake as the primary outcome the regression assumptions would not be met.

Figure 6.8 The residuals for total fruit and vegetable intake adjusted for baseline intake



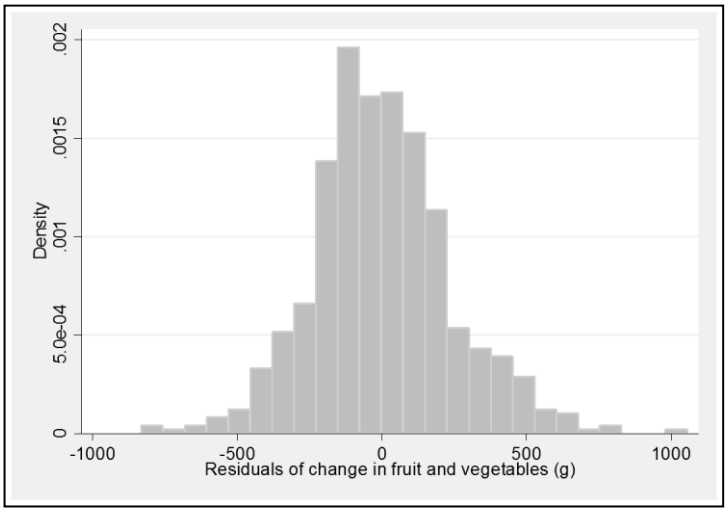
In an attempt to better meet the regression assumptions a change in fruit and vegetable intake (follow-up intake-baseline intake) variable was created. Figure 6.9 displays the histogram of the mean change in combined fruit and vegetable intake. It is evident from the histogram that the distribution of change in fruit and vegetable intake is much closer to a normal distribution than follow-up fruit and vegetable intake.

Figure 6.9 A histogram of mean change in fruit and vegetable intake



Further analysis of the residuals of mean change in combined fruit and vegetable intake are presented in Figure 6.10. The plot of the residuals illustrates that change in mean difference in fruit and vegetable intake is broadly normally distributed, making it suitable for multi-level regression analysis.

Figure 6.10 The residuals for change in mean fruit and vegetable intake



Change at follow-up has been used before to analyse RCT trials. However, it is necessary to assess if there is a baseline imbalance between the two groups in these trials, to determine if it is appropriate to use change instead of adjusting for baseline (Vickers and Altman, 2001). As there appeared to be little imbalance at baseline for fruit and vegetables in either trial change was used to analyse the primary outcome for both these trials.

6.4.3 General descriptive

Table 6.1 describes the demographic details for the children who completed trial 1. The children's age and percentage of boys and girls and ethnicity was very similar. There was an evident difference in free school meal percentage, with the RHS-led group having 33 percent of children receiving a free school meal compared to 24 percent in the teacher-led group.

Table 6.1 Follow-up demographics for children in Trial 1

	RHS-led (n=312)			Teacher-led (n=329)		
	Mean	**SE**	**95% CI**	**Mean**	**SE**	**95% CI**
Child Characteristic						
Age (years)	8.2	0.07	8.1, 8.4	8.1	0.06	8.0, 8.3
Boys (%)	50			51		
Ethnicity n (%)						
White	92 (30)			117 (35)		
Mixed	18 (6)			22 (7)		
Asian or British Asian	72 (23)			39 (12)		
Black or British Black	38 (12)			55 (17)		
Chinese or other ethnic group	10 (3)			8 (2)		
Prefer not to say	82 (26)			88 (27)		
School characteristic						
FSME (%)	33			24		
IMD score	34			30		
Children with English as an additional language (%)	54			38		

Table 6.2 describes the demographic details for the children who completed Trial 2. The children's age and percentage of boys and girls and ethnicity was very similar. Again the ethnic diversity of this sample is illustrated in Trial 2. In Trial 1 it was evident that there was a difference in free school meal percentage between the two groups, however, for Trial 2 there is very little difference between free school meal percentage, IMDS and percentage of children with English as an additional language.

Table 6.2 Follow-up demographics for children in Trial 2

	Teacher-led (n=488)			Comparison Group (n=428)		
	Mean	**SE**	**95% CI**	**Mean**	**SE**	**95% CI**
Child Characteristic						
Age (years)	8.3	0.03	8.2, 8.3	8.2	0.03	8.2, 8.3
Boys (%)	52			48		
Ethnicity						
White	111 (23)			74 (17)		
Mixed	42 (9)			47 (11)		
Asian or British Asian	68 (14)			35 (8)		
Black or British Black	100 (20)			85 (20)		
Chinese or other ethnic group	21 (4)			7 (2)		
Prefer not to say	146 (30)			177 (42)		
School characteristic						
FSME (%)	24			23		
IMD score	33			33		
Children with English as an additional language (%)	47			42		

Table 6.3 shows the baseline nutrient and food intake for all children in Trial 1 broken down by intervention allocation, RHS-led and Teacher-led. At baseline values for key foods, nutrients and energy were all closely matched across the two intervention groups, with the mean energy intake for the RHS-led group of 2085 kcal (95%CI: 1971, 2103) compared to the Teacher-led mean intake of 2046 kcal (95%CI: 1987, 2103).There was only 5 g difference in mean carbohydrates intake (RHS-led mean: 265 g, 95%CI 257, 272; Teacher-led mean: 270, 95%CI: 263, 277); and 5 mg difference in vitamin C intake (RHS-led mean: 108 mg, 95%CI: 102, 114; Teacher-led mean: 103 mg, 95%CI: 97,108). There was a very small difference in fruit and vegetable intake, with the Teacher-led consuming on average more vegetables (RHS-led mean: 86 g, 95%CI: 78, 93; Teacher-led mean: 101 g, 95%CI: 94,106) and more total fruit (RHS-led mean: 190 g, 95%CI: 174, 204; Teacher-led mean: 201 g, 95%CI: 195, 224).

Table 6.3 Baseline nutrient and food intake for all children enrolled in Trial 1

	RHS-Led (n=465)			Teacher-led (n=563)		
	Mean	**SE**	**95% CI**	**Mean**	**SE**	**95% CI**
Nutrients						
Energy (kcal)	**2038**	33.4	1971, 2103	**2046**	29.7	1987, 2103
Energy (KJ)	**8568**	140.0	8293, 8843	**8603**	124.6	8358, 2103
Protein (g)	**75**	1.6	71, 78	**74**	1.3	71, 76
Carbohydrate (g)	**265**	3.8	257, 271	**270**	3.6	263, 277
Fibre (Englyst) (g)	**13**	0.3	12, 13	**14**	0.2	13, 13
Fat (g)	**83**	1.9	79, 86	**82**	1.6	78, 84
Total sugars (g)	**130**	2.4	125, 135	**132**	2.2	127, 136
Iron (mg)	**11**	0.2	10, 11	**11**	0.2	11, 11
Calcium (mg)	**862**	17.8	827, 897	**871**	15.3	841, 901
Potassium (mg)	**2778**	47.4	2685, 2871	**2792**	72.0	2709, 2874
Sodium (mg)	**2686**	66.4	2555, 2816	**2646**	51.7	2544, 2747
Folate (µg)	**228**	4.5	218, 236	**226**	3.9	218, 233
Carotene (µg)	**1922**	79.3	1766, 2078	**2249**	75.8	2099, 2397
Vitamin A (retinol equiv) (µg)	**408**	21.5	365, 449	**412**	16.8	379, 445
Vitamin C (mg)	**108**	3.1	102, 114	**103**	2.6	97, 108
Foods						
Total vegetables (non-pulses, bean, lentil, dahl or seed)(g)	**86**	3.6	78, 93	**101**	3.2	94, 106
Pulses, beans, seeds (g)	**20**	2.2	15, 24	**19**	1.7	15, 22
Fruit (non-dried) (g)	**190**	7.6	174, 204	**210**	7.3	195, 224
Total fruit (g)	**192**	7.7	176, 206	**208**	7.3	193, 222
Dried fruit (g)	**2**	0.4	1., 2	**2**	0.4	1, 3
Total fruit & vegetables (excluding pulses & beans) (g)	**276**	8.9	258, 293	**310**	8.4	293, 326
Sweets, toffees, mints (g)	**5**	0.5	3, 5	**4**	0.4	3, 5
Chocolate bars, Mars etc. (g)	**8**	0.8	6, 9	**8**	0.7	9, 9
Crisps, savoury snacks (g)	**12**	0.8	10, 13	**10**	0.6	9, 11
Nuts (g)	**1**	0.4	0.5, 2	**1**	0.3	0.6, 1
Milk or milky drink (ml)	**131**	7.2	117, 145	**105**	5.7	94, 116
Fizzy pop, squash, fruit drink (ml)	**166**	9.4	147, 184	**167**	8.8	150, 184
Fruit juice (pure) (ml)	**122**	7.0	108, 135	**104**	5.5	93, 114

Table 6.4 shows the baseline nutrient and food intake for all children in Trial 2 broken down intervention allocation, Teacher-led and comparison group. At baseline values for key foods, nutrients and energy were all closely matched across the two groups. Compared to Trial 1 there was a small difference in mean energy intake between the two groups with the Teacher-led group on average consuming 2034 kcal (95%CI: 1979, 2089) and the comparison group consuming on average, 1970 kcal (95%CI: 1917, 2021). There was a small difference of 11 g in mean carbohydrates intake (Teacher-led mean: 267, 95%CI 260, 273; Comparison group mean: 256, 95%CI: 250, 262); and 2 mg difference in vitamin C intake (Teacher-led mean: 115 mg, 95%CI: 109, 120; Comparison mean: 117, 95%CI: 111, 121). However, unlike the small differences in Trial 1 for vegetable intake, for Trial 2 there was almost no difference in consumption, with the Teacher-led consuming on average, 93 g of vegetables (95%CI: 86, 99) and the Comparison group consuming on average, 98 g (95%CI: 90,104). There was a small difference of 8 g in fruit consumption, with the comparison group consuming slightly more fruit than the Teacher-led group (Teacher-led mean: 204 g, 95%CI: 190, 216; Comparison group mean: 196 g, 95%CI: 183, 208).

Table 6.4 Baseline nutrient and food intake for all children enrolled in Trial 2

	Teacher-led (n=667)			Comparison Group (n=698)		
	Mean	**SE**	**95% CI**	**Mean**	**SE**	**95% CI**
Nutrients						
Energy (kcal)	**2034**	28.0	1979, 2089	**1970**	26.4	1917, 2021
Energy (KJ)	**8554**	117.4	8323, 8784	**8281**	110.3	8064, 8497
Protein (g)	**74**	1.2	71, 76	**72**	1.2	69, 73
Carbohydrate (g)	**267**	3.3	260, 273	**256**	3.0	250, 262
Fibre (Englyst) (g)	**13**	0.2	12, 13	**12**	0.2	11, 12
Fat (g)	**82**	1.6	78, 85	**80**	1.6	77, 83
Total sugars (g)	**133**	1.9	128, 136	**128**	1.9	123, 131
Iron (mg)	**11**	0.2	10, 11	**11**	0.2	10, 11
Calcium (mg)	**873**	14.8	843, 902	**816**	14.1	788, 843
Potassium (mg)	**2723**	39.2	2646, 2800	**2645**	36.0	2574, 2715
Sodium (mg)	**2710**	51.7	2608, 2811	**2601**	51.2	2500, 2701
Folate (µg)	**232**	3.9	224, 239	**220**	3.5	212, 226
Carotene (µg)	**1979**	63.7	1853, 2103	**2137**	66.5	2006, 2267
Vitamin A (retinol equiv) (µg)	**408**	17.3	373, 441	**399**	18.6	362, 435
Vitamin C (mg)	**115**	2.7	109, 120	**117**	2.5	111, 121
Foods						
Total vegetables (non-pulses, bean, lentil, dahl or seed)(g)	**93**	3.3	86, 99	**98**	3.4	90, 104
Pulses, beans, seeds (g)	**18**	1.7	14, 21	**10**	1.1	7, 11
Total fruit (g)	**204**	6.6	190, 216	**196**	6.5	183, 208
Fruit (non-dried) (g)	**203**	6.6	190, 216	**195**	6.5	181, 207
Dried fruit (g)	**1**	0.3	6, 1	**1**	0.3	0.7, 1
Total fruit & vegetables (excluding pulses & beans) (g)	**297**	7.8	281, 312	**294**	7.7	278, 308
Sweets, toffees, mints (g)	**4**	0.4	3, 4	**4**	0.4	3, 5
Chocolate bars, Mars etc. (g)	**6**	0.6	5, 8	**6**	0.6	5, 7
Crisps, savoury snacks (g)	**12**	0.6	10, 12	**12**	0.6	10, 13
Milk or milky drink (ml)	**111**	5.6	99, 121	**95**	5.5	84, 105
Fizzy pop, squash, fruit drink (ml)	**192**	8.8	174, 208	**207**	8.9	189, 224
Fruit juice (pure) (ml)	**134**	6.5	122, 146	**130**	5.7	118, 141

Table 6.5 describes the nutrient and food intake for all children who completed Trial 1 compared to children who did not complete the whole trial. Overall these results reveal that there was very little difference for key nutrients and foods between children who completed Trial 1 baseline and follow-up and children who did not complete follow-up. The most noticeable difference was for mean energy intake, with children who completed the trial having on average, 196 kcal less than children who did not complete the trial (Completers: 1936 kcal, 95%CI: 1879, 1994; Non completers: 2090 kcal, 95%CI: 2010, 2169). However, there was very little difference between vitamin C intake (Completers: 102 mg, 95%CI: 97, 107; Non completers: 103 mg, 95%CI: 97, 110); and vegetable consumption (Completers: 91 g, 95%CI: 85, 97; Non completers: 93, 95%CI: 85, 100). There was a small difference of 11 g in mean fruit intake with the children who completed the trial consuming on average more fruit than children who did not complete the trial (Completers: 200 g, 95%CI: 187, 213; Non completers: 189 g, 95%CI: 172, 206).

Additional descriptive analysis was conducted to explore the baseline nutrient and food intake for children who did not complete follow-up by intervention allocation. These results are presented in Table 9.1 on page 241. These results revealed again very little difference for children who did not complete Trial 1 by intervention allocation. As expected, there was a slight difference in energy consumption with the Teacher-led group consuming more than the RHS-led group (RHS-led mean: 2046, 95%CI: 1922, 2169; Teacher-led mean: 2119, 95%CI: 2015, 2223). Similar findings were found for the primary outcome measures of fruit and vegetable intake, with the Teacher-led group consuming slightly higher intakes (for vegetables RHS-led mean: 85 g, 95%CI: 71, 97; Teacher-led mean: 98 g, 95%CI: 88, 107 and for fruit RHS-led mean: 167 g, 95%CI: 140, 192; Teacher-led mean: 204 g, 95%CI: 181, 226).

Table 6.5 Baseline nutrient and food intake of all children who completed Trial 1 vs children who did not complete Trial 1

	Participants who completed both baseline & follow-up collection (n=665)			Participants who did not complete follow-up (baseline only) (n=388)		
	Mean	**SE**	**95% CI**	**Mean**	**SE**	**95% CI**
Nutrients						
Energy (kcal)	**1936**	29.0	1879, 1994	**2090**	40.3	2010, 2169
Energy (KJ)	**9147**	121.8	7908, 8386	**8787**	168.9	8455, 9119
Protein (g)	**71**	1.2	68, 73	**76**	1.8	72, 79
Carbohydrate (g)	**256**	3.5	249, 263	**269**	4.6	260, 278
Fibre (Englyst) (g)	**12**	0.2	12, 13	**13**	0.3	12, 14
Fat (g)	**76**	1.5	73, 79	**86**	2.3	81, 90
Total sugars (g)	**128**	2.1	123, 132	**128**	2.7	123, 134
Iron (mg)	**10**	0.1	10, 11	**11**	0.2	10, 11
Calcium (mg)	**827**	15.0	797, 856	**880**	19.8	841, 919
Potassium (mg)	**2673**	41.4	2591, 2754	**2799**	55.9	2689, 2909
Sodium (mg)	**2503**	49.5	2406, 2600	**2767**	76.1	2617, 2916
Folate (µg)	**216**	3.7	207, 224	**229**	5.2	219, 240
Carotene (µg)	**2078**	69.9	1941, 2215	**2004**	87.5	1831, 2176
Vitamin A (retinol equiv) (µg)	**386**	16.5	354, 419	**424**	22.0	381, 467
Vitamin C (mg)	**102**	2.5	97, 107	**103**	3.3	97, 110
Foods						
Total vegetables (non-pulse, bean, lentil, dahl or seed)(g)	**91**	3.0	85, 97	**93**	4.0	85, 100
Pulses, beans, seeds (g)	**18**	1.6	15, 21	**21**	2.5	15, 25
Total fruit (g)	**200**	6.6	187, 213	**189**	8.7	172, 206
Fruit (non-dried) (g)	**198**	6.5	185, 210	**191**	8.9	173, 208
Dried fruit (g)	**3**	0.4	2, 3	**1**	0.2	0.1, 1.1
Total fruit & vegetables (excluding pulses & beans) (g)	**303**	7.6	287, 317	**282**	10.2	261, 302
Sweets, toffees, mints (g)	**4**	0.4	3, 5	**4**	0.5	3, 5
Chocolate bars, Mars etc. (g)	**8**	0.6	6, 9	**9**	0.9	7, 10
Crisps, savoury snacks (g)	**11**	0.6	9, 12	**11**	0.8	9, 12
Milk or milky drink (ml)	**117**	5.7	105, 128	**110**	7.1	95, 123
Fizzy pop, squash, fruit drink (ml)	**157**	8.0	141, 172	**172**	102.3	152, 192
Fruit juice (pure) (ml)	**111**	5.5	99, 121	**107**	6.9	93, 120

Table 6.6 shows the mean nutrient and food intake at baseline for all children who completed Trial 2 compared to the children who did not complete the trial. Similar to Trial 1 there are some small nutrient differences between the two groups. Overall these results reveal that there was very little difference for key nutrients and foods between children who completed Trial 2 baseline and follow-up and children who did not complete follow-up. Similar to Trial 1 the most noticeable difference was for mean energy intake, with children who completed the trial having on average 135 kcal less than children who did not complete the trial (Completers: 1891, 95%CI: 1839, 1942; Non completers: 2026, 95%CI: 1959, 2092). This difference though was smaller than the difference in kcal intake for Trial 1. Again, for Trial2 there was very little difference between vitamin C intake, only 1mg (Completers: 112 g, 95%CI: 107, 116; Non completers: 111 g, 95%CI: 105, 117); and there was no difference in vegetable consumption (Completers: 92 g, 95%CI: 86, 98; Non completers: 92 g, 95%CI: 84, 99). There was, however, a small difference of 9 g in mean fruit intake, with the children who completed the trial consuming on average more fruit than children who did not complete the trial (Completers: 190 g, 95%CI: 179, 201; Non completers: 199 g, 95%CI: 182, 214).

Table 9.2 in the appendix page 242 shows the nutrient and food intake for all the children who did not complete follow-up in Trial 2 by intervention allocation. These results revealed again very little difference for children who did not complete the trial by intervention allocation. There was on average, only 10 kcal differences between the Teacher-led group and the comparison group (Teacher-led mean: 2020, 95%CI: 1912, 2126; Comparison group mean: 2030, 95%CI: 1943, 2116). Similar findings were found for the primary outcome measures of fruit and vegetable intake, with the Teacher-led group consuming slightly higher intakes (for vegetables Teacher-led mean: 95 g, 95%CI: 85, 104; Comparison group mean: 87 g, 95%CI: 74, 99 and for fruit Teacher-led mean: 199 g, 95%CI: 177, 219; Comparison mean: 195 g, 95%CI: 170, 218).

Table 6.6 Baseline nutrient and food intake of all children who completed Trial 2 vs children who did not complete Trial 2

	Participants who completed both baseline & follow-up collection (n=970)			Participants who did not complete follow-up (baseline only) (n=443)		
	Mean	**SE**	**95% CI**	**Mean**	**SE**	**95% CI**
Nutrients						
Energy (kcal)	**1891**	26.1	1839, 1942	**2026**	34.1	1959, 2092
Energy (KJ)	**7952**	109.5	7736, 8166	**8517**	142.5	8237, 8797
Protein (g)	**68**	1.1	66, 70	**74**	1.5	71, 77
Carbohydrate (g)	**248**	3.2	215, 254	**262**	3.9	254, 269
Fibre (Englyst) (g)	**12**	0.2	11, 12	**12**	0.3	11, 13
Fat (g)	**76**	1.4	73, 79	**83**	2.0	78, 86
Total sugars (g)	**124**	1.8	120, 127	**130**	2.5	125, 134
Iron (mg)	**10**	0.2	10, 10	**11**	0.2	10, 11
Calcium (mg)	**804**	13.3	778, 830	**839**	17.9	803, 874
Potassium (mg)	**2531**	35.2	2461, 2599	**2726**	49.1	2629, 2822
Sodium (mg)	**2535**	45.1	2443, 2620	**2634**	66.9	2502, 2765
Folate (µg)	**216**	3.4	209, 223	**222**	4.7	212, 231
Carotene (µg)	**1953**	55.0	1844, 2060	**2070**	81.8	1908, 2230
Vitamin A (retinol equiv) (µg)	**368**	13.6	341, 394	**438**	26.1	386, 488
Vitamin C (mg)	**112**	2.3	107, 116	**111**	3.1	105, 117
Foods						
Total vegetables (non-pulses, bean, lentil, dahl or seed)(g)	**92**	2.9	86, 98	**92**	3.8	84, 99
Pulses, beans, seeds (g)	**13**	1.0	10, 14	**15**	2.2	10, 19
Total fruit (g)	**190**	5.6	179, 201	**199**	8.0	182, 214
Fruit (non-dried) (g)	**190**	5.6	178, 200	**197**	8.0	181, 212
Dried fruit (g)	**1**	0.2	0.6, 1	**2**	0.4	0.7, 2
Total fruit & vegetables (excluding pulses & beans) (g)	**297**	6.7	284, 310	**290**	6.7	271, 309
Sweets, toffees, mints (g)	**4**	0.3	3, 4	**4**	0.5	2, 4
Chocolate bars, Mars etc. (g)	**6**	0.5	4, 6	**8**	0.8	6, 9
Crisps, savoury snacks (g)	**11**	0.5	9, 11	**13**	0.8	11, 14
Milk or milky drink (ml)	**94**	4.5	84, 102	**110**	7.4	95, 124
Fizzy pop, squash, fruit drink (ml)	**186**	7.2	171, 199	**208**	11.3	185, 230
Fruit juice (pure) (ml)	**133**	5.1	122, 142	**116**	6.7	103, 129

Table 6.7 shows the baseline nutrient and food intake for all the children who did complete baseline and follow-up in Trial 1, with the mean energy intake for the RHS-led group of 2034 kcal (95%CI: 1956, 2111) compared to the Teacher-led mean intake of 1993 kcal (95%CI: 1925, 2059). There was only 2 grams difference in mean carbohydrates intake (RHS-led mean: 265 g, 95%CI 256, 273; Teacher-led mean: 267 g, 95%CI: 259, 275); and 2 mg difference in vitamin C intake (RHS-led mean: 108 g, 95%CI: 100, 115; Teacher-led mean: 105 g, 95%CI: 98, 112). There was a small difference in fruit and vegetable intake, with the Teacher-led consuming on

average more vegetables (RHS-led mean: 87 g, 95%CI: 78, 95; Teacher-led mean: 102, 95%CI: 93, 110) and more total fruit (RHS-led mean: 201 g, 95%CI: 183, 219; Teacher-led mean: 214 g, 95%CI: 195, 232). This difference in intake was also noted in the 5 A Day variable (RHS-led mean: 342 g, 95%CI: 319, 364; Teacher-led mean: 374 g 95%CI: 347, 382). The baseline nutrient and food intake overall though are very similar in terms of levels of nutrients; this would suggest there was no evidence of imbalance between the groups.

Table 6.7 Baseline nutrient intake for all children who completed baseline and follow-up collection for Trial 1

	RHS-led (n=312)			**Teacher-led (n=329)**		
	Mean	**SE**	**95% CI**	**Mean**	**SE**	**95% CI**
Energy (kcal)	**2034**	39.4	1956, 2111	**1993**	34.1	1925, 2059
Energy (KJ)	**8552**	164.9	8227, 8876	**8375**	143.0	8103, 8666
Protein (g)	**75**	1.8	71, 78	**73**	1.5	69, 75
Carbohydrate (g)	**265**	4.4	256, 273	**267**	4.3	259, 275
Fibre (Englyst) (g)	**13**	0.3	12, 13	**13**	0.3	12, 13
Fat (g)	**82**	2.3	77, 86	**78**	1.7	74, 81
Total sugars (g)	**132**	2.9	126, 137	**134**	2.6	128, 138
Iron (mg)	**11**	0.2	10, 11	**11**	0.2	10, 11
Calcium (mg)	**861**	21.6	818, 903	**858**	18.7	821, 895
Potassium (mg)	**2771**	54.7	2663, 2878	**2784**	51.3	2683, 2884
Sodium (mg)	**2632**	76.3	2481, 2782	**2572**	57.6	2458, 2685
Folate (µg)	**227**	5.3	216, 237	**224**	4.5	214, 232
Carotene (µg)	**1956**	98.8	1765, 2146	**2352**	101.7	2152, 2552
Vitamin A (retinol equiv) (µg)	**400**	25.1	350, 449	**403**	22.7	358, 448
Vitamin C (mg)	**108**	3.7	100, 115	**105**	3.5	98, 112
Total vegetables (non-pulses, bean, lentil, dahl or seed)(g)	**87**	4.4	78, 95	**102**	4.3	93, 110
Pulses, beans, seeds (g)	**16**	2.2	12, 20	**21**	2.4	16, 25
Total fruit (g)	**201**	9.3	183, 219	**214**	9.5	195, 232
Fruit (non-dried) (g)	**201**	9.1	182, 218	**211**	9.5	191, 229
Dried fruit (g)	**3**	0.6	1, 3	**3**	0.7	2, 4
Total fruit & vegetables (excluding pulses & beans) (g)	**269**	10.7	248, 290	**300**	10.5	278, 320
Sweets, toffees, mints (g)	**5**	0.7	3, 6	4	0.5	2, 4
Chocolate bars, Mars etc. (g)	**9**	1.0	6, 10	**7**	0.9	5, 9
Crisps, savoury snacks (g)	**12**	1.0	10, 14	**10**	0.8	8, 11
Milk or milky drink (ml)	**138**	8.9	120, 153	**106**	7.6	91, 120
Fizzy pop, squash, fruit drink (ml)	**163**	11.4	141, 185	**163**	11.8	139, 185
Fruit juice (pure) (ml)	**119**	8.5	102, 135	**112**	7.6	95, 126

Table 6.8 shows the baseline nutrient and food intake for all the children who did complete baseline and follow-up for Trial 2. At baseline the values for key foods, nutrients and energy were all closely matched across the two groups. Similar to Trial 1 there was a small difference in mean energy intake between the two groups with the Teacher-led group on average consuming 2039 kcal (95%CI: 1974, 2103) and the Comparison group consuming on average, 1932 kcal (95%CI: 1867, 1996). There was only 13 g difference in mean carbohydrates intake (Teacher-led mean: 267, 95%CI 259, 275; Comparison group mean: 254 g, 95%CI: 246, 275); and there was no difference in vitamin C intake (Teacher-led mean: 118 g, 95%CI: 111, 124; Comparison mean: 118, 95%CI: 111, 124). Again, there were similar results between the groups for Trial 2 for fruit and vegetable consumption with only small differences between the groups. Teacher-led group consuming on average less vegetables (Teacher-led mean: 95g, 95%CI: 87, 102; Comparison group mean: 100 g 95%CI: 90,108) and more fruit (Teacher-led mean: 206 g, 95%CI: 190, 221; Comparison group mean: 193 g, 95%CI: 177, 209).

Table 6.8 Baseline nutrient intake for all children who completed baseline and follow-up collection for Trial 2

	Teacher-led (n=488)			Comparison Group (n=428)		
	Mean	**SE**	**95% CI**	**Mean**	**SE**	**95% CI**
Nutrients						
Energy (kcal)	**2039**	32.7	1974, 2103	**1932**	32.8	1867, 1996
Energy (KJ)	**8576**	137.3	8306, 8845	**8125**	137.3	7854, 8394
Protein (g)	**75**	1.4	71, 77	**69**	1.4	66, 72
Carbohydrate (g)	**267**	4.0	259, 275	**254**	3.6	246, 261
Fibre (Englyst) (g)	**13**	0.3	12, 13	**12**	0.2	11, 12
Fat (g)	**82**	18.0	78, 85	**78**	2.0	74, 82
Total sugars (g)	**133**	2.3	128, 137	**127**	2.4	122, 132
Iron (mg)	**11**	0.2	10, 11	**11**	0.2	10, 10
Calcium (mg)	**877**	17.6	842, 911	**810**	17.5	775, 844
Potassium (mg)	**2730**	45.0	2642, 2818	**2585**	43.4	2499, 2670
Sodium (mg)	**2742**	58.4	2627, 2990	**2575**	64.2	2448, 2700
2856.91Folate (µg)	**235**	4.5	225, 243	**220**	4.3	211, 228
Carotene (µg)	**2024**	74.9	1876, 2170	**2089**	83.9	1924, 2254
Vitamin A (retinol equiv) (µg)	**398**	18.8	361, 434	**374**	21.1	332, 415
Vitamin C (mg)	**118**	3.2	111, 124	**118**	3.2	111, 124
Foods						
Total vegetables (non-pulses, bean, lentil, dahl or seed)(g)	**95**	3.8	87, 102	**100**	4.7	90, 108
Pulses, beans, seeds (g)	**16**	1.6	12, 19	**10**	1.4	7, 13
Total fruit (g)	**206**	7.9	190, 221	**193**	8.2	177, 209
Fruit (non-dried) (g)	**206**	7.9	190, 221	**192**	8.2	176, 208
Dried fruit (g)	**1**	0.3	0.5, 1	**1**	0.3	0.4, 1
Total fruit & vegetables (excluding pulses & beans) (g)	**204**	282.3	282, 317	**296**	9.6	277, 314
Sweets, toffees, mints (g)	**4**	0.5	3, 5	**4**	0.6	3, 5
Chocolate bars, Mars etc. (g)	**6**	0.7	4, 7	**6**	0.7	4, 7
Crisps, savoury snacks (g)	**12**	0.7	10, 13	**11**	0.7	9, 12
Milk or milky drink (ml)	**101**	6.2	89, 113	**97**	7.0	82, 110
Fizzy pop, squash, fruit drink (ml)	**189**	10.1	168, 208	**203**	11.1	181, 224
Fruit juice (pure) (ml)	**141**	7.4	126, 155	**138**	7.5	123, 152

6.4.4 Change in fruit and vegetable intake Trial 1

Table 6.9 displays the change in fruit, vegetables and combined fruit and vegetables (follow-up minus baseline) and the intervention mean difference, unadjusted and also adjusted for index of multiple deprivation, age, gender and ethnicity for Trial 1. In the unadjusted model, intraclass correlation for Trial 1 was 0.003; therefore 0.3% of the variation was at the school level for change in total fruit and vegetable intake. For both groups there was a small decrease in fruit intake after adjusting for possible confounders (RHS-led: 8 g, 95%CI: -69, 52; Teacher-Led: -20 g, 95%CI: -36, 77). For vegetable consumption there was no significant differences found in the unadjusted or adjusted model (intervention effect: -16 g, 95%CI: -11, 38). The teacher-led group did have on average, a higher mean change in vegetable consumption, of 29 g (95%CI: -6, 66) compared to 16 g (95%CI: -11, 38) in the RHS-led group.

Whereas, for combined fruit and vegetable intake there was a borderline significant difference in the unadjusted model (intervention effect 40, 95%CI: -1, 80; P=0.05) with the teacher-led group having a higher mean change of 8 g (95%CI: -19, 36) and the RHS-led group consuming a mean change of -32 g (95%CI: -60, -3). However, after adjusting for possible cofounders this difference was not significant (intervention effect: -40, 95%CI: -88, 1; p=0.06).

6.4.5 Intention to Treat Analysis

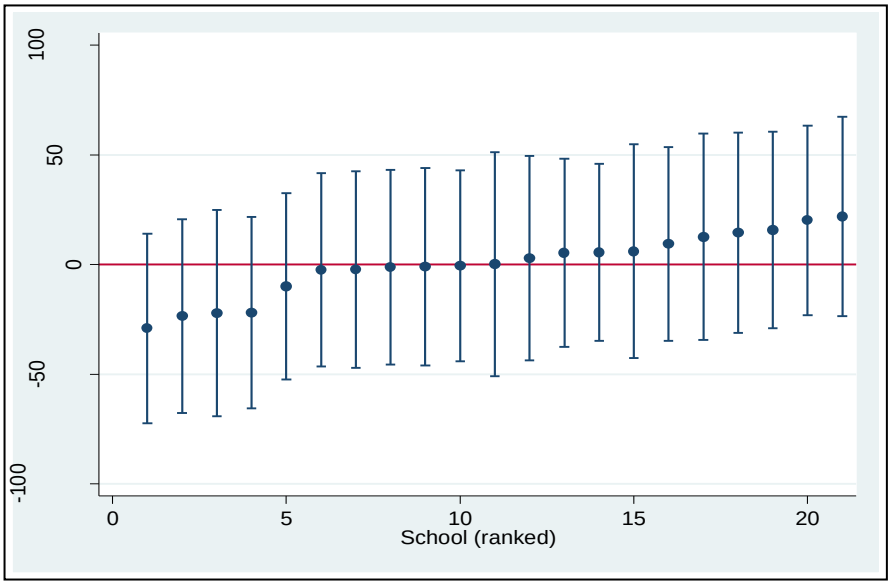
Table 6.9 Intervention effect on change in fruit and vegetables for Trial 1

Food	RHS-led (n=312)			Teacher-led Intervention (n=329)			Intervention effect			
	Mean (g)	SE	95% CI	Mean (g)	SE	95% CI	Mean diff	SE	95% CI	P value
Unadjusted										
Change in fruit (g)	**-33**	11.8	-56, -10	**-6**	11.5	-28, 16	**-27**	16.4	-5, 59	0.1
Change in vegetables (g)	**2**	9.0	-15, 20	**16**	8.6	-1, 32	**-13**	12.4	-37,10	0.3
Change in combined fruit and vegetables (g)	**-32**	14.5	-60, -3	**8**	14.0	-19, 36	**-40**	20.2	-1, 80	0.05
Adjusted[a]										
Change in fruit (g)	**-8**	30.8	-69, 52	**-20**	29.0	-36, 77	**-28**	16.4	-60, 3	0.08
Change in vegetables (g)	**16**	19.6	-11, 38	**29**	18.2	-6, 66	**-13**	12.8	39, 11	0.2
Change in combined fruit and vegetables (g)	**1**	39.4	-75, 78	**41**	36.7	-27, 116	**-40**	22.8	-88, 1	0.06

[a]adjusted for gender, age, ethnicity, index of multiple deprivation score

The plot of the school residuals with their 95% confidence limit are presented in ascending order Figure 6.11. All of the schools do pass through zero, indicating that the schools do not differ significantly from the average line at the 5% level. From the adjusted model, results state that 1.2% of the variance in change in mean fruit and vegetable intake can be attributed to the difference between schools.

Figure 6.11 Plot of the school residuals for change in fruit and vegetable intake in ascending order with their 95% confidence limit for Trial 1



6.4.6 Change in fruit and vegetable intake Trial 2

Table 6.10 displays the change in fruit, vegetables and combined fruit and vegetables at baseline and follow-up and the intervention mean difference, unadjusted and also adjusted for index of multiple deprivation, age, gender and ethnicity for Trial 2. In the unadjusted model, the intraclass correlation for Trial 2 was 0.07; therefore 7% of the variation was at the school level for change in total fruit and vegetable intake. For mean change in fruit intake the Teacher-led group (mean change in fruit: 44 g, 95%CI: -28, 118) consumed on average 22 g more than the comparison group (mean change in fruit 22 g, 95%CI: -50, 94). However these differences in mean change for fruit intake were not significant in the unadjusted or adjusted models. Whereas for vegetable intake, the comparison group, on average consumed more vegetables 17 g (95%CI: -30, 21) compared to the Teacher-led group 10 g (95%CI: -36, 52). Nevertheless this difference was not significant.

Due to having a higher intake of fruit the Teacher-led group consumed on average a 15 g (95%CI -36, 148) more total fruit and vegetables than the comparison group, this difference was not significant in either the adjusted or the unadjusted model.

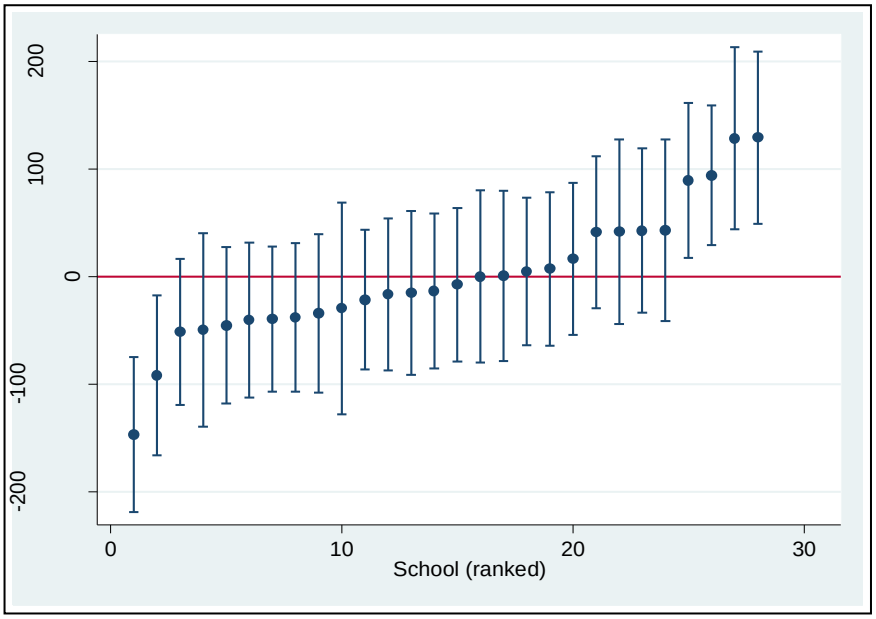
Table 6.10 Intervention effect on change in fruit and vegetables for Trial 2

Food	Teacher-led Intervention (n=312)			Comparison Group (n=329)			Intervention effect			
	Mean (g)	SE	95% CI	Mean (g)	SE	95% CI	Mean difference	SE	95% CI	P value
Unadjusted										
Change in fruit (g)	**13**	17.6	-20.9, 48.2	**-12**	17.1	-45.9, 21.0	**26**	24.5	-74.2, 22.0	0.3
Change in vegetables (g)	**16**	10.2	-3.8, 36.1	**22**	9.9	1.9, 40.7	**-5**	14.2	-22.7, 33.0	0.7
Change in combined fruit and vegetables (g)	**29**	23.0	-15.3, 74.9	**9**	22.4	-34.8, 52.8	**20**	32.1	-83.7, 42.1	0.5
Adjusted[a]										
Change in fruit (g)	**44**	37.5	-28, 118	**22**	36.9	-50, 94	**22**	24.3	-70, 24	0.3
Change in vegetables (g)	**10**	21.3	-36, 52	**17**	20.9	-30, 21	**-7**	14.2	-35, 20	06
Change in combined fruit and vegetables (g)	**56**	47.1	-36, 148	**40**	46.4	-50, 131	**15**	32.0	-36, 148	0.6

[a]adjusted for gender, age, ethnicity, index of multiple deprivation score

The plots of the residuals with their 95% confidence limits are presented in ascending order in Figure 6.12. It is evident that the majority of the schools do pass through zero, indicating that the schools do not differ significantly from the average line at the 5% level. From the adjusted model of mean change in combined fruit and vegetable results state that 7.3% of the variance in mean change of fruit and vegetable intake can be attributed to the difference between schools.

Figure 6.12 Plot of the school residuals for change in fruit and vegetable intake in ascending order with their 95% confidence limit for Trial 2



6.4.7 Differences in nutrient and key foods

For both trials the differences in key nutrients and foods were explored to see if there was an effect of either intervention on their mean intakes. Results are presented in Table 6.11 for Trial 1 and Table 6.12 for Trial 2, unadjusted and also adjusted for age, gender, ethnicity and index of multiple deprivation. Overall there was very little difference in either trial for these key nutrients and foods. The mean differences were small for nearly all nutrients and food except for energy and carotene intake. Whilst there were differences in mean intakes for these two, they were not significant. The only significant difference was found in Trial 1 for vitamin C intake in the adjusted model. Once the adjustments were made there was a 13 mg (95% CI:2,23) per day difference between the RHS-led and Teacher-led groups, with the Teacher-led group having a significantly higher intake of vitamin C.

Table 6.11 Intervention effect on essential nutrient intake unadjusted for Trial 1

Food	RHS-led (n=312)			Teacher-led Intervention (n=329)			Intervention effect			
	Mean(g)	SE	95% CI	Mean(g)	SE	95% CI	Mean diff	SE	95% CI	P-value
Unadjusted										
Total energy intake (KJ/day)	**7266.0**	524.6	6237.8, 8294.1	**7388.7**	506.4	6396.2, 8381.3	**-122.8**	435.3	-730, 976	0.8
Total energy intake (kcal/day)	**1729.6**	124.8	1485.1, 1974.2	**1757.8**	120..4	1521.8, 1993.8	**-28.2**	103.8	-175, 231	0.8
Fat intake (g/day)	**75.3**	5.4	64.8, 85.8	**73.3**	5.1	63.4, 83.2	**2.0**	5.5	-12.8, 8.7	0.7
Salt intake (g/day)	**2426.1**	179.2	2074.9, 2777.2	**2394.7**	170.7	2060.2, 2729.2	**31.4**	188.7	-401, 338	0.9
Sugars (g/day) including non-milk extrinsic sugars	**87.4**	6.7	74.2, 100.5	**96.3**	6.7	83.2, 109.5	**-9**	5.2	-1.2, 19.2	0.08
Carotene intake (mg/day)	**1788.0**	189.4	1416.9, 2159.1	**1967.9**	188.4	1598.6, 2337.1	**179.9**	236.2	-283, 642	0.4
Vitamin C intake (mg/day)	**74.8**	6.1	62.9, 86.7	**87.8**	5.9	76.3, 99.4	**13.0**	5.7	1.8, 24.2	0.2
Iron (µg/day)	**9.1**	0.7	7.8, 10.5	**9.4**	0.7	8.1, 10.7	**-0.3**	0.3	-0.9, 1.4	0.8
Fibre (g/day)	**11.7**	0.9	1.0, 13.4	**12.8**	0.9	11.1, 14.5	**-1.2**	0.8	-0.5, 2.8	0.2
Carbohydrates (g/day)	**213.7**	15.4	183.6, 243.9	**219.3**	15.3	189.3, 249.2	**-5.5**	10.8	-15, 26	0.6
Folate (µg/day)	**180.0**	12.5	155.4, 204.5	**189.8**	12.1	166.0, 213.6	**-9.9**	10.9	-11, 3	0.4
Protein	**64.4**	4.7	55.1, 73.6	**69.6**	4.5	60.8, 78.3	**-5.2**	4.7	-14, 4	0.3
Adjusted[a]										
Total energy intake (KJ/day)	**6387**	748.9	4920, 7855	**6587**	707.9	5199, 7974	**-199**	430.4	-1043, 644	0.6
Total energy intake (kcal/day)	**1520**	178.2	1171, 1870	**1567**	168.4	1237, 1897	**-46**	102.5	-247, 154	0.6
Fat intake (g/day)	**65**	8.2	49, 81	**64**	7.7	49, 79	**1**	5.2	-9, 11	0.8
Salt intake (g/day)	**2272**	286	1711, 2833	**2257**	267.7	1732, 2781	**16**	190.4	-357, 388	0.9
Sugars (g/day) including non-milk extrinsic sugars	**90**	10.5	70, 111	**99**	10.0	80, 118	-8	5.1	**-18, 2**	0.1
Carotene intake (mg/day)	**1995**	864	242, 3748	**2164**	878	442, 3886	**168**	230	-281.9, 618	0.5
Vitamin C intake (mg/day)	**113**	31.7	51, 175	**125**	31	64, 187	**13**	5.5	2.0, 23.5	0.02
Iron (µg/day)	**8**	1.0	6, 10	**8**	0.9	6, 10	**-0.4**	0.6	-1, 0.9	0.5
Fibre (g/day)	**10**	1.3	7, 13	**11**	1.3	9, 14	**-1**	0.8	-3, 1	0.1
Carbohydrates (g/day)	**186**	21.5	144, 228	**193**	20.6	153, 234	**-7**	10.9	-28, 14	0.5
Folate (µg/day)	**169**	19.7	131, 208	**180**	18.6	144, 217	**-11**	10.9	-32, 10	0.3
Protein	**58**	7.1	44, 72	**64**	6.7	51, 77	**-6**	4.8	-15, 3	0.2

[a]adjusted for gender, age, ethnicity, index of multiple deprivation score

Table 6.12 Intervention effect on essential nutrient intake unadjusted for Trial 2

Food	Teacher-led Intervention (n=488)			Comparison Group (n=428)			Intervention effect			
	Mean(g)	SE	95% CI	Mean(g)	SE	95% CI	Mean diff	SE	95% CI	P-value
Unadjusted										
Total energy intake (KJ/day)	**7848.5**	454.3	6958.1, 8738.8	**7806.6**	463.6	6898, 8715	**41.9**	403.6	-832.9, 749.2	0.9
Total energy intake (kcal/day)	**1868.5**	108.1	1656.7, 2080.3	**1859.9**	110.2	1642, 2075	**9.6**	96.3	-198.3, 179.0	0.9
Fat intake (g/day)	**81.5**	4.5	72.7, 90.3	**82.2**	4.5	73, 91	**-1**	4.9	-8.9, 10.3	0.9
Salt intake (g/day)	**2707.5**	144.5	2424.3, 2990.7	**2745.6**	146.0	2459, 3032	**-38.1**	158.1	-262.0, 338.2	0.8
Sugars (g/day) including non-milk extrinsic sugars	**88**	6.7	75.0, 101.2	**87**	6.8	74, 100	**1.2**	5.8	-12.7, 10.2	0.8
Carotene intake (mg/day)	**2426.5**	231.9	1971, 2881.0	**2064.2**	227.2	1619, 2509	**-362.2**	302.8	-955.7, 231.3	0.2
Vitamin C intake (mg/day)	**92.6**	6.1	80.6, 104.5	**90.9**	5.9	79, 103	**-1.7**	6.3	-14.0, 10.6	0.8
Iron (µg/day)	**10.7**	0.6	9.5, 11.8	**10.5**	0.6	9, 11	**0.1**	0.6	-1.3, 10	0.8
Fibre (g/day)	**11.9**	0.8	10.5, 13.4	**11.6**	0.8	10, 13	**0.3**	0.8	-1.8, 1.2	0.7
Carbohydrates (g/day)	**219.0**	14.0	191.6, 246.4	**216.4**	14.3	188, 244	**3**	11.4	-24.9, 19.7	0.8
Folate (µg/day)	**201.5**	10.7	180.4, 222.5	**198.1**	10.9	177, 219	**3.4**	10.2	-23.3, 16.6	0.7
Protein	**70.7**	3.9	63.2, 78.3	**38.8**	3.9	61, 76	**2**	3.9	-9.5, 5.7	0.6
Adjusted[a]										
Total energy intake (KJ/day)	**7761**	720	6349, 9174	**7719**	717	6313, 9125	**42**	404	-751, 835	0.9
Total energy intake (kcal/day)	**1845**	171.6	1509, 2182	**1836**	170	1501, 2170	**9**	95.5	-179, 198	0.9
Fat intake (g/day)	**76**	7.9	60, 91	**77**	7.9	61, 92	**-1**	4.8	-10, 8	0.8
Salt intake (g/day)	**2621**	259.1	2113, 3129	**2656**	257	2152, 3159	**-34**	151.9	-332, 263	0.8
Sugars (g/day) including non-milk extrinsic sugars	**108**	11.4	-20, 6	**107**	11.3	85, 129	**1**	5.7	-10, 12	0.8
Carotene intake (mg/day)	**1668**	922.5	-140, 3476	**283**	136	16, 549	**-367**	304	-963, 228	0.2
Vitamin C intake (mg/day)	**75**	30.2	16, 134	**73**	30	14, 132	**2**	6	-14,9	0.7
Iron (µg/day)	**10**	0.9	8, 12	**10**	0.9	8, 12	**0.1**	0.6	-1, 1.2	0.8
Fibre (g/day)	**12**	1.2	9, 14	**11**	1.2	9, 14	**0.3**	0.8	-1, 2	0.6
Carbohydrates (g/day)	**227**	21.7	184, 270	**225**	21.6	182, 267	**2**	11.4	-20, 24	0.8
Folate (µg/day)	**192**	18.9	155, 229	**188**	18.8	151, 225	**4**	10.2	-15, 24	0.6
Protein	**70**	6.5	58, 83	**68**	6.4	56, 81	**2**	3.9	-6, 9	0.6

[a]adjusted for gender, age, ethnicity, index of multiple deprivation score

6.4.8 Differences in food and drink intake

An additional analysis was conducted to determine if there were differences in non-essential food intake (sweets, toffees, mints; chocolate bars; crisps, savoury snacks), and commonly consumed drinks (milk; fizzy pop, squash, and fruit drink and pure fruit juice). The results from this analysis are presented in Table 9.3 and 9.4 on page 243 and 244 of the appendix. For both trials there were no differences found in non-essential foods or drinks, after adjusting for age, gender, ethnicity and index of multiple deprivation. Overall there was very little difference between the different intervention groups. For Trial 1 the RHS-Led consumed 19 mls (95%CI: -49, 11) less milk than the Teacher-led group. However, this difference was not significant.

6.5 Sensitivity Analysis

6.5.1 Baseline values brought forward

Sensitivity analysis was carried out using baseline data brought forward to explore the effect on the primary outcome. The results from this analysis are presented for Trial 1 in Table 6.13 and for Trial 2 in Table 6.14. The same methodology used to explore the intervention effect in the main analysis was applied to baseline values brought forward. As you can see from Table 6.13 there was very little difference in the results for baseline brought forward compared to the main trial analysis for Trial 1. Instead of having a decrease in mean change in fruit intake, there is almost no change 2 g for the RHS-led group and 10 g for the Teacher-led group. The mean difference in vegetable intake increases from 13 g to 35 g, however, after the adjustments are made this difference is not significant. The difference between combined change in fruit and vegetable intake was negligible between the main intention-to-treat model and baseline brought forward for Trial 1.

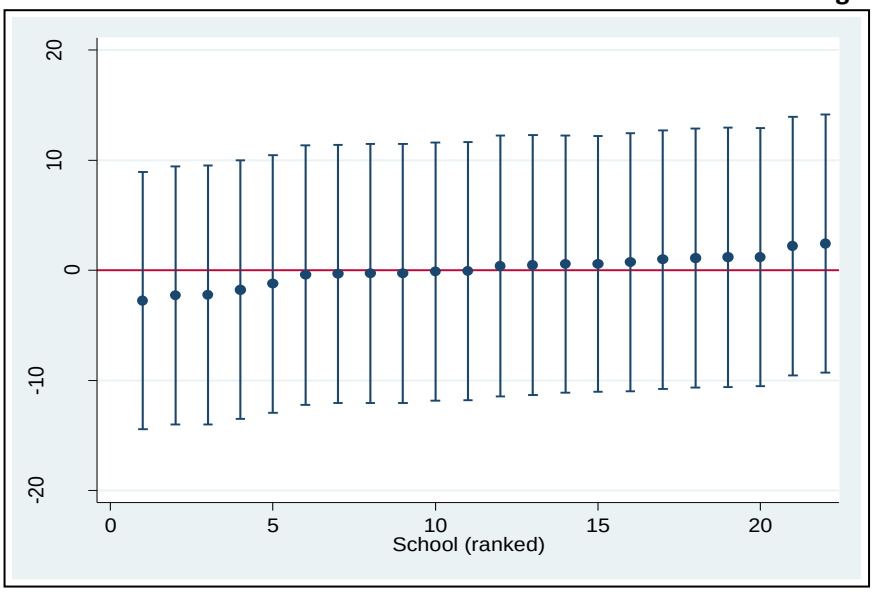
Table 6.13 Intervention effect on change in fruit and vegetables for Trial 1

Food	RHS-led (n=312)			Teacher-led Intervention (n=329)			Intervention effect			
	Mean (g)	SE	95% CI	Mean (g)	SE	95% CI	Mean diff	SE	95% CI	P-value
Unadjusted										
Change in fruit (g)	**2**	6.9	-11, 15	**11**	6.2	-1.4, 22	**-9**	9.3	-9, 27	0.3
Change in vegetables (g)	**177**	15.7	146, 207	**212**	14.2	184, 240	**-35**	21.2	76,-6	0.1
Change in combined fruit and vegetables (g)	**-14**	8.8	-31, 3	**5**	7.9	-10, 21	**-19**	11.8	42,-4,	0.1
Adjusted[a]										
Change in fruit (g)	**17**	17.2	-16, 51	**27**	16.7	-5, 60	**-10**	9.2	-28, 7	0.2
Change in vegetables (g)	**141**	29.3	84, 199	**180**	28.1	125, 506	**-38**	22.0	-81, 5	0.08
Change in combined fruit and vegetables (g)	**172**	71.3	33, 312	**195**	71.4	55, 335	**-22**	12.0	-46, 1	0.06

[a]adjusted for gender, age, ethnicity, index of multiple deprivation score

The plots of the residuals with their 95% confidence limit are presented in ascending order in Figure 6.13. There was even less divergence from zero for all the schools, indicating that the schools do not differ significantly differ from the average line at the 5% level. From the adjusted model of the mean change in combined fruit and vegetable, results state that 0.1% of the variance in change in mean fruit and vegetable intake can be attributed to the difference between schools.

Figure 6.13 Plot of the school residuals for change in fruit and vegetable intake in ascending order with their 95% confidence limit for Trial 1 baseline values brought forward



For Trial 2 displayed in Table 6.14, shows that differences between the main analysis and the baseline brought forward are minor, with only a slight decrease in all three mean differences for fruit, vegetables and combined fruit and vegetable intake. Again, once adjusted for the covariates, these differences in mean intakes were not significant.

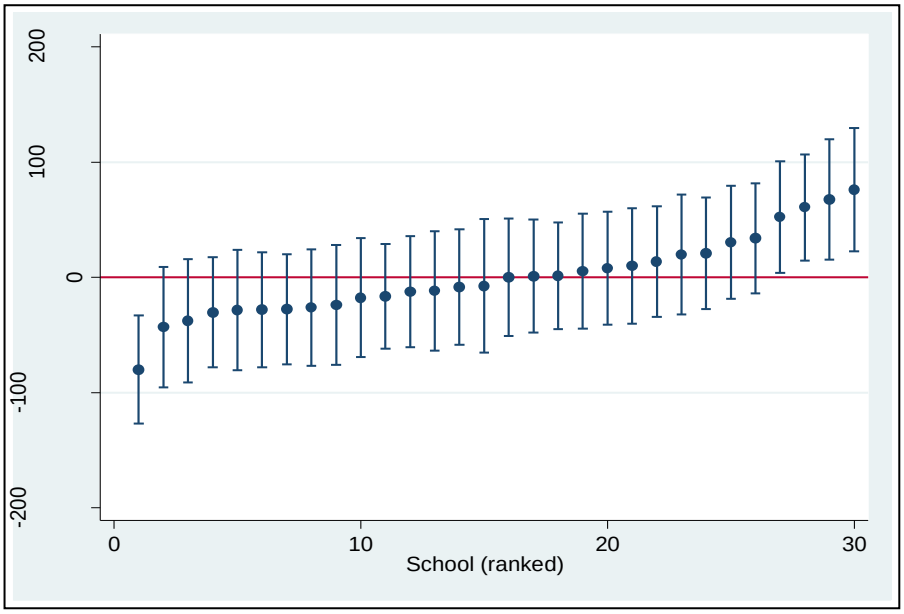
Table 6.14 Intervention effect on change in fruit and vegetables Trial 2

Food	Teacher-led Intervention (n=488)			Comparison Group (N=428)			Intervention effect			
	Mean(g)	SE	95% CI	Mean(g)	SE	95% CI	Mean diff	SE	95% CI	P-value
Unadjusted										
Change in fruit (g)	**27**	10.0	8, 46	**13**	10.0	-7, 32	**14**	14.1	-42, 12	0.3
Change in vegetables (g)	**224**	12.7	199, 249	**211**	12.8	186, 236	**12**	18.0	-48, 22	0.5
Change in combined fruit and vegetables (g)	**28**	13.7	1, 55	**9**	13.8	-18, 36	**19**	19.5	-58, 19	0.3
Adjusted[a]										
Change in fruit (g)	**44**	23.8	-2, 91	**32**	23.6	-14, 78	**13**	14.0	-14, 40	0.3
Change in vegetables (g)	**227**	30.8	166, 287	**208**	30.6	148, 268	**18**	17.9	-16, 54	0.3
Change in combined fruit and vegetables (g)	**49**	31.8	-12, 112	**32**	31.6	-29, 94	**17**	19.2	-20, 55	0.4

[a]adjusted for gender, age, ethnicity, index of multiple deprivation score

Figure 6.14 shows very little difference compared to the main analysis. The overall plot shows the majority of the schools do pass through zero, indicating that the schools do not differ significantly from the average line at the 5% level. From the adjusted model of the mean change in combined fruit and vegetable results state that 3.8% of the variance in change in mean fruit and vegetable intake can be attributed to the difference between schools.

Figure 6.14 Plot of the school residuals for change in fruit and vegetable intake in ascending order with their 95% confidence limit for Trial 1 baseline values brought forward



6.5.2 Differences between boys and girls by Intervention allocation

Tables 6.15 and 6.17 show the differences between boys and girls by intervention allocation. As you can see from the table, there is very little difference between boys and girls in the RHS-led group, with both showing a mean decrease in fruit (girls: -34 g, 95%CI: -68, 1; boys: -31, 95%CI: -64, 2) and for vegetable consumption almost no difference (girls: -1 g, 95%CI: -17, 30; boys: 5 g, 95%CI: -14, 25). For the combined mean change in fruit and vegetables, boys in the RHS-led group decreased in consumption less than girls (girls: -37 g, 95%CI: -76, 1.2; boys: -26, 95%CI: -65, 12). There results for the teacher-led schools revealed, that the girls tended to consume more vegetables than boys (girls: 28 g, 95%CI: 6, 49; boys: 5 g, 95%CI: 5, -16, 26), this difference was also reflected in combined fruit and vegetable intake, with girls on average having a mean change of 15g (95%CI: -63, 55) in fruit and vegetables compared to 2 g change for boys (95%CI: -36, 63).

Table 6.15 Trial 1: Difference for boys and girls fruit and vegetable intake adjusted for baseline intake, ethnicity, gender and IMD score

Food	Girls			Boys		
	Mean(g)	SE	95% CI	Mean(g)	SE	95% CI
RHS-led						
Change in fruit (g)	**-34**	16.9	-68, -1	**-31**	16.8	-64, 2
Change in vegetables (g)	**-1**	10.1	-17, 30	**5**	10.1	-14, 25
Change in combined fruit and vegetables (g)	**-37**	19.9	-76, 1	**-26**	19.7	-65, 12
Teacher-led						
Change in fruit (g)	**-10**	16.2	-42, 21	**-2**	15.7	-32, 28
Change in vegetables (g)	**28**	11.0	6, 49	**5**	10.8	-16, 26
Change in combined fruit and vegetables (g)	**15**	20.7	-63, 55	**2**	20.1	-36, 63

For Trial 2, there was very little difference between the two groups in either the teacher-led intervention or the comparison group, with the Teacher-led girls having a slightly higher mean change of 32 g (95%CI: -27, 91) in fruit and vegetables compared to the boys mean change of 27 g (95%CI: -32, 87). In the comparison group there was a difference in fruit intake between boys and girls, with the girls having a decrease in mean intake of 9 g (95%CI: -46, 28) and the boys having a mean change of 17 g (-50, 14). However, their vegetable and combined fruit and vegetable intake were very similar (please see table 6.16).

Table 6.16 Trial 2: Difference for boys and girls fruit and vegetable intake, adjusted for baseline intake, ethnicity, gender and IMD score

Food	Girls			Boys		
	Mean(g)	SE	95% CI	Mean(g)	SE	95% CI
Teacher-led						
Change in fruit (g)	**15**	23.3	-43, 38	**12**	20.9	-38, 43
Change in vegetables (g)	**17**	13.3	-8, 20	**15**	13.4	-10, 41
Change in combined fruit and vegetables (g)	**32**	30.4	-27, 91	**27**	30.5	-32, 87
Comparison Group						
Change in fruit (g)	**-9**	15.9	-46, 28	**17**	16.6	-50, 14
Change in vegetables (g)	**24**	9.3	6, 42	**18**	9.0	0, 36
Change in combined fruit and vegetables (g)	**9**	19.4	-29, 46	**6**	20.1	-33, 46

6.5.3 Differences between boys and girls interaction effect

Additional analysis was conducted to explore if there was an interaction between gender and the intervention. The results from this analysis are presented in tables 6.17 and 6.18. After adjusting for age, ethnicity and IMD score no interactions effects were detected.

Table 6.17 Intervention effect for boys and girls on fruit and vegetables adjusted for age, ethnicity, and IMD score for Trial 1

Food	RHS-led(n=312)			Teacher-led(n=329)			Interaction			
	Mean(g)	SE	95% CI	Mean(g)	SE	95% CI	Mean difference	SE	95% CI	P-value
Unadjusted										
Change in fruit (g)	**4**	23.5	-42, 49	**9**	22.9	-36, 53	**5**	32.8	-59, 69	0.8
Change in vegetables (g)	**6**	12.1	-1, 58	**-22**	11.7	-45, 0	**29**	16.8	-3, 62	0.08
Change in combined fruit and vegetables (g)	**11**	27.5	-43, 64	**-13**	26.8	-65, 39	**24**	38.4	-76, 2	0.06
Adjusted[a]										
Change in fruit (g)	**11**	23.3	-34, 56	**15**	22.6	-29, 59	**3**	32.3	-66, 16	0.9
Change in vegetables (g)	**8**	11.9	-15, 31	**-21**	11.6	-44, 0	**29**	16.6	-3, 62	0.07
Change in combined fruit and vegetables (g)	**18**	27.1	-34, 72	**-6**	26.3	-57, 45	**24**	37.7	-49, 98	0.5

[a]adjusted for gender, age, ethnicity, index of multiple deprivation score

Table 6.18 Intervention effect for boys and girls on fruit and vegetables adjusted for age, ethnicity, and IMD score for Trial 2

Food	Teacher-led Intervention(n=488)			Comparison Group(N=428)			Interaction			
	Mean(g)	SE	95% CI	Mean(g)	SE	95% CI	Mean difference	SE	95% CI	P-value
Unadjusted										
Change in fruit (g)	**-3**	20.7	-43, 37	**9**	19.4	-28, 47	**-12**	28.4	-68, 43	0.6
Change in vegetables (g)	**-2**	11.3	-24, 20	**-7**	10.5	-27, 14	**4**	15.5	-26, 34	0.7
Change in combined fruit and vegetables (g)	**-5**	25.1	-54, 44	**3**	23.4	-42, 49	**-8**	34.4	-42, 57	0.7
Adjusted[a]										
Change in fruit (g)	**5**	20.4	-35, 46	**16**	19.0	-20, 53	**-11**	27.8	-66, 42	0.6
Change in vegetables (g)	**-3**	11.4	-24, 40	**-5**	10.6	-25, 16	**2**	15.5	-28, 32	0.9
Change in combined fruit and vegetables (g)	**2**	24.9	-46, 50	**12**	23.1	-33, 57	**-10**	33.8	-76, 56	0.7

[a]adjusted for gender, age, ethnicity, index of multiple deprivation score

6.6 Discussion

6.6.1 Fruit and vegetable consumption

The results from these trials revealed that there was very little difference in children's mean change in fruit, vegetables or combined fruit and vegetable intake. For both trials the Teacher-led group had slightly higher mean intake for vegetables and combined fruit and vegetables than the RHS-led or comparison group, however there was no significant intervention effect after taking into consideration the adjustment for possible confounders. Only five other studies measured the relationship between children's fruit and vegetable intake and a gardening intervention (McAleese & Rankin, 2007; Parmer et al., 2009; Lautenschlager & Smith, 2007; Wang, 2009; & Morgan et al., 2010). The results from these five studies were mixed, with two studies revealing a significant difference for fruit and vegetable intake (McAlesse & Rankin, 2007; Wang, 2009), one (Lautenschlager & Smith, 2007) found boys had higher consumption of fruit and vegetables compared to girls. Parmer et al., (2009) found a significant increase in vegetable consumption and Morgan (2010) found no differences in fruit or vegetable intake (measured separately only).

Of the four studies that did show an effect on fruit or vegetable intake, two used self-selection to determine which school received the intervention (Parmer et al, 2009; Wang, 2009). For Parmer et al., 2009 the teacher were able to choose if they received the intervention or not, and Wang 2009 was based on existing gardening activities within the schools. One study (Morgan et al., 2009) stated that the head teacher chose which classes would receive the intervention and the fourth study (McAleese & Rankin et al., 2007) used convenience sampling for the three schools involved in the study; 2 of the 3 schools were randomly assigned, whilst the third school was assigned based on garden availability. However, for both of the current trials gardening area or existing activities was not a requirement and all schools were randomly assigned to their intervention group.

6.6.2 Nutrient consumption

For both trials the differences in key nutrients and foods were explored to see if there was an effect of either intervention on their mean intakes. Overall there was very little difference in either trial for these key nutrients and foods. The only significant difference was in Trial 1 for vitamin C intake in the adjusted model. Once the adjustments were made there was a 13 mg per day difference between the RHS-led and Teacher-led groups, with the Teacher-led group having a significantly higher intake of vitamin C. To the author's knowledge, no other gardening intervention has explored dietary intake to the level of detail of the current studies.

Only two studies Davis et al., 2011 and McAleese and Rankin 2007 explored some key nutrient data, identifying a significant increase in dietary fibre in the gardening intervention group compared to the control group, and significant increase in fibre, vitamins A and C respectively.

6.6.3 Potential barriers to changing children's fruit and vegetable consumption

Changing children's fruit and vegetable patterns is a challenging task. Academic literature shows that the main barriers for increasing children's fruit and vegetable intake are availability, convenience, taste preferences, peer pressure, parental/school support and knowledge (O'Dea, 2003). Whilst school based interventions attempt to battle against these issues, the successful implementation of an intervention is often determined by the time allocated and perceived importance of the school teachers and parents. The main barrier for teachers not implementing school based interventions is preparation time (Knai et al., 2006). The teacher's willingness to teach the intervention and own beliefs in the importance of the garden could explain the current findings that whilst not significant, the Teacher-led intervention tended to have a higher increase in fruit and vegetables compared to the RHS-led intervention and the comparison group. Another important geographical component to acknowledge when evaluating the success of a gardening intervention is that all of the successful interventions were located in the USA in areas where fruit and vegetable could be grown all year round. Unlike the current research where the length of the growing season could have an effect on the outcome. Further analysis exploring how the delivery and implementation of the intervention may have affected the primary outcome is described in Chapter 8.

6.6.4 Limitations and strengths

One of the disadvantages of the design of this research was having two trials instead of one trial. Therefore the difference between the RHS-led intervention and the comparison group could not be analysed. However, for both trials the study design was robust using randomisation to determine which schools received the different interventions. This is the first clustered randomised controlled trial to evaluate the effectiveness of gardening in schools on children's fruit and vegetable consumption. One of the main limitations of previous literature in this area was their study design and the use of convenience sampling (Poston et al., 2005; O'Brien & Shoemaker, 2006; Koch et al., 2006). The strength of the current study is schools were randomised to either one of the intervention groups or the comparison group; therefore there was no possibility of introducing selection bias into the study. One of the fundamental problems with the previous research in this area is that schools were selected based on having

or not having a garden; those without a garden were used as a control school (Morris et al., 2001; McAleese & Rankin 2007). Other biases were constraints of the school district and characteristics such as pupil numbers (Morris & Zidenberg-Cherr, 2002), self-selection, the teachers were given the option to choose their condition group (Parmer et al, 2009; Morgan et al., 2010; Wang, 2009).

The sample size at baseline for both trials was lower than anticipated. With the response rate at follow-up for both trials combined being 60 percent. This reduced the average group size to approximately 388, 94 children less per group than the proposed sample size of 482. This reduced the power to detect the difference of 1 portion to 83 percent. The sensitivity analysis (baseline-brought-forward) was conducted to explore if the reduced sample size had an effect on the primary outcome. The results were very similar to that of the main analysis, suggesting the reduced sample size did not affect the primary analysis of the trial. Furthermore, baseline-brought-forward does not take into consideration changes in children's fruit in vegetable intake associated with age. Children's fruit and vegetable and nutrient intake does vary, and can decrease with age (Evans et al., 2010). Whilst, in some analysis baseline-brought forward can provide useful findings as it takes into consideration missing data (Liu-Seifer et al 2010), for these trials exploring change in fruit and vegetable intake provides a more accurate statistical method to evaluate the primary outcome. Furthermore, these trials are the largest trials to evaluate school gardening to date. Some of the studies in this area had a very small sample size with some only involving a few schools or one school implementing the intervention (Heim et al., 2011, Lautenschlager & Smith, 2007, Koch et al., 2006, Hermman et al. 2006, Morris et al., 2001, Poston et al., 2005). Furthermore, the current trials involved a highly diverse population in terms of ethnicity and socio-economic groups.

The dietary data was collected using a validated 24-hour food tick list CADET for children aged 3-11 years old (please see Chapter 3). The strength of the CADET diary is that it uses age and gender specific food portion sizes to calculate food and nutrient intake. A one-day tick list is an economically effective way of gathering nutrient information from children. However, the disadvantage of using a 24-hour food frequency questionnaire is it uses pre-allocated portion sizes for each item in CADET which is based on average weighed intakes from UK children (Cade et al., 2006). A one-day tick list may not reflect true nutrient intake in the longer term. This study attempted to improve the quality of the data by providing parents and children with an instruction DVD to help explain how to complete the CADET Home Food Diary. In this study the trained fieldworkers also collected and reviewed all Home Food Diaries; this was for two reasons; one to reduce errors in the data collected to make sure children did consume

everything ticked on the diary, but also to obtain a retrospective recall for the child who did not return the Home Food Diary. The CADET diary does avoid these issues just mentioned with child self-reported food intake, and is less of a burden on the participants than the most commonly used alternative, a weighed 4 day food diary (Hachett et al., 2002). Also, academic research suggests that a one day food frequency questionnaire can be as useful as a multiple day food diary (Blom et al., 1989; Clapp et al., 1991; & Rocket et al., 1997).

All the results were conducted using a robust statistical methodology - multilevel analysis. The benefit of this technique is that the means and confidence intervals for the different foods and nutrients will be more accurate, as the children's food consumption within a school is more similar to each other, with less variability within the sample compared to a random sample from the whole population (Rasbash et al., 2004, Aiken and West, 1991). The primary outcome measuring children's fruit and vegetable consumption, using multilevel regression analysis, was originally going to explore difference in following-up intake, adjust for baseline intake. However, due to the negative distribution of the residuals for follow-up fruit and vegetable intake, a change score was calculated by subtracting baseline fruit and vegetable intake from follow-up intake. For both trials there was no imbalance between baseline intake for fruit and vegetable intake, suggesting this was an appropriate methodology (Vickers and Altman, 2001).

6.6.5 Conclusion

In conclusion, this is the first clustered randomised controlled trial to explore if a gardening intervention can increase children's fruit and vegetable intake. The results concluded there was no change in children's fruit and vegetable intake after receiving either the RHS-led intervention or the Teacher-led intervention.

6.7 Chapter Summary

This Chapter has explored the primary outcome for both trials - Can the RHS Campaign lead to increases in vegetable and fruit intake in children aged 8-9 years? It is evident that children's fruit and vegetable intake did not significantly increase after participating in either the RHS-led or Teacher-led interventions. For both trials the teacher-led intervention group had on average a higher mean change in fruit and vegetable intake compared to the RHS-led group or the comparison group. Chapter 8 will explore the adherence to the different interventions (RHS-led and Teacher-led) and identify how the different types of interventions implemented affected the primary outcome children's fruit and vegetable intake.

Chapter 6 also explored the secondary aims - What is the effect of the RHS Campaign on intake of key nutrients (fat, carbohydrate, protein, vitamin C, carotene, iron, sodium, folate)? and if there was an interaction effect between the intervention and gender. The only significant difference found in the secondary outcomes was for vitamin C intake in Trial 1. Once the adjustments were made there was a 12.7mg per day difference between the RHS-led and Teacher-led groups, with the Teacher-led group having a significantly higher intake of vitamin C.

Chapter 6 has also discussed the existing school gardening evaluations that have also explored fruit and vegetable intake, the limitations and strengths of these two trials focusing on the study design, dietary assessment methodology and statistical analysis used to analyse the trials. Also as already stated, chapter 8 will explore the two types of interventions in more details and explore the different gardening interventions used across the globe. First, chapter 7 will discuss the effects of the gardening interventions on children's knowledge and attitudes towards fruit and vegetables.

Chapter 7 - Impact of a school gardening intervention on children's knowledge and attitudes towards fruit and vegetables.

The statistical analysis for this chapter was conducted by Dr Jayne Hutchinson. The introduction for this chapter was written by MSC whilst the methodology and discussion were completed jointly by MSC and JH. As stated in Chapter 4 MSC designed the questionnaire used in this analysis.

7.1 Introduction

The psychological theory behind school gardens is based on the social cognition theory (SCT) (Bandura, 1986). The SCT is based on the assumption that to change a person's behaviour you need to change their knowledge, values and beliefs to be successful (Morris, 2000). SCT has been used to design several gardening interventions (Morgan et al., 2010, Morris et al., 2001, Morris and Zidenberg-Cherr, 2002, O'Brien and Shoemaker, 2006, Poston et al., 2005, Ratcliffe et al., 2011). Personal factors such as nutrition knowledge, food preferences (including willingness to taste), attitudes towards food, self-efficacy in eating and preparing food have already been associated with increased fruit and vegetable consumption in children and adolescents in non-gardening research (Rasmussen et al., 2006). Overall, gardening interventions have been associated with an increase in children's nutrition knowledge in the majority of the studies which assessed this (Cason, 1999, Koch et al., 2006, Morgan et al., 2010, Morris et al., 2001, Morris and Zidenberg-Cherr, 2002, Parmer et al., 2009, Ratcliffe et al., 2011, Somerset and Markwell, 2008), though not all (O'Brien and Shoemaker, 2006, Poston et al., 2005).

For these two trials to assess children's knowledge and attitudes towards fruit and vegetables a short questionnaire was developed and administered at baseline before and after the RHS interventions were implemented in the two trials. The aim of this chapter was to compare the effects of teacher-led gardening with a RHS-led school gardening intervention, and with no intervention, on children's knowledge of and attitudes towards fruit and vegetables.

7.2 Method

All schools were provided with two copies of the Child Questionnaire for each child to complete individually; once at baseline and then at follow-up after two growing seasons.

7.2.1 Fruit and vegetable knowledge

To assess knowledge of the 5-A-Day fruit and vegetable campaign, children were asked to circle on the Child Questionnaire a number between 1 and 8 in answer to the question *"How many servings of fruit and vegetables do you think you should eat every day to stay healthy?"* To test children's ability to recognise fruit they were asked to draw a line from the name of 12 different fruit and 16 different vegetables to a colour photo of each item. Apple was provided as an example. All the fruit were listed and pictured on one page: raspberries; blackberries; pears; blueberries; plums; bananas; grapes; orange; pineapple; nectarine; watermelon; kiwifruit. The vegetables were listed on another page: courgettes; spinach; French beans; parsley; lettuces; parsnips; radish; sweet-corn; carrots; leeks; spring onions; broccoli; peppers; cucumber; tomatoes; garlic (see appendix page 227). For each item, correct responses were coded 1 and incorrect responses were coded 0.

7.2.2 Attitudes towards fruit and vegetables

To assess attitudes towards fruit and vegetables the children were asked to circle whether they agreed a lot, agreed a little, disagreed a little or disagreed a lot with 10 questions (shown in Table 7.1), e.g. '*I enjoy eating fruit'* or *'I like trying new fruit'* which relates to perceived barriers to consumption, and self-efficacy was assessed using *'I try to eat lots of fruit'* and *'I'm good at preparing fruit and vegetables'*. Perceived social influences and availably in the home environment were evaluated with the questions *'My family encourages me to eat fruit and vegetables' and 'There's usually lots of fruit and vegetables to eat at home'.*

7.2.3 Gardening experience

To determine gardening experience the children were asked to circle yes or no in answer to *"We grow fruit and vegetables in our garden or allotment." They were then asked 'What fruit or vegetables have you grown*?" For each child the number of different types of fruit and vegetables they listed were coded as two separate variables. Finally they were asked *"Have you tasted any fruit or vegetables from your garden or allotment?"* Yes or No, and "What fruit or vegetables have you tasted?" Each child's list of tasted items was compared to their list of own-grown fruit and vegetables and recorded for analysis as: None; Some; All fruit and vegetables grown.

7.3 Statistical analysis

Differences between intervention groups for descriptive variables were analysed using chi-squared tests for categorical variables and t-test for continuous variables.

Multilevel mixed effects logistic regression analyses were used to determine whether at follow-up there were significant differences between intervention groups relating to knowledge of 5-A-Day needed to remain healthy. This method was also to analyse differences relating to the percentage of children who agreed (a little or a lot) and the percentage of those who disagreed (a little or a lot) with the attitude statements. Odds ratios were presented unadjusted and also adjusted for baseline answers. Further analysis on over 90% of the children also adjusted for gender, ethnicity and index of multiple deprivation (IMDS). In these mixed effects analyses the fixed effect variable was the gardening intervention and the random effects variable was the school. The percentage of children who correctly identified 5-A-Day requirements, the individual fruit and vegetables and the percentage who agreed with the attitude statements were also tabled. Multilevel mixed effects logistic regression models were also used to compare between interventions the percentage of children able to identify individual fruit and vegetables.

The change from baseline to follow-up for the total number of fruit recognised and the total number of vegetables recognised was also calculated for each qualifying child and compared between interventions for both trials using independent samples t-tests. P values from multilevel mixed regression analysis adjusted for gender, ethnicity and IMDS. These methods were used to assess the change between baseline and follow-up for the number of types of fruit or vegetables children listed as own-grown. The changes in total numbers between data gathering points were approximately normally distributed.

Multilevel mixed effects regression analysis was used to determine whether there is an association between the change in knowledge of fruit and vegetables and change in actual mean fruit and vegetable intake derived from the School and Home Diary. Analyses were presented unadjusted and adjusted for gender, ethnicity and IMDS. Only children who completed both the baseline and the follow-up questions of the appropriate section of the child questionnaire were included in these analyses. Statistical analysis was performed using Stata SE version 12 (StataCorp, 2005). P-values of less than 0.05 were taken to represent statistical significance for all analysis, except relating to the recognition of individual fruit and

vegetables where p-values of less than 0.01 were taken as statically significant due to multiple testing.

7.4 Results

7.4.1 Response rate

In Trial 1 there were 404 children (69%) from the Teacher-led group and 373 (70%) from the RHS-led intervention who attempted parts of both the baseline and follow-up children knowledge and attitude questionnaires. In Trial 2, 559 children (77%) from the Teacher-led intervention group and 541 (71%) from the control group attempted this. Not all of these children completed every section of the questionnaire. The percentage of children with completed dietary data were 329 children (56%) from the teacher-led group and 323 (61%) from the RHS-led intervention in trial 1 and for trial 2, 500 children (69%) from the teacher-led group and 431 (57%) from the comparison group. The demographic characteristics of the children for each trial are described in table 6.1 and table 6.2 in chapter 6.

7.4.2 Attitudes towards fruit and vegetables

In relation to children's attitudes and perceptions about fruit and vegetables, over 90% of the children from the two trials at both baseline and follow-up agreed that eating vegetables every day kept them healthy and that their parents encouraged them to eat these. Over 90% of the children at both baseline and follow-up agreed they enjoyed eating fruit, whereas between 60-70% of children agreed they enjoyed vegetables, and only 50-60% agreed they liked trying new vegetables (follow-up percentages shown in Table 7.1 and Table 7.2). In Trial 2, children in the gardening intervention group were significantly more likely to agree they enjoyed eating vegetables at follow-up compared to the control group (69.5% vs 61.7%) even after adjusting for baseline answers (OR=1.4, 95%CI: 1.1, 1.8 p=0.03), however this was not significant after adjusting for gender, ethnicity or IMDS (OR=1.3, 95%CI: 0.9, 1.7, p=0.1). There were no other significant differences in Trial 2 for this section of the questionnaire, and there were no significant differences relating to vegetables in Trial 1 regarding to answers at follow-up. However, children in the RHS-led group in Trial 1 were significantly less likely to agree they tried to eat lots of fruit or liked to try new fruit than those in the teacher-led group, even after baseline adjustments (OR= 0.5, 95%CI: 0.3, 0.8, p=0.009) and OR= 0.5, 95%CI: 0.3, 0.9, p=0.05 respectively). In addition, after further adjustment for socio-demographic factors (including deprivation score) children in the RHS-led group were significantly less likely than those in the teacher-led group to agree there were lots of fruit and veg to eat at home (OR=0.5, 95%CI: 0.3, 0.9, p=0. 02).

As also observed in Table 7.1 and Table 7.2, at baseline a high proportion of children knew that five servings of fruit and vegetables should be eaten every day to stay healthy (>67%). Out of the children who answered this question at both baseline and follow-up there was no significant difference in the proportion of children with correct answers at follow-up between the RHS-led and the Teacher-led groups in Trial 1 (79% vs 79%). However, there was a significant difference in correct answers between the intervention groups in Trial 2 at follow-up; the Teacher-led group gave more correct answers than the comparison group (79% vs 67.5%). From the multilevel logistic regression analyses a significant difference remained (OR= 1.75, 95%CI: 1.1, 2.6, p=0.006) after adjusting for baseline answers (which were significantly different between groups), and also after further adjustment for socio-demographic factors (OR=1.7, 95%CI: 1.2, 2.6, p=0.004).

Additionally, there was no evidence that the school gardening interventions significantly increased the likelihood of children tasting their own-grown fruit and vegetables, as observed in Table 7.1 and Table 7.2.

Table 7.1 Attitudes towards fruit and vegetables for Trial 1

Attitudes and perceptions	Percentage of children agree at follow-up[a]				Odds ratios at follow-up using MLM to compare interventions					
	RHS-led N=366		Teacher-led N=394		Unadjusted		Adjusted for baseline		Additional[b] adjustment	
	Baseline	Follow-up	Baseline	Follow-up	OR	95%CI	OR	95% CI	OR	95% CI
I enjoy eating fruit	94.5	91.8	96.4	96.2	**0.4**	0.2, 1.0	**0.5**	0.2, 1.1	**0.4**	0.1, 1.0
I like trying <u>new</u> fruits	78.0	76.3	83.3	86.6	**0.5**	0.2, 0.9	**0.5**	0.2, 0.9	**0.5**	0.2, 0.9
I try to eat lots of fruit	83.0	81.3	86.7	90.1	**0.4**	0.2, 0.8	**0.4**	0.2, 0.8	**0.4**	0.2, 0.9
I enjoy eating vegetables	65.6	64.7	66.9	65.9	**1.0**	0.5, 1.8	**1.0**	0.5, 1.9	**1.1**	0.6, 1.9
I like trying <u>new</u> vegetables	58.9	58.0	61.0	60.0	**0.9**	0.6, 1.4	**0.9**	0.6, 1.4	**1.0**	0.7, 1.5
I try to eat lots of vegetables	64.6	70.9	66.7	69.6	**1.1**	0.6, 1.9	**1.1**	0.7, 1.8	**1.1**	0.7, 1.7
Eating fruit and vegetables every day keeps me healthy	93.5	94.1	94.1	97.2	**0.5**	0.2, 1.8	**0.5**	0.1, 1.7	**0.6**	0.2, 1.6
There's usually lots of fruit & vegetables to eat at home	89.2	89.8	87.6	94.1	**0.5**	0.2, 1.0	**0.5**	0.2, 1.0	**0.4**	0.2, 0.9
I'm good at preparing fruit and vegetables	71.8	74.7	81.3	83.6	**0.6**	0.3, 0.9	**0.6**	0.3, 1.4	**0.6**	0.3, 1.1
My family encourages me to eat fruit and vegetables	87.1	90.7	88.3	93.7	**0.7**	0.3, 1.4	**0.7**	0.3, 1.5	**0.7**	0.3, 1.5
% knew 5 F&V needed to stay healthy	76.2%	79.0%	72.7%	79.0%	**0.9**	0.4, 1.1	**0.8**	0.6, 1.5	**0.9**	0.4, 1.6
% tasted their own fruit and vegetables at follow-up	62.3%	62.1%	52.4%	67.8%	**0.8**	0.4, 1.2	-	-	**0.8**	0.5, 1.4

[a]Agree=percentage of children that agree a little or lot
[b]Multilevel models (MLM) adjusted for gender, ethnicity, IMDS and baseline answers
[c]Significant difference between interventions at baseline

Table 7.2 Attitudes towards fruit and vegetables for Trial 2

Attitudes and perceptions	Percentage of children agree at follow-up[a]				Odds ratios using MLM to compare interventions					
	Gardening N=537		Control group N=498		Unadjusted		Adjusted for baseline		Additional[b] adjustment	
	Baseline	Follow-up	Baseline	Follow-up	OR	95%CI	OR	95% CI	OR	95% CI
I enjoy eating fruit	96.7	97.6	96.8	97.0	**1.2**	0.5, 2.8	**1.1**	0.5, 2.7	**1.1**	0.4, 2.9
I like trying new fruits	86.0	84.0	84.5	80.4	**1.2**	0.8, 1.9	**1.2**	0.8, 1.9	**1.2**	0.7, 1.9
I try to eat lots of fruit[c]	87.2	88.2	82.7	85.8	**1.2**	0.7, 1.8	**1.1**	0.7, 1.8	**1.0**	0.6, 1.6
I enjoy eating vegetables	68.8	69.5	64.2	61.7	**1.4**	1.0, 1.8	**1.3**	1.0, 1.8	**1.2**	0.9, 1.6
I like trying new vegetables	62.8	59.5	60.5	56.9	**1.1**	0.8, 1.4	**1.0**	0.8, 1.4	**0.9**	0.7, 1.2
I try to eat lots of vegetables[c]	72.8	75.5	66.7	68.6	**1.4**	0.9, 2.0	**1.3**	0.9, 1.9	**1.2**	0.8, 1.8
Eating fruit and vegetables every day keeps me healthy	94.9	97.0	96.2	96.4	**1.2**	0.5, 2.7	**1.2**	0.5, 2.7	**1.2**	0.5, 2.8
There's usually lots of fruit & vegetables to eat at home	89.6	92.8	88.9	89.5	**1.5**	0.9, 2.3	**1.5**	0.9, 2.3	**1.5**	0.9, 2.5
I'm good at preparing fruit and vegetables	79.3	78.1	77.9	79.3	**0.9**	0.6, 1.2	**0.9**	0.6, 1.2	**0.8**	0.6, 1.1
My family encourages me to eat fruit and vegetables	89.9	92.8	87.7	91.9	**1.1**	0.7, 1.7	**1.1**	0.6, 1.7	**0.9**	0.5, 1.6
% knew 5 F&V needed to stay healthy[c]	73.6%	79.1%	67.3%	67.5%	**1.8**	1.2, 2.8	**1.7**	1.1, 2.6	**1.7**	1.1, 2.5
% tasted their own fruit and vegetables at follow-up	60.1%	66.4%	56.0%	58.1%	**1.4**	0.8, 2.4	**1.4**	0.8, 2.4	**1.4**	0.8, 2.4

[a]Agree=percentage of children that agree a little or lot; No=percentage of children that disagree a little or a lot
[b]Multilevel models (MLM) adjusted for gender, ethnicity, IMDS baseline answers
[c]Significant difference between interventions at baseline

The children's ability to recognise fruit was already very good at baseline (as observed in Table 7.3 and 7.4). From both trials, 80% or more of the children were able to identify each type of fruit on the questionnaire, apart from blackberries, blueberries, plums and nectarines, where only 64% or more children identified these fruits. Over 90% of the children could identify pears, bananas, grapes, oranges, pineapple and watermelon. Whereas, the ability to recognise vegetables was more varied, with 90% of children recognising sweet-corn, carrots, peppers and tomatoes, but only 50% of children identifying spinach, parsley, leeks, spring onions.

Nevertheless, as observed from Figures 7.1 to 7.4 of those who had been incorrect at baseline, about 30% of children in Trial 1 and over 20% of children in Trial 2 identified these latter four vegetables correctly for the first time at follow-up after the gardening intervention. The figures however, show that a fair proportion of children could not identify these and other items (such as blackberries, blueberries, plums and nectarines) at follow-up after previously identifying them correctly at baseline, as some of the answers were probably guesses.

In Trial 1 there were no differences at follow-up between RHS-led and teacher-led interventions which were significant at less than p=0.01. In Trial 2, significant differences at follow-up between the teacher-led intervention and the comparison group were found only in relation to nectarines in both chi^2 tests and in multilevel models adjusting for baseline, and additionally for socio-demographic variables (at $p<0.001$). Children in the comparison group were more likely to identify nectarines than those in the teacher-led intervention. Children in the Teacher-led intervention however, were significantly more likely to be able to identify leeks at follow-up than those in the comparison group, but this was not significant after baseline adjustments in multilevel models.

Table 7.3 Trial 1 Percentage of children who correctly identified the following fruit and vegetables

	% children recognised item				% point diff at follow-up RHS-led less teacher-led	Less BL = Net diff in % points	Chi^2 P value for diff at follow-up	P value for diff at follow-up using MLM logistic regression	
	RHS-led Intervention N=372		Teacher-led Intervention N=404					adj BL[a]	further adj[b]
	BL	Follow-up	BL	Follow-up					
Raspberries	84.7	90.9	89.9	94.8	-3.9	1.2	0.3	0.08	0.03
Blackberries	82.5	86.8	83.9	90.3	-3.5	-2.0	0.1	0.5	0.6
Pears	93.8	96.8	96.5	97.8	-1.0	1.7	0.4	0.4	0.5
Blueberries	76.9	81.7	82.2	88.1	-6.4	-1.1	0.01	0.4	0.7
Plums	80.4	82.0	82.6	84.2	-2.2	0.1	0.4	0.6	0.7
Bananas[c]	96.8	98.9	99.5	99.0	-0.1	2.6	0.9	-	-
Grapes	91.9	96.0	94.8	97.5	-1.6	1.3	0.2	0.3	0.5
Orange	96.5	96.8	97.5	96.5	0.2	1.3	0.9	0.8	1.0
Pineapple	96.5	96.8	96.0	98.0	-1.2	-1.7	0.3	0.3	0.5
Nectarine	70.7	76.9	75.7	81.4	-4.6	0.5	0.1	0.3	0.5
Watermelon	98.7	99.5	98.8	98.5	0.9	1.1	0.2	0.3	0.3
Kiwifruit	95.4	98.1	95.1	97.8	0.3	0.0	0.7	0.6	0.8
Courgettes	46.7	72.0	55.3	74.8	-2.9	5.7	0.4	0.9	0.7
Spinach	39.7	63.9	43.4	62.8	1.1	4.8	0.8	0.5	0.9
French beans	71.7	83.7	76.9	83.4	0.3	5.5	0.9	0.6	0.8
Parsley[c]	27.5	52.0	36.2	49.1	2.9	11.7	0.4	0.2	0.2
Lettuce	78.5	90.8	82.6	91.3	-0.6	3.5	0.8	0.9	1.0
Parsnips[c]	38.9	62.0	51.9	65.0	-3.1	9.9	0.4	0.9	1.0
Radish	52.7	74.7	61.0	75.7	-1.0	7.3	0.7	0.7	0.8
Sweet-corn	96.2	98.4	98.0	99.5	-1.1	0.7	0.1	0.1	-
Carrots	94.6	99.2	97.5	98.8	0.4	3.4	0.6	0.5	0.3
Leeks	38.0	56.5	41.7	62.3	-5.8	-2.1	0.1	0.4	0.3
Spring Onion	38.9	59.2	40.7	61.5	-2.3	-0.5	0.5	0.9	0.6
Broccoli[c]	88.6	96.2	94.8	94.0	2.2	8.4	0.2	0.2	0.2
Peppers	90.2	97.3	95.0	97.3	0.0	4.8	1.0	0.8	0.9
Cucumber	73.1	89.1	80.7	89.6	-0.5	7.1	0.8	0.9	0.6
Tomatoes	97.0	98.1	98.3	98.2	-0.2	1.1	0.9	-	-
Garlic	68.2	93.2	71.6	88.1	5.1	8.5	0.02	0.03	0.04

[a]P value from multilevel mixed logistic regression testing the odds of children correctly identifying fruit items at follow-up between interventions, adjusting for ability to identify fruit at baseline

[b]P value from multilevel mixed logistic regression testing the odds of children correctly identifying fruit items at follow-up between interventions, adjusting for ability to identify fruit at baseline, gender, ethnicity and index of multiple deprivation.

[c]Significant differences ($p<=0.01$) were found using chi^2 tests between different interventions for the percentage of children of who could identify individual items at baseline.

[d]Fisher's exact test was used instead of chi^2 tests since there were less than 5 children in more than 20% of the compared groups

Table 7.4 Trial 2 Percentage of children who correctly identified the following fruit and vegetables

	Percentage children recognised item				% point diff at follow-up RHS-led - teacher-led	Less BL = Net diff in % points	Chi^2 P value for diff at follow-up	P value for diff at follow-up using MLM logistic regression	
	Teacher-led Intervention N=556		Control group N=535						
	BL	Follow-up	BL	Follow-up				adj BL[a]	further adj[b]
Raspberries	83.2	92.6	85.8	92.2	0.5	3.0	0.8	0.7	0.9
Blackberries	78.2	86.5	80.9	89.7	-3.2	-0.5	0.1	0.2	0.2
Pears	95.3	98.0	94.2	97.2	0.8	-0.3	0.4	0.4	0.4
Blueberries	73.9	84.2	74.4	83.6	0.6	1.1	0.8	0.8	1.0
Plums	74.5	79.0	74.4	83.6	-4.6	-4.7	0.05	0.08	0.06
Bananas	98.6	98.7	97.6	97.8	1.0	0.0	0.2	0.2	0.2
Grapes	93.5	96.4	91.2	96.6	-0.2	-2.5	0.8	0.8	0.4
Orange	96.2	96.4	95.9	96.1	0.3	0.0	0.8	0.8	1.0
Pineapple	95.5	97.7	94.8	97.2	0.5	-0.3	0.8	0.7	0.5
Nectarine	64.9	71.4	64.5	78.5	-7.1	-7.5	0.007	0.006	0.001
Watermelon	97.5	98.6	95.9	99.1	-0.5	-2.1	0.4	0.4	0.2
Kiwifruit	94.2	96.9	92.9	97.9	-1.0	-2.3	0.3	0.4	0.3
Courgettes	50.4	66.7	47.5	61.8	4.9	1.9	0.1	0.4	0.5
Spinach	45.1	62.0	43.7	55.6	6.4	4.9	0.03	0.3	0.5
French beans	74.3	84.2	69.9	81.9	2.4	-2.0	0.3	0.8	0.7
Parsley	31.5	46.4	30.4	44.4	2.0	0.9	0.5	0.7	0.9
Lettuce	79.9	89.3	78.6	87.9	1.3	0.0	0.5	0.8	0.9
Parsnips	48.0	57.6	44.4	56.1	1.5	-2.1	0.6	1.0	0.8
Radish	53.1	70.8	50.3	64.3	6.5	3.7	0.02	0.2	0.2
Sweet-corn	97.1	98.4	97.2	98.5	-0.1	-0.1	0.9	0.9	0.3
Carrots	95.7	96.9	95.8	98.5	-1.6	-1.4	0.09	0.1	0.5
Leeks	39.0	53.1	36.3	43.9	9.1	6.5	0.003	0.08	0.1
Spring Onion	40.4	56.0	43.1	57.5	-1.5	1.2	0.6	0.7	0.6
Broccoli	89.5	93.3	91.3	94.7	-1.4	0.4	0.3	0.4	1.0
Peppers	90.8	94.9	92.6	96.2	-1.3	0.6	0.3	0.4	0.4
Cucumber	76.1	86.1	79.2	89.0	-3.0	0.1	0.1	0.2	0.4
Tomatoes	96.2	98.2	96.8	96.8	1.4	2.0	0.1	-	-
Garlic	69.0	87.9	71.3	86.2	1.7	3.9	0.4	0.5	0.6

[a]P value from multilevel mixed logistic regression testing the odds of children correctly identifying fruit items at follow-up between interventions, adjusting for ability to identify fruit at baseline

[b]P value from multilevel mixed logistic regression testing the odds of children correctly identifying fruit items at follow-up between interventions, adjusting for ability to identify fruit at baseline, gender, ethnicity and index of multiple deprivation.

[c]Significant differences ($p<=0.01$) were found using chi^2 tests between different interventions for the percentage of children of who could identify individual items at baseline.

[d]Fisher's exact test was used instead of chi^2 tests since there were less than 5 children in more than 20% of the compared groups

Figure 7.1 Trial 1 Percentage of children in the RHS-led gardening intervention group who could identify fruit and vegetables

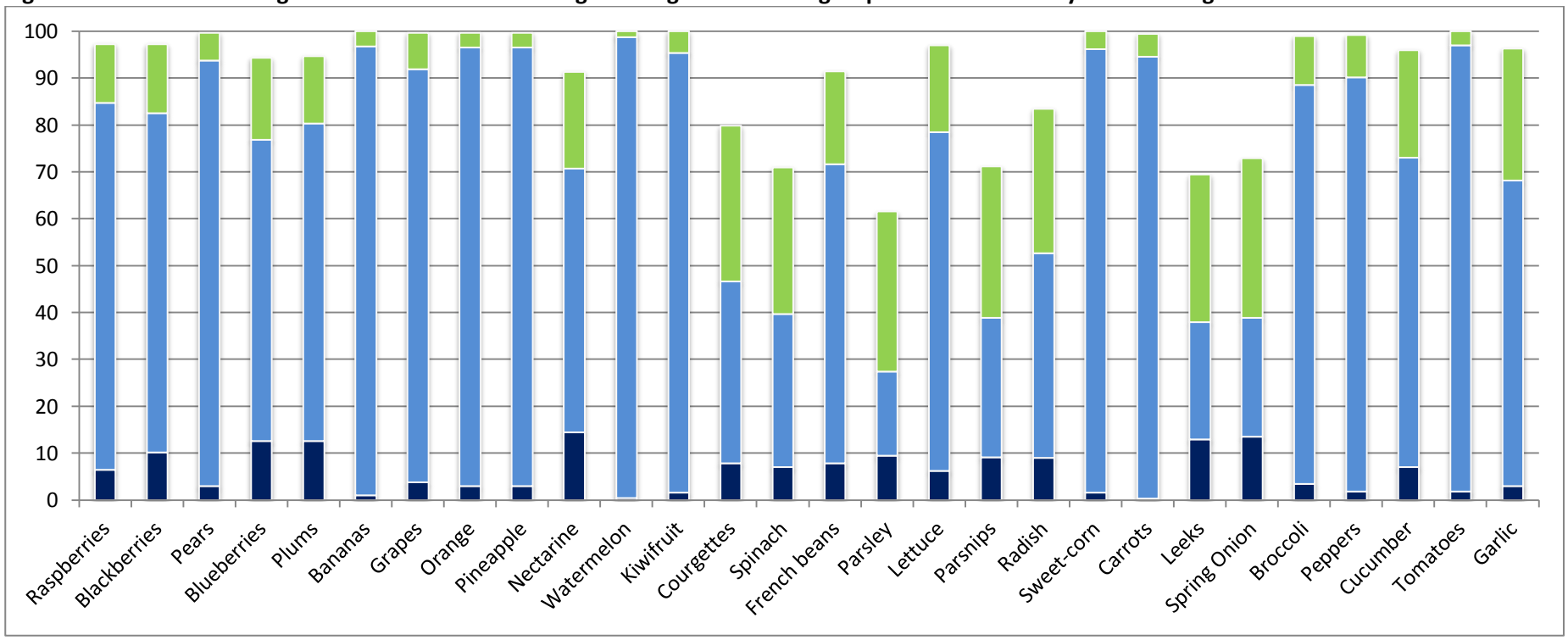


Figure 7.2 Trial 1 Percentage of children in the Teacher-led group who could identify fruit and vegetables

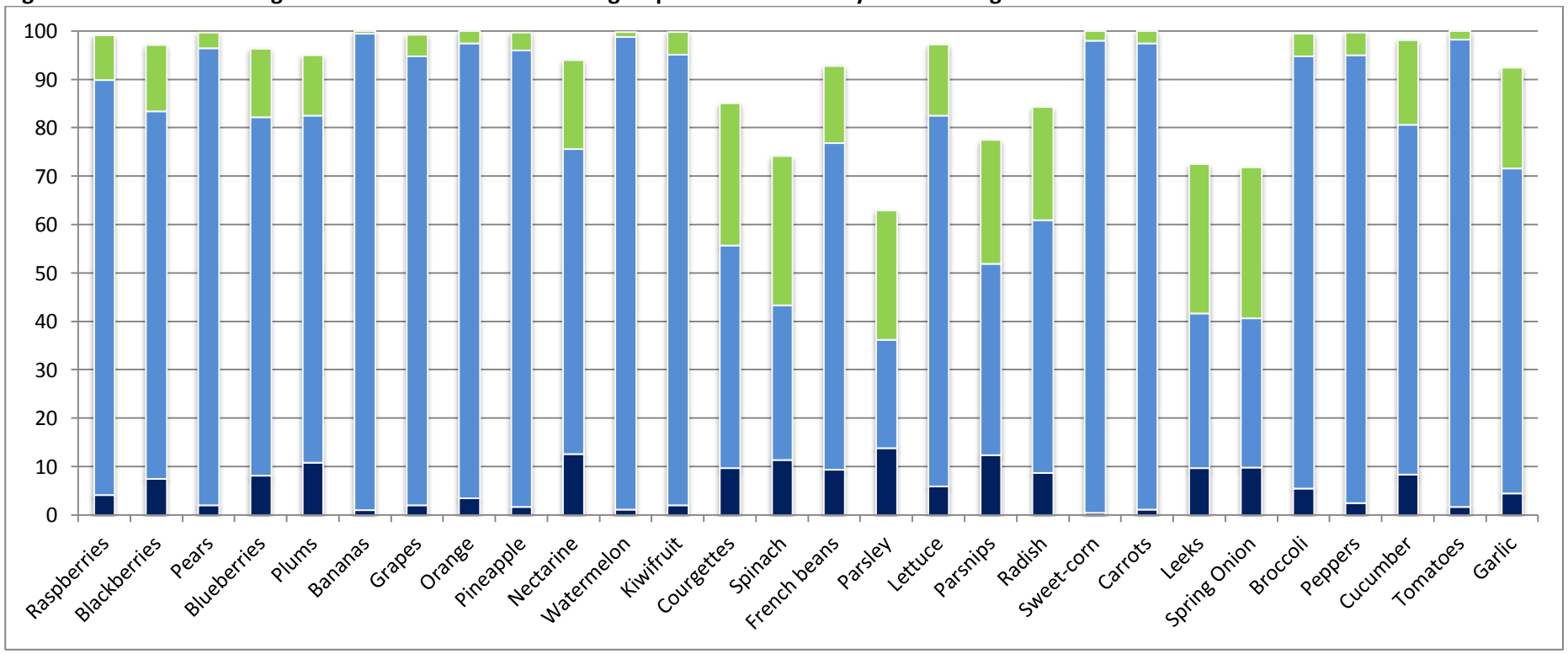


Figure 7.3 Trial 2 Percentage of children in the Teacher-led intervention group who could identify fruit and vegetables

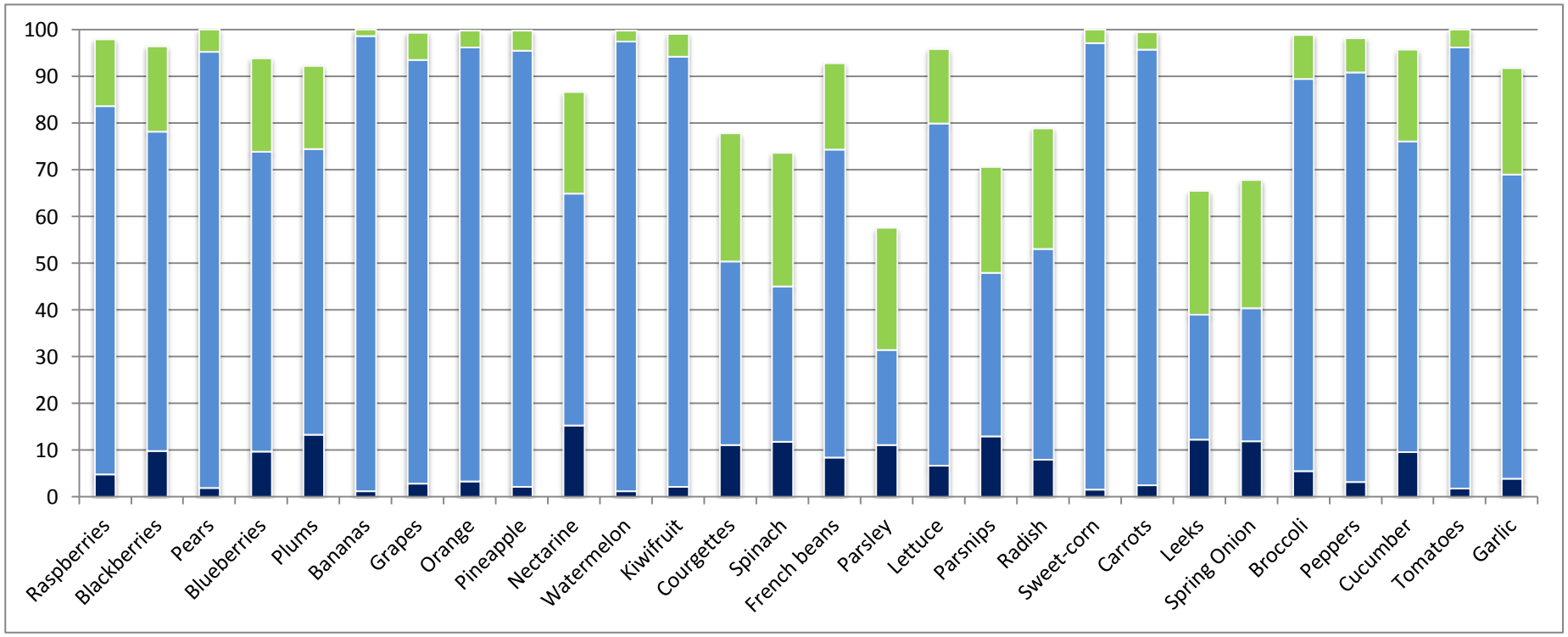


Figure 7.4 Trial 2 Percentage of children in the Comparison group who could identify fruit and vegetables

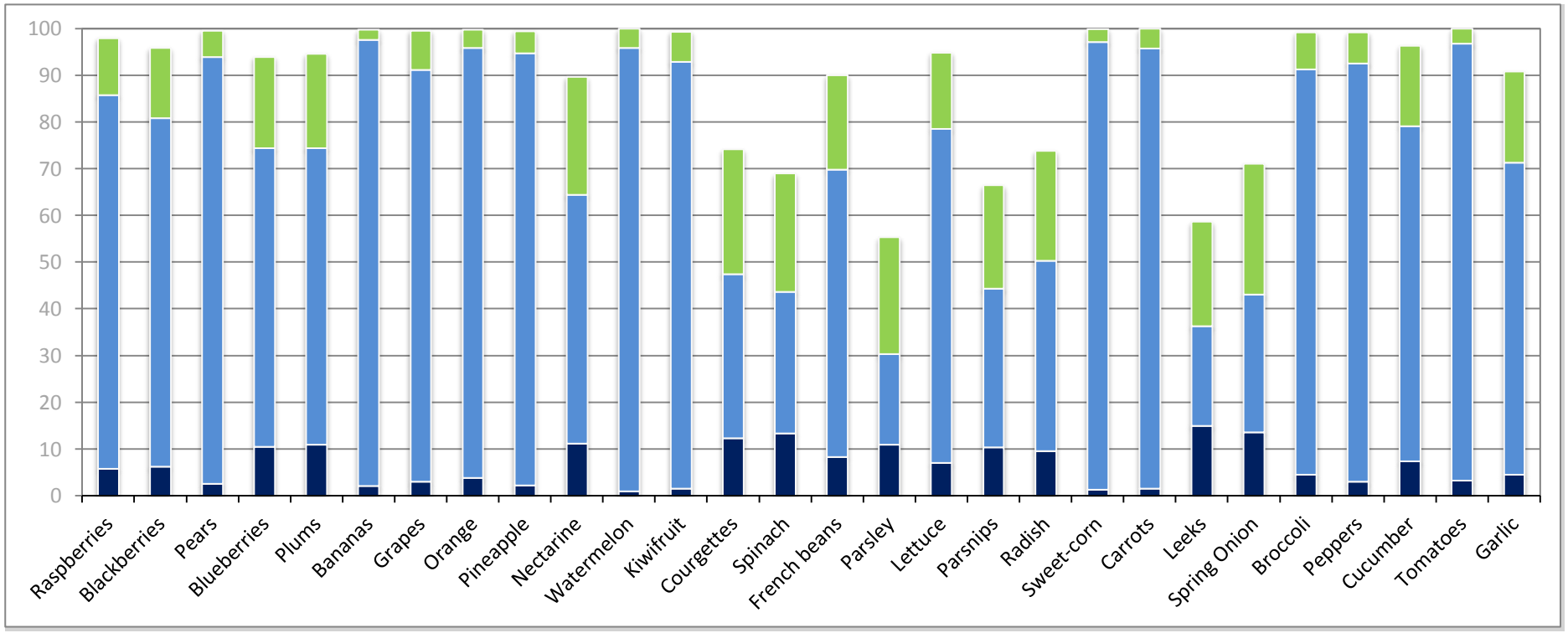


Table 7.5 reports the mean number of fruit and vegetables recognised at baseline and follow for both trials. It is evident when comparing the change in total fruit recognised from baseline to follow-up that there was no significant difference between intervention groups, either in Trial 1 or in Trial 2 in the unadjusted independent t-test analyses or after adjustment for socio-demographic variables in multilevel analyses. Similarly, there was no significant difference in the change in total vegetables recognised between intervention groups for Trial 2 as observed in Table 7.5. However in Trial 1 there was a significantly larger increase in the number of vegetables recognised from baseline to follow-up for the RHS-led group compared to the Teacher-led group (a mean increase of 2.44 vs 1.65 out of a total of 16 vegetables). This was statistically significant in multilevel analyses after adjusting for socio-demographic variables in addition to this (OR=0.9, 95%CI: 0.09, 1.76). Knowledge of vegetables in the Teacher-led group was significantly higher at baseline than in the RHS-led group, adjustment for the baseline answers (OR=0.3, 95%CI: -0.36, 0.93) produced non-significant results.

Table 7.5 Mean number of fruit and vegetables recognised at baseline and at follow-up[a]

		Baseline		Follow-up		Mean change		P[b]	P[c]
	N	Mean	95%CI	Mean	95% CI	Mean	95% CI		
Trial 1									
Fruit									
RHS-led	373	**10.6**	10.5, 10.8	**11.0**	10.9, 11.2	**0.37**	0.16, 0.58		
Teacher-led	404	**10.9**	10.8, 11.1[d]	**11.2**	11.1, 11.4	**0.31**	0.14, 0.48	0.7	0.9
Vegetables									
RHS-led	369	**10.4**	10.1, 10.7	**12.9**	12.6, 13.1	**2.44**	2.01, 2.83		
Teacher-led	404	**11.3**	10.9, 11.6[d]	**12.9**	12.6, 13.2	**1.65**	1.34, 1.98	0.002	0.03
Total Fruit & Vegetables									
RHS-led	372	**20.9**	20.5, 21.4	**23.9**	23.5, 24.2	**2.79**	2.32, 3.26		
Teacher-led	404	**22.1**	21.8, 22.6	**24.2**	23.8, 24.5	**1.96**	1.59, 2.34	0.007	0.08
Trial 2									
Fruit									
Teacher-led	556	**10.5**	10.3, 10.6	**11.0**	10.8, 11.1	**0.51**	0.35, 0.67		
Comparison group	535	**10.4**	10.3, 10.6	**11.1**	11.0, 11.2	**0.67**	0.49, 0.85	0.2	0.3
Vegetables									
Teacher-led	552	**10.8**	10.5, 11.0	**12.4**	12.1, 12.7	**1.65**	1.36, 1.95		
Comparison group	532	**10.7**	10.4, 11.0	**12.1**	11.9, 12.4	**1.45**	1.17, 1.72	0.3	0.6
Total Fruit & Vegetables									
Teacher-led	558	**21.1**	20.7, 21.5	**23.3**	23.0, 23.7	**2.15**	1.78, 2.51		
Comparison group	536	**21.0**	20.7, 21.4	**23.1**	22.8, 23.5	**2.10**	1.74, 2.45	0.8	0.9

[a] only includes children who completed sheets at both time points
[b] used independent t-test to test difference between interventions of mean change between baseline and follow-up
[c] used multilevel mixed regression to test difference between interventions of mean change between baseline and follow-up adjusting for gender, ethnicity, index of multiple deprivation score

Similarly, in Trial 2 there was a significantly larger increase in the total number of fruit and vegetables recognised from baseline to follow-up for the RHS-led group compared to the

Teacher-led group (p=0.007 in the t-test), but this was not significant after adjusting for socio-demographic variables in multilevel models (Table 7.5).

Using multilevel mixed effects regression analysis there was no significant evidence for any of the gardening groups of an association between the change in fruit or vegetables, or total fruit and vegetables identified from baseline to follow-up and the change in actual intake of fruit or vegetables derived from the School and Home Diary (Table 7.6). Although the results for Trial 1 showed decreases in fruit intake in-line with increased recognition of fruit they were not statistically significant. Conversely, point estimates for Trial 2 indicated an increase in intake with increased recognition in the gardening group for vegetables, though again this was not statistically significant.

Table 7.6 Increase in fruit and vegetable intake associated with identifying one additional fruit or vegetable between baseline and follow-up

		Unadjusted		Adjusted		
	N	Mean	95% CI	Mean	95% CI	p values
Trial 1						
Fruit						
RHS-led	295	**-0.05**	-11.3, 11.2	**-1.59**	-13.3, 10.2	0.8
Teacher-led	317	**-4.71**	-17.7, 8.25	**-3.62**	-16.3, 9.03	0.6
Vegetable						
RHS-led	293	**0.43**	-2.69, 4.55	**-0.29**	-3.07, 3.01	1.0
Teacher-led	312	**1.35**	-2.27, 4.97	**1.36**	-2.23, 4.95	0.5
Fruit and Vegetable						
RHS-led	292	**0.71**	-4.98, 6.39	**0.03**	-5.71, 5.78	0.8
Teacher-led	312	**-1.52**	-8.45, 5.41	**-1.59**	-8.43, 5.26	0.7
Trial 2						
Fruit						
Teacher-led	467	**-3.54**	-13.7, 6.55	**-3.71**	-13.7, 6.26	0.5
Comparison group	405	**-1.24**	-10.7, 8.18	**-2.19**	-11.7, 7.30	0.7
Vegetable						
Teacher-led	460	**1.68**	-1.16, 4.53	**1.77**	-1.08, 4.61	0.2
Comparison group	403	**-2.13**	-5.90, 1.65	**-1.68**	-5.46, 2.09	0.4
Fruit and Vegetable						
Teacher-led	459	**-0.91**	-6.16, 4.34	**-0.87**	-6.05, 4.32	0.7
Comparison group	401	**0.67**	-5.32, 6.65	**0.82**	-5.21, 6.84	0.8

[b]adjusted for gender, ethnicity, and IMDS

There was no significant difference between RHS-led and Teacher-led for Trial 1 in the change between baseline and follow-up for the number of types of fruit or vegetables children listed as own-grown. However in Trial 2, there was a significant increase in types of own-grown fruit listed by the Teacher-led group compared to the comparison group (mean= 0.3, 95%CI: 0, 0.6), but a significant decrease in types of vegetables listed, however, after adjusting for gender, ethnicity and IMDS and baseline these differences were no longer significant.

Table 7.7 Mean number of types of own-grown fruit and vegetables at baseline and at follow-up[a]

Fruit	N	Baseline Mean	95% CI	Follow-up Mean	95% CI	Mean change	95% CI	P[b]	P[c]
Trial 1									
Fruit									
RHS-led	77	**1.9**	1.7, 2.3	**1.8**	1.6, 2.1	**-0.1**	-0.5, 0.2		
Teacher-led	105	**2.0**	1.8, 2.3	**2.2**	1.9, 2.5	**0.1**	-0.2, 0.)	0.3	0.9
Vegetables									
RHS-led	120	**2.4**	2.1, 2.6	**2.6**	2.3, 2.9	**0.3**	-0.1, 0.6		
Teacher-led	169	**2.7**	2.4, 3.0	**2.6**	2.2, 2.9	**-0.1**	-0.5, 0.2	0.1	0.07
Trial 2									
Fruit									
Teacher-led	126	**1.9**	1.6, 2.1	**2.1**	1.9, 2.4	**0.3**	0.0, 0.6		
Comparison group	121	**2.1**	1.8, 2.3	**1.9**	1.7, 2.1	**-0.1**	-0.5, 0.2	0.05	0.2
Vegetables									
Teacher-led	142	**2.5**	2.2,2.7	**2.4**	2.2, 2.6	**-0.1**	-0.3, 0.2		
Comparison group	221	**2.0**	1.8, 2.2	**2.5**	2.2, 2.9	**0.5**	0.2, 0.9	0.005	0.02

[a]only includes children who completed this question at both time points
[b]used independent t-test to test difference between interventions of mean change between baseline and follow-up
[c]used multilevel mixed regression to test difference between interventions of mean change between baseline and follow-up adjusting for gender, ethnicity, and IMDS

Using multilevel mixed effects regression analysis there was no significant evidence for any of the gardening groups of an association between the change in fruit or vegetables, and growing fruit and vegetables at home or tasting from and vegetables grown at home. This analysis is presented in Table 7.8 with the unadjusted and adjusted models.

Table 7.8 Mean change in children's fruit and vegetable intake and effect of growing fruit and vegetable

		Unadjusted		Adjusted		
Do you grow your own fruit and vegetavles?	**N**	**Mean**	**95%CI**	**Mean**	**95% CI**	**P-value**
Trial 1	608	**20**	-20, 61	**21**	-10, 74	0.1
Trial 2	881	**2**	-40, 34	**3**	-34, 41	0.8
Have you tasted the fruit and vegetables you have grown?						
Trial 1	608	**-3**	-44, 37	**13**	-30, 57	0.7
Trial 2	881	**22**	-8, 71	**22**	-8, 71	0.1

7.5 Discussion

The results from the two RCT trials provide very limited evidence that gardening interventions in schools increase children's knowledge, awareness or attitudes towards eating fruit and vegetables.

7.5.1 Knowledge

For Trial 1 the RHS-led gardening group was associated with an increase in the total number of vegetables recognised, however, this difference was not significant after adjustment for baseline measurement. On average, children allocated to the RHS-led group were likely to be able to identify significantly more vegetables after the intervention than the Teacher-led group; however this may be explained by the fact that there was significantly more scope for improvement from baseline in the RHS-led intervention group. Furthermore, there were no significant increases in the ability to identify individual vegetables. Moreover, the increase in total vegetable recognition was not associated with an increase in vegetable intake.

Whilst, for Trial 2 there were a few significant increases that remained after adjustment for socio-demographic variables in the Teacher-led school gardening intervention compared to the comparison group which did not receive any assistance or support with gardening activities in school. The Teacher-led children were more likely to have an increased awareness of the 5-A-Day recommendations to stay healthy; were more likely to recognise nectarines (though no other fruit and vegetables); and to report a decrease in own-grown fruit compared to the comparison group. Additionally, there was no evidence in any of the gardening intervention groups that on average an increase in the number of fruit and vegetables recognised was associated with an actual increase in consumption of fruit and vegetables.

Contrary to the results of the current trials, previous US and Australian studies which tested for the identification of individual vegetables found significant increases in the ability to identify them in the gardening interventions compared to controls, after taking into account pre-test scores (Morgan et al., 2010, Parmer et al., 2009, Ratcliffe et al., 2011). However compared to the current two trials, these studies used real vegetables and tested only a small number (five to six items) as opposed to the photos of 16 vegetables used in this study. Furthermore, studies that identified successful change in children's nutrition knowledge combined health, science or nutrition education alongside the gardening component of their intervention studies, whereas the RHS-led and Teacher-led interventions focussed solely on gardening education. This might explain the lack of significant findings in these trials. There were two previous studies that also found no significant change in children's knowledge after

implementing a gardening intervention, however, one did not include a control group and was a relatively small study consisting of 56 children (Koch et al., 2006) and Morris et al., (2001) which was conducted on younger children than this sample (grade one). There was one previous Australian study which used a larger number of pictures of fruit and vegetables to explore children's knowledge (31 in total) and found a significant difference between pre and post identification scores, however the historical control design was a weakness of the study (Somerset and Markwell, 2008). These previous studies involved only 320 or fewer children from one or two schools, compared to the 1867 children who took part from 52 schools in the pre and post fruit and vegetable identification test in the current two studies. The majority of previous studies also involved older children, though they would have been more likely to have produced a knowledge ceiling effect than the eight year olds in the current two studies.

Despite there being a greater increase in awareness of 5-A-Day in the Teacher-led gardening intervention group compared to the comparison group, there were no significant differences in awareness by these children that eating fruit and vegetables kept them healthy. Other previous gardening intervention studies did not report awareness of 5-A-Day separately, although this question was included in the 'Health and Nutrition from the garden' questionnaire (Genzer et al., 2001) developed for children by Genzer et al. (2001) used in some of the existing studies (Koch et al., 2006, O'Brien and Shoemaker, 2006, Poston et al., 2005). Somerset and Markwell (2009) also found no evidence that gardening interventions were associated with children being aware that eating fruit and vegetables kept them healthy.

7.5.2 Attitudes towards fruit and vegetables

Those in the RHS-led group appeared less willing to try to eat lots of fruit or to try new fruits than the Teacher-led gardening group, even after adjusting for baseline responses. Likewise, Somerset and Markwell (2009) and O'Brien and Shoemaker (2006) reported a perceived barrier to eating fruit and vegetables, with Somerset and Markwell (2009) finding that the gardening intervention group did not like trying new fruits compared to controls. In Trial 2, children in the gardening intervention group were more likely to agree they enjoyed eating vegetables at follow-up compared to the control group; however, this difference was not significant after adjusting for baseline measurements, gender, ethnicity or IMDS. It is possible the additional exposure to gardening in the RHS-led intervention may make the children more certain of their dislikes; as additional gardening exposure may produce greater contemplation of fruit and vegetables (Somerset and Markwell, 2009).

In other studies different approaches have been used to measure trying new fruit and vegetables. In taste tests, gardening interventions were associated with an increased willingness to taste a small number of fruit and vegetables in kindergarten or first graders (Cason, 1999, Morris et al., 2001), in some studies, but not in older children (Morris and Zidenberg-Cherr, 2002, Ratcliffe et al., 2011), though gardening was associated with an increased taste rating in older children in other studies (Morgan et al., 2010, Parmer et al., 2009). Questionnaire assessment of preference/willingness to taste a larger list of fruit and vegetables showed gardening interventions were associated with a preference for vegetables in some studies (Lineberger, 2000, Ratcliffe et al., 2011), Davis, 2011, Gatto, 2012), but not associated with fruit and vegetables preferences in other studies (Koch et al., 2006, Poston et al., 2005, Morris et al., 2001).

In both the current trials there was no evidence of differences before or after adjustment for baseline answers in self-efficacy, specifically in the perceived ability to prepare fruit and vegetables. Somerset and Markwell (2009) reported older grade 6 children were less confident in the intervention group than controls, but there were no significant differences between intervention groups in younger children (Somerset and Markwell, 2008). The current research provides very limited evidence that gardening interventions in schools increase factors which may mediate behaviour change in consumption of fruit and vegetables based on the principles of social cognition theory.

7.5.3 Limitations and strengths

There are some limitations. Despite randomisation of a large number of London schools there were some significant differences between intervention groups, not only relating to baseline recognition and intake of fruit and vegetables. A large number of children from schools with children who spoke English as a second language could have resulted in many children misunderstanding how to complete the questionnaires and could be a limitation of the study. A large percentage of the children in the study (~30%) did not attempt the Child questionnaire at both time points, therefore the results are potentially subject to response bias, i.e. bias relating to self-selection. Finally, it is possible that some of the inconsistencies in the results are spurious in nature and are due to multiple testing.

Another limitation of measuring children's knowledge is that naturally, children do guess if they don't know the right answer. There are very few validated tools to explore nutrition knowledge in children. A design fault of the current knowledge questionnaire was that it did not provide the children with the option of "don't know", this might have reduced the

percentage of children guessing, and improved the questionnaire's ability to accurately measure knowledge.

Compared to previous studies, strengths of this study include the large sample size and the use of schools as a random effect variable in multilevel models, and the randomisation of schools to the different interventions or comparison group. It has greater methodological strengths than the two studies on which some of the questions relating to attitudes, self-efficacy and home environment were based on (Newell et al., 2004, Somerset and Markwell, 2008); and adjustment was made for baseline responses and current controls rather than historical controls which were used, unlike the study by Somerset and Markwell (2009). (Somerset and Markwell, 2008) (Somerset and Markwell, 2008) (Somerset and Markwell, 2008) (Somerset and Markwell, 2008) (Somerset and Markwell, 2008) (Somerset and Markwell, 2008) Most previous studies had follow-up periods which were less than a year, some being 16 weeks or less (Morgan et al., 2010, O'Brien and Shoemaker, 2006), whereas the follow-up period in this trial included two growing seasons and was 18 months.

7.5.4 Conclusion

In conclusion, compared to schools that do not garden with their children, some gardening activities in schools may increase some aspects of pupil's awareness and willingness to grow and eat fruit and vegetables. Inconsistencies found suggest that more research should be done in this area in UK schools. One of the fundamental differences in gardening interventions that have shown a change in children's knowledge are that the interventions used contained a nutritional component combined with gardening. This would suggest that to improve children's knowledge in fruit and vegetables, gardening alone is not enough.

7.6 Chapter Summary

Chapter 7 has explored whether participating in the RHS-led or the Teacher-led school gardening interventions improved or affected children's knowledge and or attitudes towards fruit and vegetables. The results revealed very little evidence to support previous research that school gardening can improve children's knowledge and attitudes towards fruit and vegetables. Further analysis on the components involved in the intervention will be discussed in the next chapter. The results from these two trials indicate that the RHS-led gardening intervention in schools do not provide extra benefits over the Teacher-led intervention.

Chapter 8 - Process Evaluation of a Randomised Controlled Trial of a School Gardening Intervention and Children's Fruit and Vegetable Intake

This thesis has so far discussed the effects of the gardening intervention on children's dietary intake as well as and their knowledge and attitudes. This chapter will discuss the process evaluation undertaken in the two trials, to explore the adherence to the different interventions (RHS-led and Teacher-led) and identify how the different types of interventions implemented affected the primary outcome children's fruit and vegetable intake. This chapter captures gardening activity across all schools, including the control schools involvement in school gardens. With the nature of this type of intervention, schools will naturally tailor the intervention to their school's needs. Therefore they were pragmatic trials exploring whether the intervention worked in real-life conditions. By monitoring what activities are undertaken in school gardening, it is possible to explore if the implementation level of intervention was associated with dietary change in children's fruit and vegetables intake.

8.1 Methodology

8.1.1 School Gardening Level Interview

To identify the level of implementation and involvement of the schools in the RHS intervention (dose and intensity), as well as identify if the control schools changed their level of involvement the Gardening telephone questionnaire was designed. The school gardening level is a measurement developed by the RHS to evaluate each school's involvement in gardening, based on the following scale (Royal Horticultural Society, 2010).

- Zero : No garden
- Level 1 Planning
- Level 2 Getting Started
- Level 3 Growing and Diversifying
- Level 4 Sharing Best Practice
- Level 5 Celebrating with the Wider Community

To move from one level to the next the school needs to demonstrate more involvement in school gardening, in terms of development, teaching and interacting with the wider community. At baseline each school completed a telephone interview to assess their

gardening level. The interview is broken down into five sections, to identify which level each school was at based on the RHS scale. The questions were focused on the following aspects of gardening in schools: school culture and ethos, the school garden, teaching and learning, and community. Within each of these areas there were several questions that reflect different levels of development within school gardening that relate to the five categories, describing the different stages of developing a school garden. This interview was completed again at follow-up to assess change in gardening (please see appendix page 228).

8.1.2 Gardening process measures questionnaires

The main aim of the process evaluation was to capture details about the gardening activity within each school. Identifying which fruit and vegetables each school grows and harvests. A gardening process measure questionnaire was designed by MSC to identify the different gardening activities which were occurring in each school and which year groups were involved. This information was captured via email in September 2010 for both trials and again at follow-up via email in December 2011. The process measure questions are presented in Figure 8.1. Both trials received the same email.

Figure 8.1 Process Measures Email

Dear Schools,

Thank you so much for participating in the Evaluation of the RHS Campaign for School Gardening. We now have just seven questions we would like you to answer about gardening activities at your school that have occurred in the past year.

1) Do you have a school garden, if yes please describe (e.g. garden at the school, a few pots for growing plants in or an allotment)?
2) Which year groups are involved in gardening at your school?
3) Do you have a growing club or environmental club? If yes, which year groups are involved?
4) What fruit and vegetables has your school grown/tried to grow this summer?
5) What did you harvest?
6) What were your success/failure stories in the school garden this summer?

It is vital for the study that we collect information about your school garden, and if you need any help feel free to contact myself on the number below.

The information from this questionnaire was then collapsed into suitable variables to be used for analysis. Question 1, was broken into two variables. The variable of the question, “do you have a school garden” was coded yes or no. The second variable gardening type was coded;

- 0= Small: pots only
- 1= Medium: 1-2 raised beds
- 2= Large: More than 2 raised beds or school garden or an allotment near the school

Question 2a, how many year groups are involved in the school garden was coded:

- 0= Key stage one
- 1= Key stage two
- 2= All year groups

Question 2b was created to confirm if the year groups involved in the study were involved in school gardening. This question was coded yes or no.

Question 3a, was broken into two variables. Variable one, do you have a growing club or environmental club was coded Yes or No. Variable two, gardening clubs, was coded into 3 groups using the same method as question 2;

- 0= Key stage one
- 1= Key stage two
- 2= All year groups

Question 4 was broken down into two continuous variables;

- frequency of different types of fruit grown - continuous
- frequency of different types of vegetables grown - continuous

Then the following variables were created, as they consisted of the most commonly grown fruit and vegetables: tomatoes, lettuces, carrots, beans, corn, strawberries, apples and cucumbers.

Question 5, frequency of successfully harvest vegetables and fruit was coded;

- None
- Some
- All fruit and vegetables grown, were harvested

8.1.3 Attendance of Twilight sessions

The RHS regional advisor ran all of the Twilight session, which were hosted at schools which received the RHS-led intervention, for the Teacher-led intervention to attend. The RHS also provided Leeds University with information on the level of involvement in the twilight sessions from the Teacher-led schools and the RHS-led schools.

8.2 Statistical analysis

Statistical analysis was performed using Stata IC version 11 (StataCorp, 2005). Means and percentages for the process measures questions and general descriptive variables on the intervention implementation were generated.

8.2.1 School gardening level

The analysis was performed using clustered multilevel regression models with total fruit and vegetables as the primary outcome. The multilevel regression model was used to explore the difference in mean change of fruit and vegetable intake. These models were first conducted unadjusted, and then adjusted for age, gender, ethnicity and IMDS. The output generated for the primary analysis was effect size, standard error, 95 percent confidence internals and p-values, with a p-value of less than 0.05 taken to represent statistical significance for all of the analysis.

8.3 Results

8.3.1 RHS-led School Intervention Gardening Summary

The RHS-led Schools all had major changes to their garden space over the course of the intervention. Below is a descriptive summary of these changes by region. This information was provided by the RHS regional advisor.

Table 8.1 Description of the RHS school gardens at baseline and follow-up

School	Baseline	Follow-up
Greenwich		
1	There two main areas: allotment garden (derelict). This is a fairly large area currently set to grass at one end and also covered with landscape fabric and gravel. There are a few raised beds, and the last third of the area is blocked off by a solid wooden fence which is due to come down upon the completion of an adjacent building project. There is a large Acer at both ends, with the one nearest the entrance providing shade for the grassed area. As well as a sensory garden. This is in a courtyard area surrounded on three sides by high walls. It is in deep shade, and some thought should be taken as to planting	Now has raised beds (Two groups of five RHS Wisley staff undertook teambuilding days at the school and built 16 small raised beds and two large raised beds in a new garden area).
2	No specific 'garden' but there are planters/raised beds where growing is being carried out.	Now have a fairly large school garden consisting of raised beds and a green house. Bannockburn took part in the Hampton Court Flower Show's Scarecrow competition, celebrating characters from Lewis Carroll's famous books 'Alice's Adventures in Wonderland' and 'Through the Looking Glass'. Their 'Mr Caterpillar' gained a very respectable third prize in a field of more than 20 schools.
Tower Hamlets		
3	The school currently has a wildlife and vegetable garden complete with pond. This area is due to be demolished to create new classrooms for this expanding school.	A willow tunnel has been created. A new garden was being built over the 2011 summer holidays.
4	Various 'areas':- An excellent wildlife garden. A thriving raised pond, a spider's web design wild flower meadow, plum tree, climbers, outdoor classroom. KS2 Years 3,4,5 & 6 have their own large planter in the playground. KS1 have four large planters. There are 8 1meter long beds. These are used by Mums to grow stuff for the local co-op.	Already had growing areas, but now have a shed and greenhouse yet to be erected. A Muslim Mums Group has taken part in two informal Twilight sessions including seed sowing and pricking out seedlings.
5	There is currently no gardening.	Now have 5 raised beds for growing
Sutton		
6	A compact garden consisting of attractive gravel paths, four large raised beds, and a fenced off pond (including a small deck). There are other planters and beds around the school grounds, including some small planters in the Early Years playground planted up with herbs.	In addition to their raised beds, now has a greenhouse

Table 8.1 Continued. Description of the RHS school gardens at baseline and follow-up

7	There is one main Garden which has a number of beds and a thriving pond. A small newly cultivated bed in a shady area is planted up with a number of suitable plants. Due to fairly small total growing area, there is limited quantity, which affects the whole school exposure. There is currently no sheltered growing area to raise plants	Now have new beds built by parents (the school held two 'Get your Grown-ups Growing' events over the winter, when parents took part in digging, and the construction of new beds)
Wandsworth		
8	The current garden is extremely impressive, but there is little provision for the children to grow (in terms of growing beds). The delightful garden is known as the 'secret garden' and has many features: a 'Human Sundial' in the centre, a small lawn, wildlife area with properly layered hedge, trees, a bog area, various benches, and one small vegetable area (approx. 1.5mx3m). There are also some raised brick planters in the main playground, which have mainly permanent planting and herbs. These beds are rather	Now have two new growing areas. Development on the school grounds is ongoing.
9	There are a number of areas set out for growing: Main Garden comprised of 10 raised beds/planters (four of which are thin planters approx. 40cm) A polycarbonate greenhouse has been purchased and is to be build next to the Nursery garden. There are 3 raised beds in a separate courtyard area which year 1 use.	In addition to their 8 raised beds, the school now has two large growing beds built by parents (the school held a 'Get your Grown-ups Growing' event over the winter) and a greenhouse.
10	A few small raised beds in the main school garden which have been neglected somewhat. The timber is starting to break as the beds are made of a number of compost bin kits. There is no fence around the garden which allows the children to play on and in the beds. The school has acquired a large allotment plot (1min walk from the school). The aim is to turn this into a community garden, and use the produce for the school kitchens. This plot is totally overgrown at present.	In addition to developing their own thriving school garden, the School has taken responsibility for a plot of land on the adjacent housing estate. This is to be a School Community Garden. In conjunction with the Residents Association and with the support from the RHS, this area is gradually being developed. This process has been assisted by a team of five gardeners from RHS Wisley who spent a day on the site building beds and on another day a team of three gardeners who removed a large tree from the centre of the site. Additional raised beds were gifted to the garden by M & G Investments who sponsored a Chelsea show garden designed by Bunny Guinness. Twelve children from the school had the opportunity to visit the Flower Show to see the garden in situ and meet with Bunny Guinness. Regional advisor assisted with all elements of development, including the co-ordination of removal of the M&G garden from Chelsea to Battersea.

8.3.2 Twilight sessions

For Trial 1, all ten of the RHS-led schools attended at least one twilight session with a mean of 3.5 (SD 0.9) sessions. For schools which received the Teacher-led intervention only four schools out of the 12 attended any of the twilight sessions, with a mean of 1.5(SD 0.6), whereas for Trial 2 of the Teacher-led schools only two schools attended any twilight sessions with a mean of 1 (SD 0).

8.3.3 Implementation of gardening activities in schools Trial 1

For Trial 1 at six months, four schools stated they did not have a school garden (one from the RHS-led intervention group and three from the Teacher-led intervention group). This was reduced to two schools in the Teacher-led group and none in the RHS-led group by the end of the intervention period. The number of vegetables grown at six months to follow-up increased by an average of 1.3 for the RHS-led group, while there was no change in the number of fruits grown. For the Teacher-led group, there was a decrease in number of types of fruits (0.8) and vegetables (1.7) grown from 6 months to follow-up. The percentage of schools that stated they had a large garden at 6 months was 66 percent for both groups; this increased to 77 percent for the teacher-led group and 100 percent for the RHS-led group at follow-up, showing an improvement in land allocated to school gardening. There was however, a decrease in the number of year groups involved in school gardening in both groups. For the teacher-led schools this was a decrease of six percent, from 66 to 60; whereas the RHS-led schools decreased five percent from 75 to 70 at follow-up. Schools were also asked to comment on how successful their fruit and vegetable harvest were. These results show a decrease in success rate for the RHS-led schools from 50 percent stating they harvested all the fruit and vegetables they grow, to only 20 percent. However, the teacher-led group had an increase from 57 percent to 100 percent in successfully harvesting fruit and vegetables. This might explain in part why the Teacher-led group had on average high change in fruit and vegetable intake combined compared to the RHS-led group.

Table 8.2 School gardening characteristics from 6 months to follow-up for Trial 1

Trial 1 Process Measures	6 months				Follow-up			
	Teacher-led		RHS-led		Teacher-led		RHS-led	
	N	Mean (%)	N	Mean (%)	N	Mean (%)	N	Mean (%)
Do you have a school garden?								
(% no)	3	**25**	1	**10**	2	**17**	0	**0**
(% yes)	9	**75**	9	**90**	10	**83**	10	**100**
Number of different fruits grown	9	**2.2 (1.9)**	8	**1.0 (1.1)**	10	**1.3 (1.7)**	10	**1.0 (1.2)**
Number of different vegetables grown	9	**7.0 (3.8)**	8	**6.0(2.7)**	10	**5.3 (3.0)**	10	**7.3 (2.9)**
Size of garden (%)								
Small	1	**11**	1	**11**	0	**0**	0	**0**
Medium	2	**22**	2	**22**	2	**22**	0	**0**
Large	6	**66**	6	**66**	7	**77**	10	**100**
Which year groups are involved (%)								
Reception- year 2	0	**0**	1	**11**	0	**0**	1	**10**
Year 3- year 6	1	**13**	0	**0**	2	**20**	1	**10**
All	7	**87**	8	**88**	8	**80**	8	**80**
Are Y3 & Y 4 involved (% yes)	7	**78**	8	**88**	9	**100**	9	**90**
Do you have a gardening club (% yes)	6	**66**	6	**75**	6	**60**	7	**70**
Which year groups are involved in gardening club (%)								
Reception- year 2	0	**0**	0	**0**	0	**0**	0	**0**
Year 3- year 6	1	**25**	3	**50**	1	**25**	4	**66**
All	3	**75**	3	**50**	3	**75**	2	**33**
Successfully harvested fruit & vegetables (%)								
None	1	**14**	0	**0**	0	**0**	2	**20**
Some	2	**28**	4	**50**	0	**0**	6	**60**
All	4	**57**	4	**50**	9	**100**	2	**20**

8.3.4 Implementation of gardening activities in schools in Trial 2

The results from the process measures emails for Trial 2 are presented in Table 8.3. In the comparison group in Trial 2 at 6 months two schools were not involved in gardening and this increased to three schools at follow-up. Whereas, in the Teacher-led group there was no change, with two schools stating they did not have a school garden at 6 months and at follow-up. There was no change in fruit grown for the comparison group and a marginal increase from 2.15 at 6 months to 2.33 at follow-up for the teacher-led group. There was more variation in number of vegetables grown, with mean in the comparison group increasing by one from 6 months to follow-up and the teacher-led group increasing by three vegetables grown. Again, there was very little change in the comparison group for the percentage of schools that stated they had a large garden; at 6 months, 61 percent and 63 percent at follow-up. However, the Teacher-led group increased by 11 percent from 81 to 92 at follow-up. Schools were also asked to comment on which year groups were involved in gardening. There was an increase in both groups for the percentage of schools stating all children were involved in school gardening, from 69 to 72 percent in the comparison group and 53 to 76 percent in the teacher-led group. Schools were also asked to comment on how successful their fruit and vegetable harvest was. These results show no increase in success rate for the comparison schools. However, the Teacher-led group had an increase from 59 percent to 69 percent in successfully harvesting fruit and vegetables. This demonstrates quite a large amount of activity in school gardening for both the comparison group and the Teacher-led group.

Table 8.3 School gardening characteristics from 6 months to follow-up for Trial 2

Trial 2 Process Measures	6 months Comparison		Teacher-led		Follow-up Comparison		Teacher-led	
	N	Mean (%)	N	Mean (%)	N	Mean (%)	N	Mean (%)
Do you have a school garden?								
(%no)	2	**13**	2	**13**	3	**20**	2	**13**
(% yes)	13	**87**	13	**87**	12	**80**	13	**87**
Number of different fruits grown	13	**1.0 (1.6)**	13	**2.1 (2.6)**	12	**1.0 (1.3)**	12	**2.3 (2.1)**
Number of different vegetables grown	13	**4.6 (2.3)**	12	**7.0 (4.9)**	12	**5.7 (4.0)**	11	**10 (7.9)**
Size of garden (%)								
Small	0	**0**	0	**0**	3	**27**	0	**0**
Medium	5	**38**	2	**18**	1	**9**	1	**8**
Large	8	**62**	9	**82**	7	**63**	12	**92**
Which year groups are involved (%)								
Reception- year 2	0	**0**	1	**7**	2	**18**	1	**7**
Year 3- year 6	4	**30**	5	**38**	1	**9**	2	**15**
All	9	**70**	7	**54**	8	**77**	10	**77**
Are Y3 & Y 4 involved (% yes)	11	**84**	11	**84**	9	**82**	11	**87**
Do you have a gardening club (% yes)	8	**61**	11	**91**	8	**66**	12	**92**
Which year groups are involved in gardening club (%)								
Reception- year 2	0	**0**	1	**11**	1	**16**	1	**9**
Year 3- year 6	4	**57**	5	**55**	4	**68**	6	**54**
All	3	**43**	3	**34**	1	**16**	4	**37**
Successfully harvested fruit & vegetables (%)								
None	1	**9**	0	**0**	2	**18**	0	**0**
Some	4	**36**	5	**42**	3	**27**	4	**30**
All	6	**55**	4	**58**	6	**55**	9	**70**

8.3.5 School Gardening Level

Table 8.3 displays the change in school gardening level for the RHS-Led intervention and Teacher-Led intervention in Trial 1. Fifty percent of the schools at baseline only achieved a level 1 rating compared to 60% of the schools at follow-up achieving a level 3. This shows a large improvement in the quality of the garden and gardening being integrated into the curriculum. The mean gardening level at follow-up for the RHS-led group was 2.7 compared to the Teacher-led group of 1.9. There was slightly more movement between the levels for the RHS-Led group compared to the Teacher-Led group (a mean increase of 1.6 compared to 1.5). Multilevel regression analysis revealed that the difference between mean change in gardening rating for the RHS-led compared to the Teacher-led group was not significant (p=0.06).

Table 8.4 School gardening level at baseline and follow-up for Trial 1

Trial 1 Process Measures	**Baseline**				**Follow-up**			
	RHS-led		**Teacher-led**		**RHS-led**		**Teacher-led**	
	N	**Mean (SE)**	**N**	**Mean(SE)**	**N**	**Mean(SE)**	**N**	**Mean(SE)**
Gardening level	10	**1.1 (0.7)**	12	**1.4 (1.3)**	10	**2.7 (1.1)**	12	**1.9 (1.4)**
0 (%)	2	**20**	2	**17**	0	-	2	**17**
1	5	**50**	7	**59**	2	**20**	3	**25**
2	3	**30**	1	**8**	1	**10**	3	**25**
3	0	-	1	**8**	6	**60**	3	**25**
4	0	-	0	**0**	0	-	0	-
5	0	-	1	**8**	1	**10**	1	**8**

For Trial 2 there was less movement between the gardening levels from baseline to follow-up. Whilst there was some change for both the Teacher-led group and the control group, multilevel regression analysis revealed that the difference between mean change in gardening rating for the RHS-led compared to the Teacher-led group was not significant (p=0.7).

Table 8.5 School gardening level at baseline and follow for Trial 2

Trial 2 Process Measures	**Baseline**				**Follow-up**			
	Comparison group		**Teacher-led**		**Comparison**		**Teacher-led**	
	N	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**
Gardening level	15	**1.3 (1.6)**	15	**1 (1.2)**	15	**1.8 (1.7)**	15	**1.8 (1.2)**
0	6	**40**	5	**32**	3	**20**	2	**14**
1	5	**32**	7	**47**	6	**40**	4	**25**
2	2	**14**	2	**14**	1	**6**	6	**40**
3	2	**14**	1	**7**	2	**14**	2	**14**
4	0	**-**	0	**-**	1	**6**	0	**0**
5	0	**-**	0	**-**	2	**14**	1	**7**

8.3.6 Multi-level analysis

To explore if change in gardening level from baseline to follow-up was associated with the primary outcome - combined fruit and vegetable analysis, multilevel analysis was conducted using change in garden level score from follow-up minus baseline. These results are presented for Trial 1 in Table 8.6 and for Trial 2 in Table 8.7. The reference category in this model was no change - meaning the schools did not change or improve in gardening level from baseline to follow-up. The effects on children's fruit and vegetable intake after a change in one, two or three levels of gardening was compared to no change in gardening level. The results for all schools in Trial 1 show that there was an increase in fruit and vegetable intake in combined fruit and vegetables when schools improved by two levels or more. Increase by one level showed little or no change in children's fruit and vegetable intake, whilst increasing two levels when compared to no change improved children's fruit and vegetable intake by 37 g after adjusting for index of multiple deprivations, ethnicity and gender. Change however was only significant when schools improved by three levels of the RHS gardening score; children from these schools had on average an increase of 81 g of fruit and vegetables.

Table 8.6 Trial 1 mean change in fruit and vegetable intake and change in gardening level

	Unadjusted				**Adjusted[a]**			
Change in gardening level	**School (pupil) N**	**Mean**	**SE**	**p-value**	**Mean**	**SE**	**95% CI**	**p-value**
No change (reference category)	8 (312)	**1**			**1**			
Improved by 1 level	4 (132)	**-4**	26.3	0.8	**-5**	26.9	-58, 46	0.8
Improved by 2 levels	7 (148)	**30**	28.9	0.2	**37**	29.4	-19, 96	0.1
Improved by 3 levels	2 (49)	**68**	41.8	0.1	**81**	42.0	0, 163	0.05

[a]Adjusted for IMD Score, age, ethnicity and gender

However, this trend was not evident in Trial 2. For change in one or two gardening levels there was a negative relationship between gardening level and children's fruit and vegetable intake. Again, when schools improved by three gardening levels on average children consumed 44 g more combined fruit and vegetables than children whose schools had no change in gardening level. However these differences were not significant. Overall the distribution for Trial 2 in change in gardening level was less than the schools in Trial 1. Whilst Trial 1 had a large proportion of schools improving by one or two gardening levels at follow-up from baseline, Trial 2 had a large proportion of schools improving by one level, with only a few schools improving by two or three gardening ratings. This is to be expected since in Trial 1 all schools

received an intervention compared to Trial 2 where some of the schools received no intervention.

Table 8.7 Trial 2 mean change in fruit and vegetable intake and change in gardening level

Change in gardening level	Unadjusted				Adjusted[a]			
	School (pupil) N	Mean	SE	p-value	Mean	SE	95% CI	p-value
No change (reference category)	13 (416)	**1**			**1**			
Improved by 1 level	11 (360)	**-24**	33.6	0.4	**-30**	34.3	-98, 36	0.3
Improved by 2 levels	2 (72)	**-112**	59.0	0.06	**-111**	60.9	-230, 8	0.06
Improved by 3 levels	3 (65)	**55**	58.6	0.3	**44**	61.1	-74, 164	0.4

[a]Adjusted for IMD Score, age, ethnicity and gender

8.4 Discussion

This chapter has explored the process evaluation undertaken in the two trials, to identify adherence to the different interventions (RHS-led and Teacher-led) and identify how the different types of interventions implemented affected the primary outcome, children's fruit and vegetable intake. The description of the ten RHS-led intervention schools gardens demonstrates a high level of involvement in the construction of gardening within these schools. This was observed in the change in school garden level scores for these schools and the attendance rate for twilight sessions of 3.5. Whereas for the Teacher-led schools in Trial 1, only 4 out of the 12 schools attended any of the twilight sessions on offer to them, which might explain the lack of movement between the gardening levels. For Trial 2 again, there was only a small amount of movement between the gardening levels for both the comparison group and the Teacher-led group. Nevertheless, for all conditions groups there were schools attempting to improve their gardening levels. For trial 1, 13 schools improved their gardening level and for Trial 2, 16 schools improved their school gardening level by one level or more. This relationship with involvement in schools gardening for Trial 1 was associated with a significant change in children's fruit and vegetable intake. With schools that improved by 3 levels children on average consumed 68 grams more fruit and vegetables than schools with no change in school gardening. Whereas, for Trial 2, whilst there was an increase in fruit and vegetable consumption when schools improved by 3 levels in school gardening, this difference was not significant.

8.4.1 Theory behind school gardening

The main themes for implementing gardening in schools is to improve educational knowledge of the environment, nutrition, psychosocial and physical effects (Hackman, 1990, Armstrong, 2001, Faber et al., 2002, Morris et al., 2002, Somerset, 2005). Having a lack of access to fruit and vegetables is considered one of the main barriers to consumption. Therefore, increasing children's access to fruit and vegetables has been shown to increase consumption (Blair, 2009). The school garden is considered an innovative way of teaching nutrition and health education; an alternative to classroom teaching that is hands-on and engages the children's attention (Knai et al., 2006). Whilst school gardening might be beneficial in educating children about fruit and vegetables, the results from this study suggest that a highly productive level of involvement needs to be undertaken to show any effect on children's consumption levels.

8.4.2 Intervention design, elements and geographic location

Only five other studies measure the relationship between children's fruit and vegetable intake and a gardening intervention (McAleese & Rankin, 2007; Parmer et al., 2009; Lautenschlager & Smith, 2007; Wang, 2009; & Morgan et al., 2010). The interventions used in these studies ranged in length from 10 weeks to 2 years. Very little of the development of the gardens is described in these trials, however, in McAlessse and Rankin (2007) the school garden was described as being 7.6 meters square.

The fundamental aim of the RHS interventions was to introduce children to the basic gardening skills such as planting, watering, weeding, and harvesting. However, the five successful gardening interventions all involved additional elements in other settings as well as the gardening activities. Three interventions included cooking (Lautenschlager & Smith., 2007; Wang, 2009; & Morgan et al., 2010); two interventions included nutrition education (McAleese & Rakin, 2007; Parmer et al., 2009) and one intervention included parental newsletters and homework tasks. Whereas, for both the RHS-led and the Teacher-led interventions, it was only implemented into additional curriculum lessons at the school's desire. The primary focus of the RHS activity is to educate children in gardening. Including nutritional education or cooking with gardening might be required to achieve a positive change in children's fruit and vegetable consumption. One of the additional classes for the students was an "add a veggie to lunch day" (McAleese & Rakin., 2007). These type of activities have shown positive results in improving children's fruit and vegetable consumption (Knai et al., 2006). It should also be noted that all of these successful gardening interventions have been implemented in countries with warmer climates than England - California, Minnesota, Alabama and Florida in America and Newcastle in Australia.

The interventions for this study were either run by the RHS regional advisor or teachers within each school. Of the five successful interventions in prior trials, three of them also used teachers to implement their intervention (Wang, 2009, & Morgan et al., 2010, Parmer et al., 2009). If the classroom teacher is passionate about gardening, then this could assist with successful implementation of the intervention (Royal Horticultural Society, 2010). However, in McAleese and Rankin et al., 2007 and Parmer et al., 2009 the teachers not only taught the intervention they were also trained to complete the 24-hour food-recall workbooks for this study. Having the same people teach the intervention and collect the data could introduce bias into the results, as the teachers could have been motivated to demonstrate how well they have tried to implement the intervention. Only one study (Lautenschlager and Smith, 2007) had an external company similar to the RHS, the Youth Farmers and Market Project, implement their intervention and therefore reduce the risk of bias.

8.4.3 Barriers to implementing a school garden

From the literature search it was evident that there are some barriers to implementing a school garden programme. School gardens require long term commitment from the schools, and often need community assistance from parents if they are to be sustained (Ozer, 2005). Another issue found was that some schools took too long to establish the school garden, affecting the period of time in the studies for plants to germinate and grow edible fruit or vegetables. Also environmental factors will play an important role in the amount of food harvested. Schools are closed over summer which is the peak harvesting season; without organising staff to water the garden and general garden maintenance the hard work during term time can be lost. With regard to the RHS school gardening levels having grounds' staff, caretaker or school grounds maintenance contractor involved in the maintenance of the garden was only required for schools from level 3 onwards. The length of time spent in the interventions could also affect the chances of long term change in children's fruit and vegetable intake with more sustained and intense intervention programmes more likely to have an impact on behaviour.

8.4.4 Limitations and Strengths

There were limitations to the present study. The issues with the methodology of assessing dietary intake have been stated in previous chapters. Validity and reliability of the process measures questionnaires have not been tested; however, this is a common weakness with health interventions, as limited resources are allocated to process evaluations. Another limitation is that the study is subject to the well-established statistical problems of multiple comparisons or testing (Miller, 1981). This study was powered to analyse the main trial

outcome, i.e. change in fruit and vegetable intake between children in the different treatment groups, and as a consequence it may not be adequately powered for the analysis undertaken in this process measures analysis from the intervention group alone.

The main strengths of the present study are it explores the process measures using measures undertaken at different time points, baseline, six months and final follow-up. This has assisted in identifying change in gardening practices in not only the intervention schools, but also the comparison schools. Few studies explore in detail the implementation of the intervention.

8.4.5 Conclusion

The results from this chapter have demonstrated that whilst there was no significant difference in the primary outcome of these trials, when gardening in schools is implemented at a high level, it can have a positive association on children's fruit and vegetable intake. Previously successful gardening interventions indicate future research needs to explore the involvement of additional activities to improve children's consumption levels. This could be through the inclusion of nutritional education or cooking lessons. Parental involvement and parental consumption levels has always been considered pivotal, and should be incorporated into intervention designs.

When an intervention is run by teachers it will naturally be tailored to meet their school's needs. Nevertheless, the limitations of gardening interventions need to be acknowledged. Whilst gardening interventions might be able to assist in small improvements in children's knowledge of the environment, nutrition, psychosocial and physical effects (Hackman, 1990, Armstrong, 2001, Faber et al., 2002, Morris et al., 2002, Somerset, 2005), additional intervention activities need to be integrated to produce lasting change on fruit and vegetable consumption.

8.5 Chapter Summary

In this chapter the process evaluation undertaken in the two trials has been discussed. It has described the adherence to the different interventions (RHS-led and Teacher-led) and has revealed that for Trial 1 if schools made substantial changes to their gardening level score from baseline to follow-up it could produce a positive effect on children's fruit and vegetable intake. Nevertheless, in relation to intervention design as discussed in this chapter, future research into school gardening should implement additional elements alongside gardening education, as the results from the current trials indicate gardening on its own has very little impact on children's fruit and vegetable intake.

Chapter 9 - Summary discussion and recommendations for future research

9.1 Summary Discussion

The interest in school gardening literature has grown over the past years, with several studies stating that school gardening can provide children with a positive learning environment to help them improve their awareness and understanding of food, where it comes from and possibly increasing children's willingness to consume fruit and vegetables. However, the evidence based research supporting these claims is based on research evaluating short term interventions using small sample sizes. Despite the lack of funding, gardening in schools has increased in popularity with gardening being added to the UK curricula for children in key stage 1-3 from September 2014. The current two trials have found very little evidence to support the claims that school gardening can improve children's fruit and vegetable intake (Chapter 6). A high level of gardening needs to be undertaken to produce a change in intake (Chapter 8). The RHS states that unless a head teacher is supportive of school gardening, despite their best efforts to improve children's knowledge and attitudes, the positive efforts will produce little or no results. When a head teacher does fully support their gardening activities, it is more likely to be successfully integrated into all school activities. School and community gardens do provide other benefits even if they do not improve children's fruit and vegetable intake, with academic literature stating they can improve psychological and social wellbeing in children (Hackman, 1990). Whilst these were not explored in the current thesis, it does demonstrate that despite our findings relating to impact on diet, school gardens can be a useful educational tool.

In regards to improving children's knowledge and attitudes towards fruit and vegetables after participating in a school gardening intervention, these two trials provide limited evidence to support this (Chapter 7). For Trial 1 the RHS-led gardening group was associated with an increase in the total number of vegetables recognised, however, this difference was not significant after adjustment for baseline measurement and possible confounders. A limitation of researching children's knowledge of fruit and vegetables, or any other healthy nutrition education is that there are very few validated tools (Bere and Bjorkelund, 2009). More pilot research needs to be conducted to determine the reliability and validity of children's knowledge questionnaires, one of the fundamental components of the Social Cognition Theory (Morris, 2000).

The process evaluations have provided some evidence to support previous research that school gardening can improve children's fruit and vegetable intake (Chapter 8). The results from this chapter has demonstrated that whilst there was no significant difference in the primary outcome of these trials, when gardening in schools is implemented at a high level, it can have a positive association on children's fruit and vegetable intake. Previously successful gardening interventions suggest that future research needs to explore involving additional activities to improve children's consumption levels (Parmer et al., 2009, Morgan et al., 2010). This could be through including nutritional education or cooking lessons. Parental involvement and own consumption levels has always been considered pivotal, and should be incorporated into intervention designs. The RHS state that for a school garden to be successfully established there are certain elements that are required. The scheme must be supported in full by the head teacher. It is not suggesting they need to be involving in the garden themselves; however each school needs to identify how gardening will fit into the school day through including gardening in the School Development Plan. Such as insuring gardening is included across the curriculum, involvement of parents, and identify methods of linking in the community, such as through visiting a local allotment, and providing staff with the training necessary to be confident to teacher gardening. Other examples are setting up a garden committee, as this will take the pressure of one school teacher to maintain the garden, and help develop on-going projects e.g. gardening clubs. Attempts need to be made to link in school gardening with the school catering company and or staff. So that any produce grown can be included in school dinners, to help encourage children to taste what they have grown and be proud of their achievement. In addition schools should attempt to use the produce from in the gardening in cooking lessons with the children, to help children learn how to prepare the food themselves (Royal Horticultural Society, 2010).

In additional to the RHS school gardening program run in this study, the RHS is currently developing new resources for teachers to use in the classroom with gardening related themes, such as grown your own food for your lunchbox. The fundamental principles behind these developments are to teach gardening in the curriculum to help children develop a "lifelong love of gardening, growing and their environment." It is should be noted that improving children's fruit and vegetables is not one of the primary aims, nevertheless, the RHS hopes that educating children in gardening will in turn lead to then having an understanding of what they eat and where in comes from. Whilst gardening interventions might be able to assist in small improvements in children's knowledge of the environment, nutrition, psychosocial and physical effects (Hackman, 1990, Armstrong, 2001, Faber et al., 2002, Morris et al., 2002,

Somerset, 2005), additional intervention activities need to be integrated to produce lasting change on fruit and vegetable consumption.

The importance in involvement of parents to help facilitate change in their children's fruit and vegetable intake was illustrated in Chapter 5 (Christian et al., 2012). From exploring the nutrient information collected at baseline, this thesis had identified positive public health messages for parents, which not only could improve their own dietary habits, but also their children's. This is the first large survey of London children to explore this association. It found that eating a family meal together at a table had the largest association on children's fruit and vegetable intake. Children in families who stated they ate together every day had 1 ½ more portions of fruit and vegetables daily than families who reported never eating together at a table, after adjusting for possible confounders. It also found that sometimes eating at a table together increased children's fruit and vegetable consumption by more than a portion. The importance of the family meal is supported by previous research in preschool children (Gibson et al., 1998) and primary school children (Rockett, 2007, Cullen et al., 2001, Christian MS, 2011). This thesis also found support that parental intake is strongly associated with children's intake (Wind et al., 2008, Blanchette and Brug, 2005). The more frequently parents stated they consumed fruit and vegetables was associated with higher consumption in their children.

Another key finding from Chapter 6 was that this thesis reports the first study in the UK to identify that cutting up fruit and vegetables facilitates primary school aged children's intake (Christian et al., 2012). If children have access to prepared fruit and vegetables at home, they are more likely to eat them. Research has been conducted in older children supporting this finding (Cullen, 2000, Wind et al., 2006). Future interventions could be tailored towards improving parental intake of fruit and vegetables, to facilitate their children's intake.

From the literature search it was evident that there are some barriers to implementing a school garden programme. School gardens require long term commitment to establish a successful garden (Ozer, 2005). It is important to have a supportive team involved in school garden to help maintain the garden over the summer months when the schools are closed. The length and time spent in the interventions will also affect the chances of long term change in children's fruit and vegetable intake. It is unlikely to affect children's consumption patterns if their involvement in the actual intervention is limited.

The dietary assessment measurement used for these trials was a 24-hour recall tick list. The strength of the CADET diary is that it uses age and gender specific food portion sizes to

calculate food and nutrient intake. This work was described in detail in Chapter 2. The results from Chapter 3 demonstrated that the CADET diary was a suitable tool to measure children's diets in the age group of these two trials. The methodology used to administer the CADET Diaries in schools was also changed for the two trials to help improve completeness of the data collected. Children's intake at school was recorded in the CADET tool by trained fieldworkers and intake at home was recorded by parents/carers. An instructional DVD was sent home for parents to watch, to help them understand how to complete the CADET diary. Also, after the School Food Diary collection day, the field worker returned to the schools to collect and check the Diaries with all the children, and if necessary conduct a retrospective recall. A one-day tick list is an economically effective way of gathering nutrient information from children, however, may not reflect true nutrient intake in the longer term. The CADET diary does avoid the issues with child self-reported food intake, and is less of a burden on the participants than the most commonly used alternative, a weighed 4 day food diary (Hachett et al., 2002). Further improvements to the CADET diary could be implemented to reduce portion sizes error for melon and watermelon, which had significant differences between the mean intakes of the two diary methods.

For all analysis in this thesis the results were conducted using a robust statistical methodology - multilevel analysis (Chapter 6-8). The benefit of this technique is that the means and confidence intervals for the different foods and nutrients will be more accurate, as the children's food consumption within a school is more similar to each other, with less variability within the sample compared to a random sample from the whole population (Rasbash et al., 2004, Aiken and West, 1991). This level of analysis is rarely applied to the secondary outcomes such as children's knowledge and the process measures questionnaires.

9.2 Recommendations for future research and policy impact

Despite the lack of evidence of a quantitative impact of school gardening on children's intake, the literature often describes positive attributes of school gardening identified through qualitative methods. When a school garden is successfully integrated into the school environment, it can provide a link between the community and the school. Beyond investigating school gardening initiatives, to increase children's fruit and vegetable intakes, research needs to focus on intervention designs that tackle individual intake, family intake, school environment and communities (Ozer, 2006). The RHS believe that school gardening can provide vital links to members of the community who otherwise have little involvement with their child's education, but was not assessed in this study (Morrison, 2013). This is supported in academic literature (Block et al., 2012, Somerset, 2009).

Successful fruit and vegetables interventions tended to only have a small impact on children's fruit and vegetable intakes (Evans et al., 2012). School gardening interventions that have identified a change in children's diets tended to have additional components, rather than relying solely on gardening. A recent systematic review on school based interventions to improve children's inactivity and nutrition knowledge stated that for interventions to be successful the vital components were integrating the intervention into the school curriculum, parental involvement through homework activities and developing a whole school approach through influencing changes to school policy around nutrition and physical activity education (Katz, 2009, Shaya et al., 2008). Future research into school gardening should be conducted only if additional components are included such as cooking. The results from this study suggest using a holistic approach and incorporating nutrition education or cooking along with parental involvement would be more likely to achieve higher consumption levels and increase children's knowledge. The WHO and Food and Agriculture Organisation believe that school based interventions are a fundamental part of improving the population's fruit and vegetable intake (WHO, 2004). To improve children's fruit and vegetable intake schools need the support from industry and governments to improve access to fruit and vegetable in all the settings that children spend time.

In Australia a school gardening and cooking programme that has had government support to develop the required infrastructure is "The Stephanie Alexander Kitchen Garden Programme." This programme had Federal and State funding from 2008 to 2012, with the government spending 12.8 million dollars, approximately 8.7 million pounds over 650 schools to develop cooking and gardening facilities. The government has also recently invested an additional 5.4 million dollars (approximately 3.6 million pounds) on this programme (Gibbs et al., 2009). This

is the type of national investment that is needed in the UK to help educate children in the importance of fruit and vegetables and nutritional education. The design of the programme also does reflect the findings from this thesis that nutritional education should integrated into the curriculum using a combined approach e.g. gardening and cooking. It is important also that the vegetables the children grow, such a carrots are actually cut up and eaten by the children. If governments want to successfully tackle nutrition education in schools, then they need to support interventions that have identified mechanisms for increasing fruit and vegetable consumption in children, whether it be distribution programmes (providing a free piece of fruit or vegetables to children daily), nutrition education, gardening and or cooking, and provide the funding for schools to tailor these interventions to meet their school's needs, and support the development and education of the teachers within their schools. Schools, and more importantly head teachers, need to be more involved in the decision making of the types of nutrition interventions used within their school, to reflect their school environment as well as the skills and training of their teaching staff.

Future research should also be conducted to explore the effect of community gardens and children's fruit and vegetable intake. Currently, there is a need for a robust study design to ascertain the role community gardens play as an intervention tool to improve children's diets. Similar to school gardening, there are other benefits of community gardens besides focusing on fruit and vegetable consumption. Again, similar to school gardening, community gardens are seen as a positive place for bringing different sections of the community together and can have positive effects on social well-being of people involving themselves in a community garden (McCormack et al., 2010). Some community gardens have also been linked to school distribution programmes (Blair, 2009), as well other studies that have identified that community gardeners can be used as a replacement for a school gardener (Somerset et al., 2009). With the community gardeners providing support and time to help to local schools to develop children's knowledge of gardening. Schools involved in a community garden, could remove the responsibility of the schools' role in running and maintaining the garden, which might make school gardening easier to maintain.

In addition to school based intervention studies, there needs to be more focus on the home environment. The current thesis has also identified the importance of eating together as a family to improve children's fruit and vegetable intake (Christian et al., 2012). Future intervention studies need to focus on parental involvement supporting the mechanism for positive reinforcement and rewards around fruit and vegetable consumption, such as cutting up fruit and vegetables and eating fruit and vegetables together. Intervention designs need to

encourage families to try and create easy meals with different types of vegetables or highlight the importance of eating a snack such as an apple or handful or strawberries together. Demonstrating ways to incorporate fruit and vegetables into their families' food environment is essential. A recent study stated the barriers for parents are cost, family preferences and limited choice of fruit and vegetable in restaurants. More pilot studies are needed attempting to improve the family home environment to develop a suitable intervention to help assist parents overcome these issues (Kraak et al., 2013).

Furthermore, more research needs to be conducted to improve the quality of the tools used to evaluate these programmes. There are very few validated tools to explore nutrition knowledge in children - testing and developing these tools is essential to accurately measure children's understanding of healthy dietary behaviour. Another limitation of measuring children's knowledge is that naturally, children do guess if they don't know the right answer. The design of nutrition knowledge questionnaires should always provide children with the option to write *"don't know"* or *"D"* for don't know - this could reduce the percentage of children guessing, and improve the questionnaire's ability to accurately measure knowledge. Furthermore, knowledge questionnaires should be assessed for reliability, a possible method would be to use children's school assessment scores and validity, through conducting a test re-test evaluation.

9.3 Conclusion

To conclude, this thesis has looked at the results from the first cluster randomised controlled trials designed to evaluate a school gardening intervention. The primary analysis from the two trials has found very little evidence to support the claims that school gardening alone can improve children's fruit and vegetable intake. However, when a gardening intervention is implemented at the highest intensities within the schools there was a suggestion that it can improve children's fruit and vegetable intake by a portion. Improving children's fruit and vegetable intake remains a challenging task. Future intervention designs need to integrate a greater level of parental involvement and included related components such as cooking to substantially improve children's fruit and vegetable intake.

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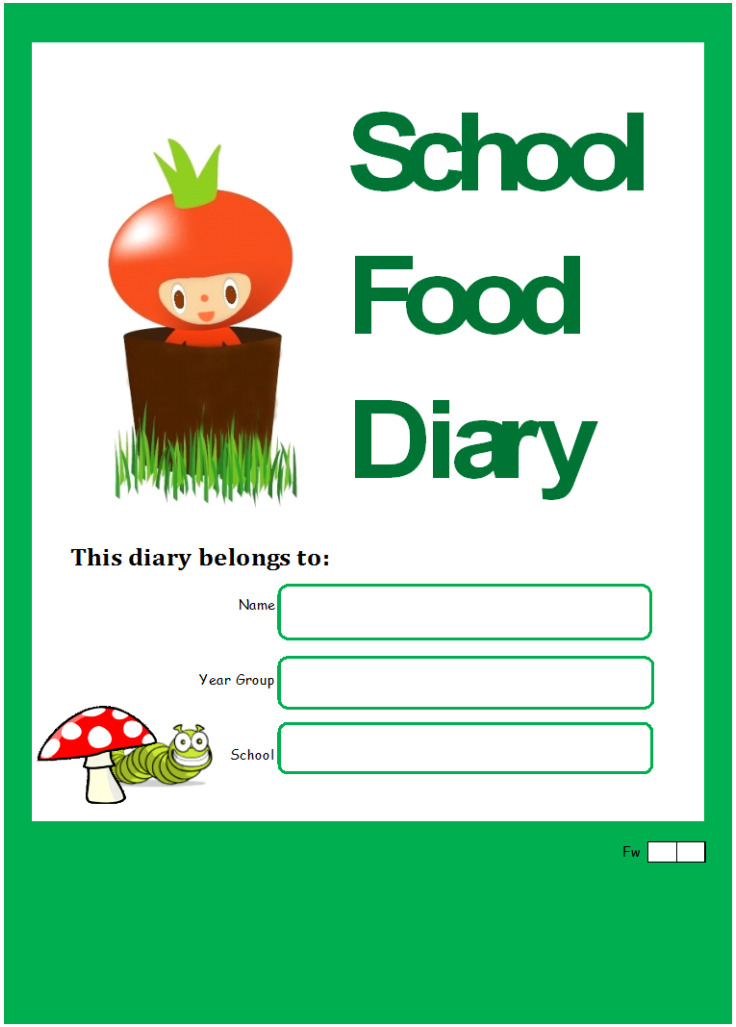
Appendices

Nutrition Assessment Tools - School Food Diary.



School Food Diary

This diary belongs to:

Name

Year Group

School

Fw

HOW TO FILL IN THE SCHOOL FOOD DIARY

Starting with the column headed "**Morning break**" tick all the items of food and drink that the child eats and drinks until lunch time.

In the next column, tick everything the child eats or drinks at '**lunchtime**'.

In the afternoon break, tick all the items of food and drink the child has eaten at school in the "**afternoon break**" column.

If they do not have anything to eat or drink at a mealtime, please tick "**nothing to eat**" and/or "**nothing to drink**" on page 8.

If the child attends a breakfast club, this information needs to be completed in the Home Food Diary.

If you cannot find the exact food or drink listed. Please tick the item you think is the closest match e.g.

Spaghetti Bolognese is: **pasta with meat, fish (and sauce)**
Popadom is: **crisps/savoury snack**

Here are some **EXAMPLES** of how to fill in the School Food Diary

Tommy had a cereal bar and 2 chocolate biscuits for morning break therefore ticked these foods in the column **"Morning break"**

B EXAMPLE: Snack Food	Morning break	Lunch time	Afternoon break
1 Crisps, savoury snacks (cheddars)	☐	☐	☐
2 Crackers, crispbread etc	☐	☐	☐
3 Cereal bar muesli bar, flapjack	☑	☐	☐
4 Chocolate biscuit	☑	☐	☐

1

A	Drinks	Morning break	Lunch time	Afternoon break
1	Milk, milky drink, lassi	☐	☐	☐
2	Tea, coffee	☐	☐	☐
3	Drinking chocolate etc	☐	☐	☐
4	Fizzy drink (pop/cola), squash, fruit drink (e.g. Ribena)	☐	☐	☐
5	Diet, low calorie drink (including fizzy low calorie)	☐	☐	☐
6	Fruit juice (pure)/smoothies	☐	☐	☐
7	Water	☐	☐	☐

B	Snack Food	Morning break	Lunch time	Afternoon break
1	Crisps, savoury snacks (mini cheddars)	☐	☐	☐
2	Crackers, crispbread etc	☐	☐	☐
3	Cereal bar, muesli bar, flapjack	☐	☐	☐
4	Chocolate biscuit	☐	☐	☐
5	Other biscuit	☐	☐	☐
6	Croissant, waffles, pop tarts	☐	☐	☐
7	Yoghurt, fromage frais	☐	☐	☐
8	Nuts	☐	☐	☐

C	Sandwich, bread	Morning break	Lunch time	Afternoon break
1	Sandwich (tick filling separately). Bread, roll, toast crumpet	☐	☐	☐
2	Croissant, sweet waffles, pop tarts	☐	☐	☐

3	Garlic bread, naan, paratha	☐	☐	☐
4	Chapatti, pitta bread, wrap, roti etc	☐	☐	☐
5	Cracker, crispbread etc	☐	☐	☐

D	Spreads, Sauces, Soup	Morning break	Lunch time	Afternoon break
1	Margarine, butter	☐	☐	☐
2	Tomato Ketchup, brown sauce	☐	☐	☐
3	Mayonnaise, salad cream	☐	☐	☐
4	Sweet spread e.g. jams, honey	☐	☐	☐
5	Savoury spread e.g. marmite, pate	☐	☐	☐
6	Gravy	☐	☐	☐
7	Soup	☐	☐	☐

E	Cheese, Eggs	Morning break	Lunch time	Afternoon break
1	Hard cheese, e.g. Cheddar, Red Leicester	☐	☐	☐
2	Cheese spread, triangle, string	☐	☐	☐
3	Cottage cheese	☐	☐	☐
4	Quiche - meat, fish or vegetable	☐	☐	☐
5	Scrambled egg, omelette, fried egg	☐	☐	☐
6	Poached, boiled egg	☐	☐	☐

F	Chicken, Turkey	Morning break	Lunch time	Afternoon break
1	.....sliced or plain	☐	☐	☐

2	….nuggets, dippers, kiev, etc	☐	☐	☐
3	….in a creamy sauce, curry e.g. korma or tikka masala	☐	☐	☐
G	**Other Meats e.g.**	Morning break	Lunch time	Afternoon break
1	….sliced roast, steak, chops	☐	☐	☐
2	….stew casserole, mince, curry lamb or keema	☐	☐	☐
3	….beef burger, hamburger, doner kebab	☐	☐	☐
4	Bacon	☐	☐	☐
5	Ham	☐	☐	☐
6	Sausages	☐	☐	☐
7	Sausage roll, meat pie, pasty, fried dumplings	☐	☐	☐
8	Corned beef, luncheon meats, salami, pepperoni	☐	☐	☐
9	Offal e.g. liver, kidney	☐	☐	☐
H	**Fish**	Morning break	Lunch time	Afternoon break
1	Fish fingers	☐	☐	☐
2	Fried fish in batter (as in fish and chips)	☐	☐	☐
3	White fish (not fried) e.g. cod, haddock, plaice	☐	☐	☐
4	Tuna or other oily fish (including canned or fresh)	☐	☐	☐
5	Shellfish e.g. prawns, mussels	☐	☐	☐
I	**Vegetarian**	Morning break	Lunch time	Afternoon break
1	Vegetable pie, pasty	☐	☐	☐

2	Samosa, pakora bhajee	☐	☐	☐
3	Quorn, veggie mince, sausages etc	☐	☐	☐
4	Mixed vegetable curry	☐	☐	☐
5	Paneer (cheese curry)	☐	☐	☐
J	**Pizza, Pasta, Rice etc**	Morning break	Lunch time	Afternoon break
1	Pizza	☐	☐	☐
2	Boiled rice	☐	☐	☐
3	Fried rice	☐	☐	☐
4	Noodles	☐	☐	☐
5	Pasta-plain, cous cous	☐	☐	☐
6	Pasta with tomato sauce (no meat)	☐	☐	☐
7	Pasta with cheese sauce	☐	☐	☐
8	Pasta with meat, fish (and sauce)	☐	☐	☐
9	Yorkshire pudding, pancake	☐	☐	☐
K	**Vegetables & Beans**	Morning break	Lunch time	Afternoon break
1	Mixed vegetables	☐	☐	☐
2	Tomatoes	☐	☐	☐
3	Cucumber	☐	☐	☐
4	Coleslaw	☐	☐	☐
5	Other salad vegetables e.g. lettuce	☐	☐	☐
6	Stir-fried vegetables	☐	☐	☐
7	Broccoli, brussel sprouts, cabbage	☐	☐	☐

8	Courgettes	☐	☐	☐
9	Spinach	☐	☐	☐
10	Parsnips	☐	☐	☐
11	Radish	☐	☐	☐
12	Leeks	☐	☐	☐
13	Carrots	☐	☐	☐
14	Cauliflower	☐	☐	☐
15	Peas, sweetcorn	☐	☐	☐
16	Celery	☐	☐	☐
17	Peppers, red, green, yellow etc	☐	☐	☐
18	Other vegetable	☐	☐	☐
19	Baked beans	☐	☐	☐
20	Lentils, dahl	☐	☐	☐
21	Other beans	☐	☐	☐
22	Seeds e.g. sunflower, sesame	☐	☐	☐
L	**Potato**	Morning break	Lunch time	Afternoon break
1	Boiled, mashed, jacket	☐	☐	☐
2	Chips, roast, potato faces etc	☐	☐	☐
M	**Fruit**	Morning break	Lunch time	Afternoon break
1	Fruit salad (tinned or fresh)	☐	☐	☐

2	Apple	☐	☐	☐
3	Pear	☐	☐	☐
4	Banana	☐	☐	☐
5	Orange, satsuma etc	☐	☐	☐
6	Grapes	☐	☐	☐
7	Melon, watermelon	☐	☐	☐
8	Pineapple	☐	☐	☐
9	Strawberry, raspberry etc	☐	☐	☐
10	Peach, nectarine, plum, apricot, mango	☐	☐	☐
11	Kiwi	☐	☐	☐
12	Other fresh fruit	☐	☐	☐
13	Dried fruit	☐	☐	☐
N	**Desserts, Puddings Cakes etc**	Morning break	Lunch time	Afternoon break
1	Jelly, ice lolly	☐	☐	☐
2	Ice cream, frozen dessert (e.g. Vienetta)	☐	☐	☐
3	Cream, custard	☐	☐	☐
4	Mousse, milk puddings, e.g. rice pudding	☐	☐	☐
5	Cakes, buns, sponge pudding	☐	☐	☐
6	Sweet pies, tarts, crumbles	☐	☐	☐

O	Sweets	Morning break	Lunch time	Afternoon break
1	Sweets, toffees, mints	☐	☐	☐
2	Chocolate bars, e.g. Mars, Galaxy	☐	☐	☐
P	Cereals	Morning break	Lunch time	Afternoon break
1	Sugar-coated e.g. Frosties, Sugar Puffs	☐	☐	☐
2	Hi-fibre e.g. Branflakes, Weetabix, Shreddies, muesli	☐	☐	☐
3	Other e.g. Cornflakes, Rice Krispies etc	☐	☐	☐
4	Prridge, Ready Brek	☐	☐	☐
5	Milk on cereal	☐	☐	☐
6	Sugar on cereal	☐	☐	☐
Q	NOTHING TO EAT	☐	☐	☐
R	NOTHING TO DRINK	☐	☐	☐
S	OTHER FOOD NOT ON THE LIST (please list below)	☐	☐	☐

School Fruit and vegetable Scheme ☐

Packed Lunch ☐ School meal ☐

Home Food Diary

YR School

Home Food Diary

This diary belongs to: Please fill in the boxes below..

Name

Mobile/telephone number
(for use by the Project only)

Dear Parent or Carer,

Your child's school is helping us with a study to look at what children are eating. You have agreed to us recording everything your child eats and drinks for 24 hours - from 9am today to 9am tomorrow. The School staff have ticked what your child has eaten and drunk at school today on a separate questionnaire.

All you need to do is to tick the food and drink your child eats from when they get home from school, until 9am tomorrow morning. If your child ate or drank with someone else after school, ask your child or your child's carer what they ate and tick the foods and drinks they consumed.

HOW TO FILL IN THE HOME FOOD DIARY

Please look through the diary so that you know where to find each food.
Starting with the column headed **"Before tea (after school)"** tick all the food and drink that your child eats and drinks after finishing school today until their evening meal.

In the columns headed **"Evening meal/tea"**, tick all the items of food and drink your child had for their evening meal.

In the column headed "**After tea/during night"** tick all the items of food and drink your child had after their evening meal and during the night.

In the column headed "**Breakfast/before school",** tick all the items of food and drink your child had at home before going to school the following morning (if your child eats anywhere else, this will be filled in by a teacher).

If they do not have anything to eat or drink at a mealtime, please tick **"nothing to eat"** and/or **"nothing to drink"** on page 9.

If you cannot find the exact food or drink listed. Please tick the item you think is the closest match e.g.

Spaghetti Bolognese is: **pasta with meat, fish (and sauce)**
Popadom is: **crisps/savoury snack**

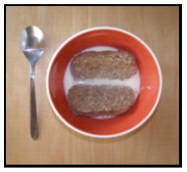
If you cannot find a close match, please tick **"other food not on the list"** on page 9.

There are some additional questions that we would like you to complete at the end of the diary (page 12). When the diary is completed, please make sure it is placed in your child's bag and sent back to school.

Here are some **EXAMPLES** of how to fill in the Home Food Diary

Tommy had a cereal bar and 2 chocolate biscuits when he got home from school so his mum ticked these foods in the column '**Before tea/(after school)**'

B **EXAMPLE 1: Snack Food**	Before tea /after school	Evening meal/tea	After tea/ during night	Breakfast/ before school
1 Crisps, savoury snacks (cheddars)	☐	☐	☐	☐
2 Crackers, crispbread etc	☐	☐	☐	☐
3 Cereal bar muesli bar, flapjack	☑	☐	☐	☐
4 Chocolate biscuit	☑	☐	☐	☐



The following morning Tommy had a bowl of weetabix with milk for breakfast so his mum ticked these foods in the column '**Breakfast/before school**

P **EXAMPLE 2: Cereals**	Before tea (after school)	Evening meal/tea	After tea/ during night	Breakfast/ before school
1 Sugar-coated e.g. Frosties, Sugar Puffs	☐	☐	☐	☐
2 Hi-fibre e.g. Branflakes, Weetabix, Shreddies, muesli	☐	☐	☐	☑
3 Other e.g. Cornflakes, Rice Krispies etc	☐	☐	☐	☐
4 Milk on cereal	☐	☐	☐	☑
5 Sugar on cereal	☐	☐	☐	☐

A **Drinks**	Before tea /after school	Evening meal/tea	After tea/ during night	Breakfast/ before school
1 Milk, milky drink, lassi	☐	☐	☐	☐
2 Tea, coffee	☐	☐	☐	☐
3 Drinking chocolate etc	☐	☐	☐	☐
4 Fizzy drink (pop/cola), squash, fruit drink (e.g. Ribena)	☐	☐	☐	☐
5 Diet, low calorie drink (including fizzy low calorie)	☐	☐	☐	☐
6 Fruit juice (pure)/smoothies	☐	☐	☐	☐
7 Water	☐	☐	☐	☐

B **Snack Food**	Before tea /after school	Evening meal/tea	After tea/ during night	Breakfast/ before school
1 Crisps, savoury snacks (cheddars)	☐	☐	☐	☐
2 Crackers, crispbread etc	☐	☐	☐	☐
3 Cereal bar, muesli bar, flapjack	☐	☐	☐	☐
4 Chocolate biscuit	☐	☐	☐	☐
5 Other biscuit	☐	☐	☐	☐
6 Croissant, waffles, pop tarts	☐	☐	☐	☐
7 Yoghurt, fromage frais	☐	☐	☐	☐
8 Nuts	☐	☐	☐	☐

C **Sandwich, bread**	Before tea /after school	Evening meal/tea	After tea/ during night	Breakfast/ before school
1 Sandwich (tick filling separately). Bread, roll, toast crumpet	☐	☐	☐	☐
2 Croissant, sweet waffles, pop tarts	☐	☐	☐	☐

3 Garlic bread, naan, paratha	☐	☐	☐	☐
4 Chapatti, pitta bread, wrap, roti etc	☐	☐	☐	☐
5 Cracker, crispbread etc	☐	☐	☐	☐

D Spreads, Sauces, Soup	Before tea /after school	Evening meal/tea	After tea/ during night	Breakfast/ before school
1 Margarine, butter	☐	☐	☐	☐
2 Tomato Ketchup, brown sauce	☐	☐	☐	☐
3 Mayonnaise, salad cream	☐	☐	☐	☐
4 Sweet spread e.g. jams, honey	☐	☐	☐	☐
5 Savoury spread e.g. marmite, pate	☐	☐	☐	☐
6 Gravy	☐	☐	☐	☐
7 Soup	☐	☐	☐	☐

E Cheese, Eggs	Before tea /after school	Evening meal/tea	After tea/ during night	Breakfast/ before school
1 Hard cheese, e.g. Cheddar, Red Leicester	☐	☐	☐	☐
2 Cheese spread, triangle, string	☐	☐	☐	☐
3 Cottage cheese	☐	☐	☐	☐
4 Quiche - meat, fish or vegetable	☐	☐	☐	☐
5 Scrambled egg, omelette, fried egg	☐	☐	☐	☐
6 Poached, boiled egg	☐	☐	☐	☐

F Chicken, Turkey	Before tea /after school	Evening meal/tea	After tea/ during night	Breakfast/ before school
1 .....sliced or plain	☐	☐	☐	☐

2 .....nuggets, dippers, kiev, etc	☐	☐	☐	☐
3 .....in a creamy sauce, curry e.g. korma or tikka masala	☐	☐	☐	☐

G Other Meats e.g.	Before tea /after school	Evening meal/tea	After tea/ during night	Breakfast/ before school
1 .....sliced roast, steak, chops	☐	☐	☐	☐
2 .....stew casserole, mince, curry or keema	☐	☐	☐	☐
3 .....beef burger, hamburger, doner, kebab	☐	☐	☐	☐
4 Bacon	☐	☐	☐	☐
5 Ham	☐	☐	☐	☐
6 Sausages	☐	☐	☐	☐
7 Sausage roll, meat pie, pasty, fried dumplings	☐	☐	☐	☐
8 Corned beef, luncheon meats, salami, pepperoni	☐	☐	☐	☐
9 Offal e.g. liver, kidney	☐	☐	☐	☐

H Fish	Before tea /after school	Evening meal/tea	After tea/ during night	Breakfast/ before school
1 Fish fingers	☐	☐	☐	☐
2 Fried fish in batter (as in fish and chips)	☐	☐	☐	☐
3 White fish (not fried) e.g. cod, haddock, plaice	☐	☐	☐	☐
4 Tuna or other oily fish (including can or fresh)	☐	☐	☐	☐
5 Shellfish e.g. prawns, mussels	☐	☐	☐	☐

I Vegetarian	Before tea /after school	Evening meal/tea	After tea/ during night	Breakfast/ before school
1 Vegetable pie, pasty	☐	☐	☐	☐

2	Samosa, pakora bhajee	☐	☐	☐	☐
3	Quorn, veggie mince, sausages etc	☐	☐	☐	☐
4	Mixed vegetable curry	☐	☐	☐	☐
5	Paneer (cheese curry)	☐	☐	☐	☐

J	Pizza, Pasta, Rice etc	Before tea /after school	Evening meal/tea	After tea/ during night	Breakfast/ before school
1	Pizza	☐	☐	☐	☐
2	Boiled rice	☐	☐	☐	☐
3	Fried rice	☐	☐	☐	☐
4	Noodles	☐	☐	☐	☐
5	Pasta-plain, cous cous	☐	☐	☐	☐
6	Pasta with tomato sauce (no meat)	☐	☐	☐	☐
7	Pasta with cheese sauce	☐	☐	☐	☐
8	Pasta with meat, fish (and sauce)	☐	☐	☐	☐
9	Yorkshire pudding, pancake	☐	☐	☐	☐

K	Vegetables & Beans	Before tea /after school	Evening meal/tea	After tea/ during night	Breakfast/ before school
1	Mixed vegetables	☐	☐	☐	☐
2	Tomatoes	☐	☐	☐	☐
3	Cucumber	☐	☐	☐	☐
4	Coleslaw	☐	☐	☐	☐
5	Other salad vegetables e.g. lettuces	☐	☐	☐	☐
6	Stir-fried vegetables	☐	☐	☐	☐
7	Broccoli, brussel sprouts, cabbage	☐	☐	☐	☐

K	Vegetables & Beans	Before tea /after school	Evening meal/tea	After tea/ during night	Breakfast/ before school
8	Courgettes	☐	☐	☐	☐
9	Spinach	☐	☐	☐	☐
10	Parsnips	☐	☐	☐	☐
11	Radish	☐	☐	☐	☐
12	Leeks	☐	☐	☐	☐
13	Carrots	☐	☐	☐	☐
14	Cauliflower	☐	☐	☐	☐
15	Peas, sweetcorn	☐	☐	☐	☐
16	Celery	☐	☐	☐	☐
17	Peppers, red, green, yellow etc	☐	☐	☐	☐
18	Other vegetable	☐	☐	☐	☐
19	Baked beans	☐	☐	☐	☐
20	Lentils, dahl	☐	☐	☐	☐
21	Other beans	☐	☐	☐	☐
22	Seeds e.g. sunflower, sesame	☐	☐	☐	☐

L	Potato	Before tea (after school)	Evening meal/tea	After tea/ during night	Breakfast/ before school
1	Boiled, mashed, jacket	☐	☐	☐	☐
2	Chips, roast, potato faces etc	☐	☐	☐	☐

M	Fruit	Before tea (after school)	Evening meal/tea	After tea/ during night	Breakfast/ before school
1	Fruit salad (tinned or fresh)	☐	☐	☐	☐
2	Apple	☐	☐	☐	☐

M	Fruit	Before tea (after school)	Evening meal/tea	After tea/ during night	Breakfast/ before school
3	Pear	☐	☐	☐	☐
4	Banana	☐	☐	☐	☐
5	Orange, satsuma etc	☐	☐	☐	☐
6	Grapes	☐	☐	☐	☐
7	Melon, watermelon	☐	☐	☐	☐
8	Pineapple	☐	☐	☐	☐
9	Strawberry, raspberry etc	☐	☐	☐	☐
10	Peach, nectarine, plum, apricot, mango	☐	☐	☐	☐
11	Kiwi	☐	☐	☐	☐
12	Other fresh fruit	☐	☐	☐	☐
13	Dried fruit	☐	☐	☐	☐

N	Desserts, Puddings, & Cakes etc	Before tea (after school)	Evening meal/tea	After tea/ during night	Breakfast/ before school
1	Jelly, ice lolly	☐	☐	☐	☐
2	Ice cream, frozen dessert (e.g. Vienetta)	☐	☐	☐	☐
3	Cream, custard	☐	☐	☐	☐
4	Mousse, milk puddings, e.g. rice pudding	☐	☐	☐	☐
5	Cakes, buns, sponge pudding	☐	☐	☐	☐
6	Sweet pies, tarts, crumbles	☐	☐	☐	☐

O	Sweets	Before tea (after school)	Evening meal/tea	After tea/ during night	Breakfast/ before school
1	Sweets, toffees, mints	☐	☐	☐	☐
2	Chocolate bars, e.g. Mars, Galaxy	☐	☐	☐	☐

P	Cereals	Before tea (after school)	Evening meal/tea	After tea/ during night	Breakfast/ before school
1	Sugar-coated e.g. Frosties, Sugar Puffs	☐	☐	☐	☐
2	Hi-fibre e.g. Branflakes, Weetabix, Shreddies, muesli	☐	☐	☐	☐
3	Other e.g. Cornflakes, Rice Krispies etc	☐	☐	☐	☐
4	Porridge, Ready Brek	☐	☐	☐	☐
5	Milk on cereal	☐	☐	☐	☐
6	Sugar on cereal	☐	☐	☐	☐
Q	NOTHING TO EAT	☐	☐	☐	☐
R	NOTHING TO DRINK	☐	☐	☐	☐
S	OTHER FOOD NOT ON THE LIST (please list below)				
	_____	☐	☐	☐	☐
	_____	☐	☐	☐	☐

T Extra Questions

These questions provide us with more details about the amounts and types of food and drink usually eaten by your child on an average day. Please tick the closest answer.

1 What type of milk does your child usually have? (Tick all that apply)

Full cream (silver top, sterilised) ☐ Semi-skimmed (half fat) ☐

Skimmed ☐ Other ☐

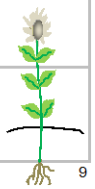
2 What type of bread/roll/toast does your child usually eat? (Tick all that apply)

None ☐ White ☐ White with added fibre ☐

Wholemeal ☐ Granary/brown ☐ Other ☐

3 Number of slices of bread eaten in a usual day ☐

Number of rolls/plain muffins eaten in a usual day ☐



4 How much pure fruit juice in total does your child usually drink at home on an average day? (One average child's beaker =1/4 pint)

None ☐ 1/4 pint ☐ 1/2 pint ☐ 3/4 pint ☐

1 pint ☐ More than 1 pint ☐

5 How much sugar, in total did your child have added to food or drink today at home?

none ☐ 1-2 teaspoons ☐ 3-4 teaspoons ☐ 5-6 teaspoons ☐

7 + teaspoons ☐

6 Where did your child eat today? (Tick all that apply)

Home ☐ School ☐ Friend/relative ☐ Childcare ☐ Other ☐

7 What does your child usually do at lunch time? (Tick one box only)

Have a school lunch/meal ☐ Take a packed lunch ☐

Go home for lunch ☐ Other ☐

The following questions are about what you and your child think about eating fruit and vegetables. Please tick the closest answer.

		Yes always	Yes, most days/often	Sometimes	Rarely	Never
8	Do you have different kinds of fruit/vegetables at home?	☐	☐	☐	☐	☐
9	Do you buy specific fruit/vegetable because your child asks for it?	☐	☐	☐	☐	☐
10	Do you cut up fruit/vegetables for your child to eat?	☐	☐	☐	☐	☐
11	Do you (parent/carer) eat fruit/vegetables every day?	☐	☐	☐	☐	☐
12	Do you eat fruit/vegetables together with your child?	☐	☐	☐	☐	☐
13	Do you have to ask your child to eat their fruit or vegetables?	☐	☐	☐	☐	☐
14	Do you allow your child to eat as much fruit/vegetables as he/she likes?	☐	☐	☐	☐	☐

		I fully agree	Yes, most days/often	Neither agree nor disagree	I disagree somewhat	I totally disagree
15	My child eats fruit every day	☐	☐	☐	☐	☐
16	My child eats vegetables every day	☐	☐	☐	☐	☐
17	My child eats enough fruit/vegetables	☐	☐	☐	☐	☐

How important are the following to you in deciding how much fruit and vegetables your family eats?

		Very important	Important	Neither unimportant or important	Unimportant	Very unimportant
18	The money I have available to spend on fruit and vegetables	☐	☐	☐	☐	☐
19	The price of fruit and vegetables	☐	☐	☐	☐	☐
20	My knowledge about ways to prepare fruit and vegetables	☐	☐	☐	☐	☐
21	The time I have available to prepare fruit and vegetables	☐	☐	☐	☐	☐
22	Likes and dislikes of my family for fruit and vegetables	☐	☐	☐	☐	☐
23	The quality of fruit and vegetables available	☐	☐	☐	☐	☐

24 How many people aged 18 years or over live in your household in total? ☐

25 How many people under 18 years live in your household in total? ☐

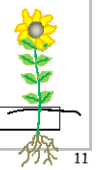
26 How many nights a week does your family eat together at a table? ☐

27 Does anyone in your household have any of the following qualifications? Tick all that apply

CSE ☐ GCE "O" Level ☐ GCSE ☐ City & Guilds ☐

"A" Levels ☐ Teaching Diploma, HNC ☐ Degree ☐

None of these ☐ Other ☐ Describe ☐



We would be very grateful if you could give us the following information. This information is used only to sort survey responses into groups and will not be used for any other purpose.

28 What is your postcode? ☐

Please tick if you have any of the following fruit or vegetables in your fridge/freezer or cupboards. If the fruit or vegetable is not listed please write in the space provided.

29 **VEGETABLES**

Baked beans ☐	Broccoli ☐	Brussel sprouts ☐	Cabbage ☐
Carrots ☐	Celery ☐	Courgettes ☐	Cucumber ☐
Leeks ☐	Lentils, Dahl ☐	Mushrooms ☐	Onions ☐
Parsnips ☐	Peas, beans, sweetcorn ☐	Peppers ☐	Radish ☐
Salad, lettuces ☐	Spinach ☐	Tomatoes ☐	

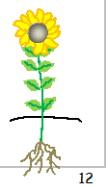
FRUIT

Apples ☐	Apricot ☐	Banana ☐	Berries ☐
Dried fruit ☐	Grapes ☐	Kiwi ☐	Mango ☐
Melon ☐	Orange, satsuma ☐	Peach, nectarine ☐	Pears ☐
Pineapple ☐	Plum ☐	**Other** …… ☐	

30 How would you describe your child's ethnic background? Tick **one** box only

White	**Asian or British Asian**	**Chinese or other ethnic Group**
British ☐	Indian ☐	Chinese ☐
Irish ☐	Pakistani ☐	Any other ethnic group ☐
Any other White background ☐	Bangladeshi ☐	
	Any other Asian background ☐	

Mixed	**Black or Black British**
White & Black Caribbean ☐	Caribbean ☐
White & Black African ☐	African ☐
White & Asian ☐	Any other Black background ☐
Any other mixed background ☐	
	Prefer not to say ☐



Child Knowledge and attitudes questionnaire

Child Questionnaire.

ID:

Name: .....

School: .....

Age: .....

1. Are you a boy or girl?

Boy Girl

2. What are your 3 favourite fruit and vegetables?

1.....

2.....

3.....

What are your 3 least favourite fruit and vegetables?

1.....

2.....

3.....

3. How many servings of fruit and vegetables do you think you should eat every day to stay healthy? Please circle one number only.

1 2 3 4 5 6 7 8

4. Do you agree or disagree with these ideas about fruit and vegetables? Circle one number on each row

Idea	Agree a lot	Agree a little	Disagree a little	Disagree a lot
I enjoy eating fruit.	1	2	3	4
I like trying new fruits.	1	2	3	4
I try to eat lots of fruit.	1	2	3	4
I enjoy eating vegetables.	1	2	3	4
I like trying new vegetables.	1	2	3	4
I try to eat lots of vegetables.	1	2	3	4
Eating fruit and vegetables every day keeps me healthy.	1	2	3	4
There's usually lots of fruit and vegetable to eat at home.	1	2	3	4
I'm good at preparing fruit and vegetables.	1	2	3	4
My family encourages me to eat fruit and vegetables	1	2	3	4

5. Please draw a line from the name of the fruit to vegetable to the matching picture.






Raspberries

Blackberries

Pears

Apples

Blueberries

Plums

Bananas

Grapes

Orange

Pineapple

Nectarine

Watermelon

Kiwifruit







Courgettes

Spinach

French Beans

Parsley

Lettuces

Parsnips

Radish

Sweet-corn

Carrots

Leeks

Spring onions

Broccoli

Peppers

Cucumber

Tomatoes

Garlic

6. The following questions are about gardening. Please circle either Yes or No for each question

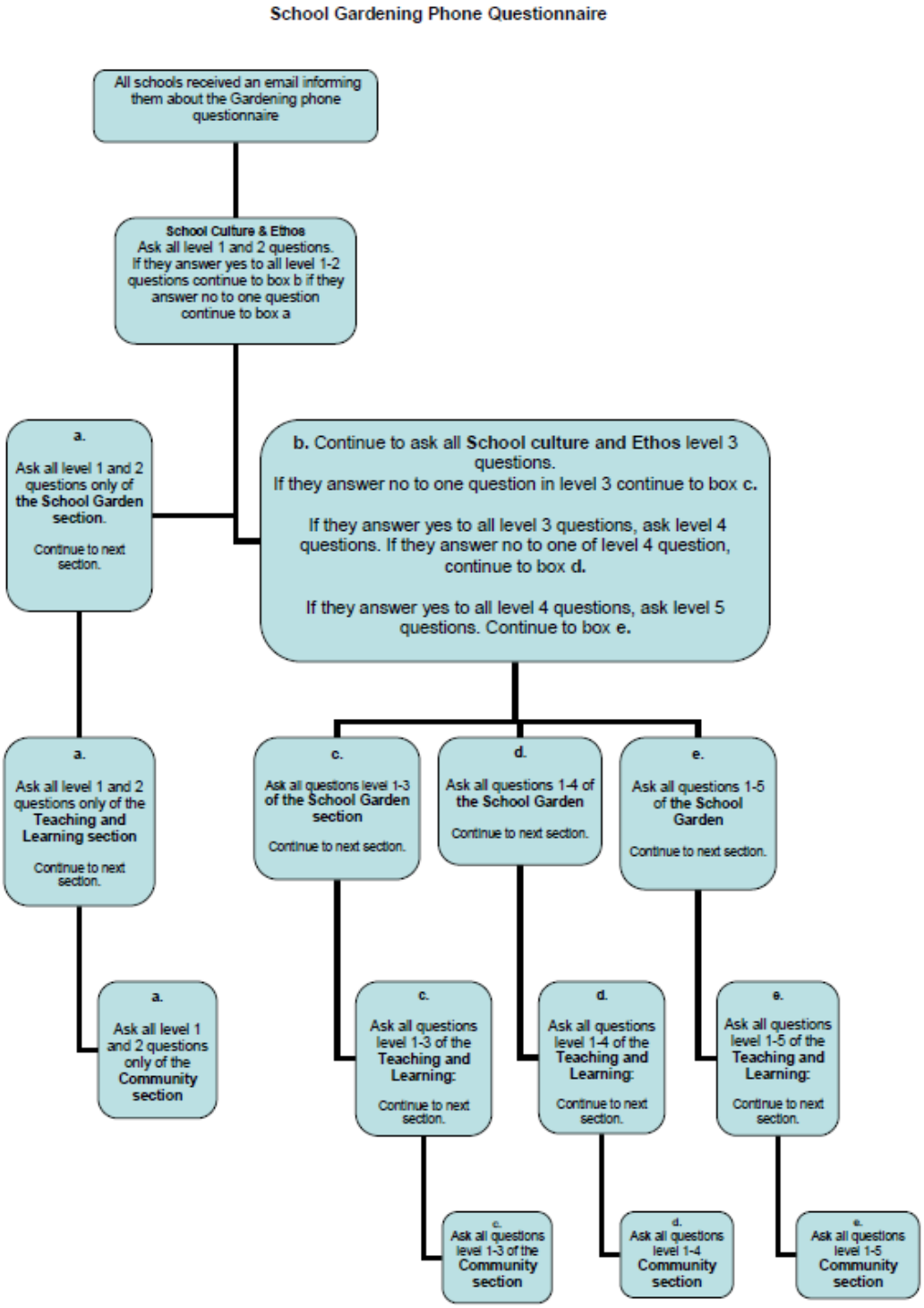
We grow our own fruit and vegetables **Yes** **No**

What fruit or vegetables have you grown?

Have you tasted any of the fruit or vegetables that you have grown? **Yes** **No**

What fruit or vegetables have you tasted?

School Gardening Questionnaire



School Culture & Ethos		Yes	No
1	Individual and or group within our school is interested in developing the school garden.		
1	We are considering fundraising options.		
2	A vision for gardening has been shared amongst members of our staff team.		
2	We have a gardening club or environmental club.		
2	We have started the fundraising process for the garden.		
3	The garden and its purpose are written into the school development plan.		
3	There is a team of staff responsible for implementing the garden project.		
3	The school grounds staff or caretaker are involved in the maintenance of the garden.		
3	Some pupils are participating in the design and development of the garden.		
3	A wide number and age range of pupils a involved in gardening activities in school lessons.		
3	We regularly raise funds for the garden through PTA and other channels.		
4	Our staff are implementing the garden project and are advocating its benefits to other schools.		
4	The design and development of the garden is led by pupils as well as teachers.		
4	Most pupils across the school are involved in gardening activities		
4	Fundraising or sourcing materials for the school garden takes place regularly.		
5	We see the garden as a key resource for Teaching and Learning, serving our pupils, our staff and our community.		
5	We regularly celebrate our achievements in the garden through our project work, assemblies and open days.		
The School Garden		**Yes**	**No**
1	We are already growing some plants inside or outside the classroom.		
1	We are conducting an audit of our school grounds.		
1	We are planning to do a risk assessment for our growing activities.		
2	A plan has been produced and an area identified for a school garden.		
2	Preparation work on the site has begun e.g. clearing the site, providing containers or raised beds, improving the soil.		
2	We have done a risk assessment for all activities carried out in the school garden.		
3	We grow a range of plants in our garden such as flowers, shrubs, trees, fruits and vegetables.		
3	We demonstrate care for the environment in our garden by gardening organically, reducing water use, using mulches and composting.		

3	A programme for caring for our garden in the holidays has been established.		
4	Our garden has a varied range of features and a good range of flowers, fruits, vegetables, shrubs and trees.		
4	We are able to demonstrate plants for different purposes, e.g. sensory, attracting wildlife, edible.		
4	We adopt good environmental and sustainable practices with regard to use of renewable resources e.g. composting, water consumption, treatment of pests and diseases.		
4	We have holiday maintenance regimes in place.		
4	We are making use of produce from the school garden in other school activities e.g. cooking		
5	We have an outstanding example of a school garden with regard to range of plants, sustainable practices and all year round care and maintenance.		
5	Our garden is considered to be an exemplar of best practice in the field of education.		
Teaching and Learning		**Yes**	**No**
1	We are looking at ways to teach our pupils gardening skills.		
1	We are auditing the skills of our teachers and will source Continuing Professional Development courses for our teachers as necessary.		
1	Our pupils are being introduced to the importance of plants in their lives.		
2	Some of our pupils have learnt basic gardening skills, including sowing, planting and watering.		
2	Our pupils have been taught to use a basic range of hand tools safely.		
2	Our pupils have been introduced to a few gardening terms		
2	One or more teachers co-ordinates gardening activities.		
3	Our pupils' gardening skills are progressing to include digging, soil preparation and weeding as well as sowing, planting and watering		
3	Our pupils have learnt how to use an increased range of tools safely including spades, forks, rakes, hoes and hand tools		
3	Our pupils are starting to become familiar with gardening vocabulary and can name and identify some crops and weeds.		
3	In addition to self-confidence, patience and nurturing skills, pupils are learning to work together in teams and develop skills of co-operation and respect for others and the world around them.		
3	Pupils are learning about where their food comes from and how to grow food for a healthier diet.		
3	Several staff have the necessary skills to manage horticultural aspects of and teach in the garden.		
3	The garden is being used as a resource to teach more than one curriculum subject.		

3	We have some signs and plant labels in the garden to build on the learning taking place there for children, parents and visitors to the school.		
4	Our pupils have more advanced skills including making seed drills, propagating from cuttings, as well as digging, soil preparation, weeding, sowing, planting and watering.		
4	Pupils have taken part in construction activities including making raised beds, compost bins, willow structures or plant supports.		
4	Our pupils have learnt how to use an increased range of tools safely and can select a tool appropriate to the task. Our pupils can clean and maintain their tools.		
4	We regularly use a good range of gardening vocabulary with our pupils and they can identify and name crops and weeds.		
4	In addition to self-confidence, patience, respect and the skills of nurturing, teamwork and co-operation, pupils are using the garden to develop their problem solving capabilities and to communicate effectively.		
4	Our pupils are made more aware of the importance of eating healthily by growing their own food.		
4	Older pupils sometimes act as mentors to younger children in the garden.		
4	Lead staff have sufficient gardening skill levels to train others within the school.		
4	Staff may have undertaken Continuing Professional Development workshops in gardening and are actively involved in training others.		
4	Lessons are being taught through the school garden in two or more curriculum subjects.		
4	There is a good level of information (signs and labels) in the garden to ensure that all aspects of learning are explained to the widest audience, e.g. a sign to explain how composting works and plant labels that include information about a particular plant.		
5	Our pupils are competent in all the horticultural skills required to prepare, plant, nurture and maintain the garden.		
5	Older pupils can plan ahead, understand seasonality and have the skills to design and construct elements of the garden.		
5	Our pupils use and care for a comprehensive range of tools.		
5	Older pupils are able to coach younger pupils within the school.		
5	Pupils can define a range of gardening terms and use them appropriately.		
5	Our pupils have gained many key skills and life skills through gardening including: self-confidence, patience, nurturing/caring, teamwork/ co-operation, respect for others, problem solving, communication, mentoring.		
5	Our pupils are keeping garden journals and can use the garden to plan do and review their own work.		
5	Some pupils are developing enterprise skills linked to the garden and its produce.		
5	We regularly hold briefings and planning meetings in the garden to maximise its use as a resource for teaching and learning.		
5	We are able to receive staff from other schools for mentoring/coaching.		

5	Most of the National Curriculum subjects are being taught by linking to the school garden		
5	We have produced a comprehensive range of interpretation materials, both in the garden and the classroom, to explain the work we do there.		
Community		**Yes**	**No**
1	We are planning to involve members of the wider school and/or local community in our gardening activities		
2	One or more parents or members of the wider school community help with gardening activities.		
2	The school governors are aware of our gardening activities and take an interest in them.		
3	Our governors and parents take an active interest in the garden and several participate regularly in gardening and related fundraising activities.		
4	An established team of volunteers from the local community (including parents and governors) regularly work alongside pupils in gardening activities.		
4	We encourage outside experts to come and share their skills with pupils and teachers in the school garden.		
5	A cross section of the whole community is involved with our school garden.		
5	We welcome outside experts to come and share skills.		
5	We host open days to our garden at least once a year for the local community.		
5	Our garden provides opportunities for adult (life-long) learning.		

One final question, who runs your school garden, is it a trained gardener, or teacher?

School Recruitment Letter for Trial 1 Schools

February 2010

Dear Headteacher,

Work with the RHS to develop your school garden

Schools wanted in London Boroughs of Tower Hamlets, Sutton, Wandsworth and Greenwich!

Are you interested in developing your school garden with practical help from a trained RHS school gardening advisor? Could your school benefit from professional training to help teachers develop horticultural skills and make best use of the garden to deliver the whole curriculum? Would you like free teacher resources, tools and seeds? Then please read on...

The **RHS** is bringing its national **Campaign for School Gardening** to London with a new schools advisor, James Bliss. A passionate and enthusiastic horticulturalist, Jim is the third of nine new Campaign advisors who will be working across the regions of the UK to support schools in their gardening.

Jim's main role is one of teacher training, showing teachers how to grow plants from seed, to garden sustainably, to plan seasonally and to develop fruit and vegetable gardens to support healthy eating. The RHS wants teachers to discover just how versatile schools gardens can be; offering exciting learning opportunities across the curriculum and giving children new possibilities for their personal development. There will be plenty of opportunities for all school support staff and parent volunteers to join in too.

10 RHS-led Schools needed for 2010-2012

To reach the maximum number of teachers, the RHS is looking for ten RHS-led Schools across the boroughs who will be prepared to host twilight training events for local teachers once a term over the next two years. The selected RHS-led Schools will receive day-long visits every half term from Jim, helping them to build on practical skills and expertise while developing their gardens.

RHS-led schools will also be expected to participate in an evaluation of the scheme which will be conducted by researchers from the University of Leeds. The purpose of this research is to find out whether the RHS School Gardening Campaign can improve children's fruit and vegetable intake and have an impact on their overall diet. More details of the research and how it will be carried out in the participating schools is explained in the enclosed 'Further Information' sheets from the University.

What do RHS-led Schools get?

- 1 day's visit from our advisor each half term to work in the garden with teachers and children (Summer Term 2010 to Summer Term 2011 inclusive). **Please note that to accommodate the requirements of the research project, Years 3 and 4 must be involved in gardening activities, though this does not preclude the involvement of other year groups.**
- Follow up visits to aid lead teachers with planning (Autumn Term 2011 to Autumn Term 2012)
- General on going advice on the school garden, free seeds and tools
- 1 twilight teacher training session each term (Summer term 2010 to Summer term 2011 inclusive), based on seasonal tasks in the school garden (open to RHS-led School teachers and those from local schools)
- Free access to a wide range of teacher resources at **www.rhs.org.uk/schoolgardening/**

What do we need from RHS-led Schools?

- Access to a school garden area and identification of a teacher-co-ordinator
- A time commitment of 2 school days per term and one twilight session per term, with planning meetings as required
- An agreement to host training events and to help the RHS liaise with local schools
- Provision of appropriate supply cover so that teachers and children can work outside with our advisor on two days per term in Year 1 of the project
- Attendance at a RHS-led Schools open forum event once a year
- A commitment to the school garden evidenced by adopting the RHS Campaign for School Gardening benchmarking scheme with full backing/involvement of the Head Teacher
- Incorporation of the garden into the School Development Plan.

- A commitment to working with the wider community to involve them as much as possible in the school garden
- A commitment to supporting the Leeds University research project as outlined in the accompanying Information sheet
- Permission to allow staff from the University of Leeds to visit your school on 2 occasions to collect information for the evaluation. This will be repeated after 2 growing seasons.

Timescales and Application Procedure

If you feel that you would be interested in becoming an RHS RHS-led School, then we would very much like to hear from you. An application form is enclosed with this letter.

We will be assessing applications during March 2010 with a view to starting work in Schools from April 2010. As part of our assessment we may need to telephone or visit you to obtain further information. We would therefore be grateful if you would kindly complete the enclosed registration form (on coloured paper) and return this in the Freepost envelope provided by **Friday 19 March 2010**. We will be looking to work with a cross section of schools, with a good socio-economic and ethnic mix. You do not need to have a fully established garden to apply; we will welcome applications from schools at all levels, provided that there is a vision to develop gardening as a teaching and learning resource.

Schools that are not selected to be RHS-led schools

Even if you are not selected to be a RHS-led school, you will be invited to termly twilight training at your nearby RHS-led school, to help support you in developing and using your school gardening. You may also still be invited to take part in the Leeds University research project and would be expected to support it in the same way as the RHS-led Schools.

We hope to hear from you very soon. Good luck with your gardening!

Yours faithfully

Deirdre Walton

Regions Manager

RHS Learning & Communities

Further information for head teachers about the evaluation of the RHS Campaign for School Gardening

Invitation paragraph

This is an invitation for your school to take part in a research study. The first part of this information tells you why we are carrying out the study and the second part goes into more detail about how it will be carried out. Please ask us if there is anything that is not clear or if you would like more details.

What is the RHS Campaign for school gardening?

The Royal Horticultural Society (RHS) Campaign for School Gardening promotes school gardening and growing of fruit and vegetables. The Campaign provides resources to help teachers set up and make the most of their school garden, teach the National Curriculum outdoors and inspire their pupils to live healthier lifestyles.

What has this to do with the University of Leeds?

The University of Leeds, Nutritional Epidemiology Group plans to evaluate the RHS program, to find out whether the RHS School Gardening program can improve children's fruit and vegetable intake and has an impact on their overall diet. They will conduct an evaluation of the program involving two linked randomised controlled trials.

Schools from London who wish to participate in the RHS Campaign for School Gardening will be randomised to receive an intensive (10 schools) or Teacher-led gardening program (16 schools).

Why has your school been chosen?

Due to your school's interest in the RHS Gardening Program, your school has been selected randomly from schools in London.

The study involves:

All children in year 3 and 4 completing a class based questionnaire with the teaching assistant and also a questionnaire to finish at home. These questionnaires will be repeated after 2 years when the children are in years 5 and 6.

Gardening Knowledge and Attitude Questionnaire
As a class, the children will be asked to complete a questionnaire asking about their knowledge of gardening, healthy eating and what fruit and vegetables they like.

Food Questionnaire
Trained researchers will use a standard questionnaire (food diary) to help children record what they have eaten that day. The children will then take the food diary home for a parent or carer to complete for the rest of the day and breakfast the next morning.

Benefits to taking part in the study
If you take part, you will be participating in a unique study to test the benefits of providing the RHS gardening program in schools. You have a chance of receiving information, help and support to try to improve the health of a cohort of your pupils. This approach is based on the best research evidence available from the UK and around the world. We will do our best to ensure there is minimal disruption in your school if you decide to take part.

What happens when the study stops?
All data collected in participating schools will be analysed and the findings written up and submitted for publication in academic journals. A summary of the final report will be available to participating schools.

What if there is a problem?
If during the course of the study you have any concerns or complaints you will be able to contact the study team using the contact details below.

Will our taking part in the study be kept confidential?
Yes. All the information collected from the children in your school will be kept strictly confidential. Once collected, the information will have the names and addresses of children removed so that no one can be identified. All data will be stored securely at the University of Leeds. Information will be entered onto a computer and will be password protected and encrypted. The findings from this study will be analysed and written up in such a way that the identity of your school, the staff, children and parents will not be revealed in any way. All the information provided by children and parents will be kept completely confidential.

What will happen to the results of the research study?

The findings from this study will be used to evaluate how well the RHS Campaign for School Gardening program is working. It will also help identify whether participating in the program improves fruit and vegetable consumption and the health of children. The results will be submitted for publication in scientific journals and presented at scientific conferences.

Who is organising and funding the research?

RHS will organise your involvement in the Campaign for School Gardening, whilst the University of Leeds will organise the research. The funding for the evaluation study was provided from the National Institute for Health Research.

Contact Details

If you have any queries about the evaluation please contact Meaghan Kitchen (PhD student) on 0113 3438907 or via email m.s.kitchen@leeds.ac.uk

Participant Information and Consent Letter to Parents for both Trial 1 & 2

UNIVERSITY OF LEEDS

April 2010

Dear Parent,

I am writing to you today because your child's school has been chosen to take part in an important research product (evaluation of the RHS Campaign for School Gardening) and I would like your consent for your child to participate in this study.

The aim of the project is to find out if the RHS Campaign for School Gardening can improve children's fruit and vegetable intake. In order to do this I would like your child to fill in a School Food Diary and a Home Food Diary. The School Food Diary will be completed by the staff at school and your child will bring home the Home Food Diary for you to complete. They will also bring home a DVD for you to watch, explaining how to complete the Home Food Diary. This DVD is also available on you tube at

http://www.youtube.com/watch?v=AIbzqaJiHq0.

Your child then needs to return the diary and the DVD to school the next day. Your child will also complete a 'gardening questionnaire' in class. We have studied other public health prog in schools, and the children involved have enjoyed taking part.

The head teacher of your child's school is happy for pupils to participate. All information will be treated as confidential. Results of our study will not be reported for individual pupils or schools.

If you do ***not*** want your child to participate, please return the form below to school as soon as possible. If you **agree** to your child taking part **you do not need to do anything now**. If you would like to talk to someone before making your decision, please contact myself or my colleague Meaghan Kitchen on 0113 3438907. We hope that you will enjoy taking part in this important project. More information about the study is included on the next page.

Yours sincerely,

Dr Joan Ransley

Project Manager

✂……

If you would **NOT** like your child to take part in the study, please return this form on the next school day.

I ***do not*** wish my child to take part in the evaluation of the RHS Campaign for School Gardening.

Print child's name: . . . . . .

Signature of parent/carer: . . . . . Date: . . . . . .

Table 9.1 shows the nutrient and food intake for all the children who did not complete follow-up in Trial 1 by intervention allocation. As you can see from the nutrient values there are very little differences between the two groups.

Table 9.1 Baseline nutrient intake for all children who did not complete follow-up in Trial 1

	RHS-led (n=154)			Teacher-led (n=234)		
	Mean	**SE**	**95% CI**	**Mean**	**SE**	**95% CI**
Nutrients						
Energy (kcal)	**2046**	62.3	1922, 2169	**2119**	52.8	2015, 2223
Energy (KJ)	**8602**	261.2	8085, 9117	**8910**	221.3	8473, 9345
Protein (g)	**74**	2.2	68, 80	**77**	2.3	72, 81
Carbohydrate (g)	**263**	7.2	249, 277	**274**	6.0	262, 285
Fibre (Englyst) (g)	**13**	0.6	11, 13	**14**	0.4	12, 14
Fat (g)	**85**	3.6	77, 91	**87**	3.0	81, 93
Total sugars (g)	**127**	4.2	118, 134	**130**	3.7	122, 137
Iron (mg)	**11**	0.4	10, 12	**12**	0.3	10, 12
Calcium (mg)	**866**	31.4	804, 928	**889**	25.7	838, 939
Potassium (mg)	**2794**	91.5	2612, 2974	**2803**	91.5	2663, 2942
Sodium (mg)	**2794**	128.1	2541, 3047	**2750**	94.2	2563, 2935
Folate (µg)	**230**	8.4	213, 247	**229**	6.8	215, 242.
Carotene (µg)	**1855**	138.6	1580, 2128	**2103**	112.8	1880, 2324
Vitamin A (retinol equiv) (µg)	**423**	40.7	342, 503	**425**	24.9	376, 474
Vitamin C (mg)	**110**	5.7	98, 120	**100**	4.1	91, 108
Foods						
Total vegetables (non-pulse, bean, lentil, dahl or seed)(g)	**85**	6.6	71, 97	**98**	4.9	88, 107
Pulses, beans, seeds (g)	**27**	5.0	17, 36	**16**	2.5	11, 21
Total fruit (g)	**167**	13.2	140, 192	**204**	11.4	181, 226
Fruit (non-dried) (g)	**173**	14.2	144, 200	**204**	11.4	0.06, 1
Dried fruit (g)	**1**	0.5	-0.1, 1.7	**1**	0.3	181, 226
Total fruit & vegetables (excluding pulses & beans) (g)	**3**	0.2	2.7, 3.5	**4**	0.2	3.4, 4.1
Sweets, toffees, mints (g)	**4**	0.7	2, 5	**5**	0.8	3, 6
Chocolate bars, Mars etc. (g)	**7**	1.3	4, 9	**10**	1.2	7, 12
Crisps, savoury snacks (g)	**12**	1.3	9, 14	**11**	1.0	8, 12
Milk or milky drink (ml)	**118**	12.0	94, 141	**105**	8.8	87, 122
Fizzy pop, squash, fruit drink (ml)	**170**	16.7	136, 202	**174**	13.0	148, 199
Fruit juice (pure) (ml)	**128**	12.2	104, 152	**93**	7.9	77, 109

Table 9.2 shows the nutrient and food intake for all the children who did not complete follow-up in Trial 2 by intervention allocation. As you can see from the nutrient values there are very little differences between the two groups, with only 20 kcal difference between the RHS-led intervention group and the Teacher-led intervention group.

Table 9.2 Baseline nutrient intake for all children who did not complete follow-up in Trial 2

	Teacher-led (n=175)			Comparison Group (n=268)		
	Mean	**SE**	**95% CI**	**Mean**	**SE**	**95% CI**
Nutrients						
Energy (kcal)	**2020**	54.2	1912, 2126	**2030**	43.8	1943, 2116
Energy (KJ)	**8493**	226.8	8045, 8940	**8533**	183.6	8171, 8894
Protein (g)	**73**	2.3	68, 77	**75**	2.0	71, 79
Carbohydrate (g)	**265**	5.9	253, 276	**260**	5.1	250, 270
Fibre (Englyst) (g)	**13**	0.4	11, 13	**12**	0.3	11, 13
Fat (g)	**82**	3.3	75, 88	**84**	2.5	78, 88
Total sugars (g)	**132**	3.7	124, 139	**128**	3.2	122, 134
Iron (mg)	**11**	0.4	10, 11	**11**	0.3	10, 11
Calcium (mg)	**861**	27.1	807, 914	**825**	23.8	777, 871
Potassium (mg)	**2703**	80.0	2545, 2861	**2741**	62.3	2618, 2864
Sodium (mg)	**2619**	108.8	2404, 2833	**2644**	84.9	2477, 2811
Folate (µg)	**225**	7.5	210, 240	**220**	6.0	207, 231
Carotene (µg)	**1851**	121.0	1612, 2090	**2212**	109.0	1997, 2426
Vitamin A (retinol equiv) (µg)	**435**	39.9	356, 513	**439**	34.5	371, 507
Vitamin C (mg)	**107**	4.9	97, 116	**114**	4.0	106, 121
Foods						
Total vegetables (non-pulse, bean, lentil, dahl or seed)(g)	**87**	6.3	74, 99	**95**	4.8	85, 104
Pulses, beans, seeds (g)	**28**	4.7	15, 34	**9**	1.7	5, 12
Total fruit (g)	**195**	12.1	172, 219	**200**	10.7	179, 221
Fruit (non-dried) (g)	**195**	12.0	170, 218	**199**	10.6	177, 219
Dried fruit (g)	**1**	0.8	0.2, 2	**2**	0.5	0.6, 2
Total fruit & vegetables (excluding pulses & beans) (g)	**283**	14.9	253, 312	**295**	12.8	269, 320
Sweets, toffees, mints (g)	**3**	0.6	2, 4	**4**	0.6	2, 5
Chocolate bars, Mars etc. (g)	**9**	1.4	5, 11	**7**	1.0	5, 9
Crisps, savoury snacks (g)	**12**	1.2	9, 14	**13**	1.1	11, 15
Milk or milky drink (ml)	**136**	12.4	111, 160	**83**	9.1	75, 110
Fizzy pop, squash, fruit drink (ml)	**200**	17.5	165, 234	**213**	14.7	184, 242
Fruit juice (pure) (ml)	**114**	10.8	92, 135	**117**	8.5	100, 134

Table 9.3 Differences in non-essential food intake for Trial 1

Food	RHS-led Mean(g)	SE	95% CI	Teacher-led Mean(g)	SE	95% CI	Intervention effect Mean difference	SE	95% CI	P value
Unadjusted										
Sweets, toffees, mints (g)	**5**	0.7	3, 6	**5**	0.7	3, 6	**0.2**	0.9	-1, 2	0.8
Chocolate bars, Mars etc. (g)	**8**	1.1	6, 11	**8**	1.1	6, 11	**0.1**	1.5	-3, 3	0.9
Crisps, savoury snacks (g)	**12**	1.5	9, 15	**9**	1.4	6, 11	**3**	1.9	-0, 7	0.08
Milk or milky drink (ml)	**61**	12.1	37, 49	**80**	11.2	58, 102	**-19**	15.4	-49, 11	0.2
Fizzy pop, squash, fruit drink (ml)	**102**	17.5	67, 136	**103**	16.7	71, 136	**-1.7**	22.5	-45, 45	0.9
Fruit juice (pure) (ml)	**32**	2.8	26, 37	**35**	2.7	30, 40	**-3**	3.5	-10, 3.5	0.3
Adjusted for Age, IMDS, Ethnicity, & Gender										
Sweets, toffees, mints (g)	**4**	1.8	1, 8	**4**	1.7	1, 7	**0.2**	1.0	-1, 2	0.8
Chocolate bars, Mars etc. (g)	**6**	2.8	1, 12	**7**	2.6	1, 12	**-0.1**	1.4	-3, 3	0.9
Crisps, savoury snacks (g)	**14**	3.1	8, 20	**11**	2.8	5, 16	**3**	2.0	-0, 7	0.08
Milk or milky drink (ml)	**81**	25.2	31, 130	**101**	23.3	55, 146	**-20**	16.4	-52, 12	0.2
Fizzy pop, squash, fruit drink (ml)	**88**	35.5	19, 158	**89**	33.1	24, 154	**-0.7**	22.1	-44, 42	0.9
Fruit juice (pure) (ml)	**38**	6.6	25, 51	**41**	6.1	28, 53	**-2**	3.6	-9, 4	0.5

Table 9.4 Differences in non-essential food intake for Trial 2

Food	Teacher-led Mean(g)	SE	95% CI	Comparison Mean(g)	SE	95% CI	Intervention effect Mean difference	SE	95% CI	P value
Unadjusted										
Sweets, toffees, mints (g)	**5**	0.8	3, 7	**6**	0.7	5, 8.3	**-1**	1.1	-3, 0.8	0.2
Chocolate bars, Mars etc. (g)	**9**	0.9	7, 11	**9**	0.9	7, 11	**0.5**	1.3	-2, 3	0.6
Crisps, savoury snacks (g)	**10**	0.9	9, 12	**11**	0.9	9, 13	**-0.5**	0.9	9, 13	0.6
Milk or milky drink (ml)	**58**	8.1	42, 74	**59**	7.8	44, 74	**-1**	10.4	-21, 19	0.9
Fizzy pop, squash, fruit drink (ml)	**115**	13.7	88, 142	**121**	12.9	96, 146	**-6**	16.9	-39,27	0.7
Fruit juice (pure) (ml)	**35**	2.8	29, 40	**34**	2.7	28, 39	**1**	3.6	-6, 8	0.7
Adjusted for Age, IMDS, Ethnicity, & Gender										
Sweets, toffees, mints (g)	**3**	1.9	-0, 7	**4**	1.8	0, 8	**-1**	1.0	-3, 0	0.2
Chocolate bars, Mars etc. (g)	**12**	2.8	7, 18	**12**	2.7	6, 17	**0**	1.3	-1, 3	0.5
Crisps, savoury snacks (g)	**15**	2.6	10, 20	**15**	2.5	10, 20	**-0.5**	1.2	-3, 2	0.6
Milk or milky drink (ml)	**110**	20.6	70, 151	**111**	20.1	72, 151	**-1**	10.7	-21, 20	0.9
Fizzy pop, squash, fruit drink (ml)	**163**	32.6	99, 227	**170**	31.8	107, 232	**-6**	17.1	-40, 26	0.7
Fruit juice (pure) (ml)	**35**	6.3	22, 47	**34**	6.2	21, 45	**1**	3.3	-5, 7	0.7