

Exploring adolescent food choice: A food environment perspective

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Abstract

Obesity is a significant problem in young people. Relative to other age groups, less is known about health related lifestyle behaviours of young people, particularly in the transition period from adolescence to adulthood. Food choices are made within the food environment, which encompasses any opportunity to obtain food or influence food choice. Environmental exposures such as the availability and accessibility of 'more healthy' and 'less healthy' food options interact with individual factors to drive food choice. The aim of this work was to explore whether, and to what extent, the food environment to which a young person is *exposed* has an influence on individual dietary intake.

A range of methods including food diaries in conjunction with text messaging and photography, questionnaires, Global Positioning Systems (GPS), Geographical Information Systems (GIS), and qualitative interviews were used.

The majority of young people (96%) reported using a food outlet at least once over a 4-day period. Less healthy food outlets, such as takeaways and convenience stores, were the most frequently used. Being exposed to a greater number of food outlets was significantly associated with visiting a greater number of food outlets. Similarly, being exposed to a greater proportion of 'less healthy' food outlets was associated with visiting a greater proportion of 'less healthy' food outlets. However, relationships between the number of food outlets visited and dietary intake were weak and there was little evidence to suggest an association between exposure to food outlets and dietary intake. Qualitative results indicated that time, geographic location, economic cost and social occasion influenced choice of food outlet. In addition, the particular food outlet chosen appeared to dictate the food choices made with habitual repeat ordering of meals an emerging theme.

No previous research has linked individual eating behaviour to the food environment. Identifying the types of outlets young people use, the food choices made within and the factors influencing decisions and behaviours is important for the development of targeted long term obesity prevention strategies to facilitate healthier food outlet environments.

Dedication

In loving memory of two very special people taken from us far too soon.

James Wilton, 2nd October 1981 – 2nd February 2014

Roy Smith, 2nd August 1954 – 21st April 2014

Forever in our hearts.

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Statement of Contributions to Research

A number of people, including undergraduate placement students and fellow PhD students, contributed the data collection and entry at various stages of the study. All were trained and supervised by Rachel Tyrrell.

Gillian Hodge and Abigail Coleman were placement students in HNRC during 2010/11 and assisted with pilot study data collection (food diaries and anthropometric measurements) and data entry under supervision.

Lisa Burn was a placement student in HNRC during 2011/12 and assisted with food diary and anthropometric data collection during the main phase of the study. She completed questionnaire and food diary data entry and coding, and transcribed five of the qualitative interviews, under supervision.

Victoria Cox was supervised by Rachel Tyrrell when completing her undergraduate dissertation project during 2011/12. Victoria was trained to complete Measuring Food Environments surveys. The results from these surveys (n=30) were included in the final analysis.

Paul Adamson built the Food Environment Access database used for dietary analysis. Wendy Wills read the qualitative interview transcripts and provided a second option regarding the qualitative analysis coding frame.

Catherine Purvis-Mawson reviewed documents for suitability for use with young people, assisted with pilot study recruitment and provided contact details for youth workers during recruitment for the main study.

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Table of Contents

Chapter 1	Introduction	1
Chapter 2	Review of the literature	4
2.1	Literature review approach	4
2.2	Introduction	5
2.3	The obesogenic environment.....	7
2.3.1	Defining the food environment	9
2.4	Exposure food environment.....	13
2.4.1	Identifying food outlet locations	13
2.4.2	Classification of food outlets by type	15
2.4.3	Measures of exposure to food outlets	16
2.4.4	The relationship between exposure to food outlets and health outcomes.....	20
2.4.5	Using Global Positioning System and travel routes to investigate exposure to food outlets	25
2.5	Visited food environment	27
2.5.1	Organisational food environment	28
2.5.2	Visited community food outlet environment.....	34
2.5.3	Frequency of eating at food outlets and health outcomes	37
2.5.4	Consumer food environment.....	39
2.5.5	Consumer food environment and health outcomes.....	40
2.6	Individual food environment.....	44
2.6.1	Measuring health related outcomes in adolescents	45

2.6.2	Psychosocial factors influencing adolescent food choice	50
2.6.3	Socio-demographic factors influencing food choice	54
2.7	Literature review summary.....	56
2.8	Research aims and objectives	57
2.9	Methodology	58
Chapter 3	Methods development.....	59
3.1	Acceptability of methods	61
3.2	Lifestyle Questionnaire development	63
3.3	Questionnaire database development	63
3.4	Global Positioning System device testing and selection	64
3.5	Pilot study	65
3.5.1	Ethical approval and incentives.....	65
3.5.2	Study sample	65
3.5.3	Pilot study timeline	66
3.5.4	Questionnaire administration.....	68
3.5.5	Working with schools and gatekeepers.....	69
3.6	Analysis plan development	70
3.6.1	Identifying and measuring the Visited Food Environment	70
3.6.2	Identifying and measuring the Exposure Food Environment.....	72
3.7	Development of a topic guide for individual interviews	81
3.8	Summary	81
Chapter 4	Methods	82

4.1	Funding and ethics approval	84
4.2	Recruitment, consent and incentives	84
4.2.1	Recruitment criteria	84
4.2.2	Study contact details	85
4.2.3	Information leaflet.....	85
4.2.4	Consent form.....	85
4.2.5	Incentives and reimbursement	86
4.3	Individual Food Environment – Data Collection	86
4.3.1	Participation timeline	86
4.3.2	Food diary	89
4.3.3	Receipt collection	91
4.3.4	Text messaging.....	92
4.3.5	Photography.....	94
4.3.6	Questionnaires	95
4.3.7	Anthropometric measurements and calculations.....	98
4.3.8	Socio-economic status	100
4.3.9	Global Positioning System device	101
4.4	Visited Food Environment.....	102
4.4.1	Identifying and categorising the source of food	102
4.4.2	Identifying and categorising the eating location.....	103
4.4.3	Identifying and classifying visited food outlets.....	103
4.4.4	Assessing the ‘healthiness’ of food outlets using Measuring Food Environment surveys	105

4.4.5	Measuring Food Environment survey scoring	108
4.4.6	Individual measures of the visited food outlet environment	110
4.5	Exposure Food Environment	111
4.5.1	Extraction and cleaning of the Global Positioning System data	112
4.5.2	Identifying and classifying exposure food outlets	112
4.5.3	Calculating the Exposure Food Environment measures	115
4.6	Quantitative data analysis.....	117
4.6.1	Dietary analysis.....	117
4.6.2	Statistical tests	118
4.7	Individual qualitative interviews.....	119
4.7.1	Recruitment, consent and incentives	119
4.7.2	Topic guide and supporting documents	120
4.7.3	Qualitative data analysis	122
4.8	Summary	123
Chapter 5	Results: Participant characteristics	126
5.1	Ethnic origin, living arrangements and education/employment status	126
5.2	Socio-economic status.....	127
5.3	Anthropometric measurements.....	127
5.4	Summary	129
Chapter 6	Results: Home Food Environment and Lifestyle Questionnaires .	130
6.1	Response rates.....	130
6.2	Visits to fast food, restaurant and takeaway outlets.....	130

6.3	Eating behaviours and food rules at home.....	133
6.4	Home food availability.....	136
6.5	Alcohol consumption habits	140
6.6	Physical activity and sedentary behaviour	140
6.7	Summary	143
Chapter 7 Results: Dietary intake and habits.....		144
7.1	Normality testing	144
7.2	Dietary intake compared to current recommendations and national averages.....	145
7.3	Dietary intake on week and weekend days.....	147
7.4	Dietary intake and adiposity.....	149
7.5	Dietary intake and socio-economic status.....	152
7.6	Adolescent Food Habits Checklist results.....	155
7.7	Summary	156
Chapter 8 Results: Identifying and characterising the source of food.....		158
8.1	Identifying and describing of the food sources used by young people	158
8.2	Describing the source of food in relation to the eating location.....	162
8.3	Exploring the relationship between food source and dietary intake ...	164
8.4	Energy and nutrient density by food source.....	166
8.5	Summary	172
Chapter 9 Results: Relationship between the Visited Food Environment and dietary intake.....		174

9.1	Describing the visited food environment using food outlet classification categories	174
9.2	Nutrient density and food outlet environment.....	179
9.3	Visited food outlet environment and dietary intake	184
9.3.1	VFE-Count and dietary intake	185
9.3.2	Measuring Food Environment survey results	187
9.3.3	Individual Measuring Food Environments scores.....	191
9.3.4	VFE-Ratio and dietary intake	193
9.4	Summary	196
Chapter 10	Results: Relationship between the Exposure Food Environment and dietary intake, adiposity and socio-economic status	198
10.1	Exposure Food Environment Count.....	198
10.1.1	Relationship between EFE-Count, adiposity and socio-economic status	203
10.1.2	Relationship between EFE-Count and dietary intake	205
10.2	Exposure Food Environment Ratio.....	205
10.2.1	Relationship between EFE-Ratio, adiposity and socio-economic status	207
10.2.2	Relationship between EFE-Ratio and dietary intake	207
10.3	Relationship between the Exposure Food Environment, socio-economic status, adiposity and recommended dietary intake.....	208
10.4	Relationship between the Exposure and Visited Food Environments... ..	208
10.5	Summary	209
Chapter 11	Results: Findings from qualitative individual interviews	210

11.1	Interviewee characteristics	210
11.2	Introduction of themes	211
11.3	Theme 1: Eating out	213
11.3.1	Choice of food outlet	213
11.3.2	Food (meal) choice	216
11.3.3	Price, meal deals and sharing	218
11.3.4	Eating out in conjunction with other social activities	220
11.3.5	Eating out and alcohol.....	222
11.3.6	Eating out with parents.....	224
11.3.7	Eating out summary	226
11.4	Theme 2: Takeaway food	227
11.4.1	Conditions leading to takeaway eating events	227
11.4.2	Factors influencing choice of takeaway food outlet	229
11.4.3	Takeaway food (meal) choice	232
11.4.4	Takeaway food summary	234
11.5	Summary of interview findings.....	234
Chapter 12	Discussion and conclusions	236
12.1	Identifying the food environment of young people at the individual level	237
12.1.1	Importance of the home to dietary intake	237
12.1.2	Friends' and relatives' homes as a source of food	238
12.1.3	Young peoples' use of the school food environment.....	239
12.1.4	Frequency and type of food outlet use	241

12.2	Use of individual environment ratings and the relationships between the food environment and health outcomes.....	246
12.3	Exploring the drivers of food choice in young people	252
12.4	Strengths and limitations of the study	256
12.4.1	Strengths.....	256
12.4.2	Limitations	258
12.5	Policy recommendations for improving the food environment	265
12.6	Suggestions for future research.....	267
12.7	Overall conclusions	269
	References.....	271
	List of Appendices.....	292

List of Figures

Figure 1 Model of Adolescent Food Environments adapted from Glanz <i>et al.</i> (2005) model of Community Nutrition Environments.....	12
Figure 2 Terminology used in identifying geographic areas of measurement ...	17
Figure 3 Methods for measuring food outlet exposure.....	18
Figure 4 Flowchart of methods development process.....	60
Figure 5 Exposure Food Environment Count for pilot study participants (n=10) at 25, 50, 100, 200 and 400 metre buffer sizes surrounding GPS waypoints. The data lines represent the individual pilot study participants (n=10).....	77
Figure 6 Map depicting GPS waypoints, food outlet locations (Burgoine, 2010) and range of buffer sizes tested in pilot study (ID515)	79
Figure 7 Map depicting primary and secondary data collection of food outlet locations and the use of varying buffer sizes in relation to GPS waypoints located on a single road.	80
Figure 8 Overview of methods used	83
Figure 9 Photograph of a study pack which contained the following: information leaflet; photograph example sheet; QStarz GPS device and instructions; food diary; and a pen.	87
Figure 10 Timeline for participant data collection.....	88
Figure 11 Position adopted for height measurement	99
Figure 12 Calculation of Individual Measuring Food Environment Score.....	111
Figure 13 Flowchart to show the steps taken to link the Global Positioning System data with food outlet locations to establish the Exposure Food Environment of individuals	115
Figure 14 Process of calculating the EFE-Count from GPS waypoints and food outlet database using ArcGIS v10.1.....	116

Figure 15 Distribution of participants within Index of Multiple Deprivation (IMD) quintiles for the North East of England.....	127
Figure 16 Frequency of visiting fast food, takeaway and other types of restaurant. Source (a) LSQ (n=44), (b) HFEQ (n=45).....	132
Figure 17 Eating habits and behaviours at home. Source: HFEQ (n=45)	134
Figure 18 Parent/ guardian food rules at home. Source: HFEQ (n=45)	135
Figure 19 General availability of food in the home. Source: HFEQ (n=45)	137
Figure 20 Availability of fruits and vegetables in the home. Source: HFEQ (n=45)	138
Figure 21 Availability of food items in the home. Source: HFEQ (n=45)	139
Figure 22 Frequency of alcohol consumption by beverage type. Source: LSQ (n=44)	140
Figure 23 Self-reported number of hours per day spent in screen based sedentary behaviour on weekdays and weekend days. Source: LSQ (n=44) .	141
Figure 24 Physical activity: Over the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day? Source: LSQ (n=44)	142
Figure 25 Scatterplot to show the correlation between mean daily energy density (KJ/100g) and BMI (n=45)	150
Figure 26 Scatterplot to show the correlation between mean daily of saturated fat (% energy) and BMI (n=45).....	150
Figure 27 Scatterplot to show the correlation between mean daily of alcohol (% energy) and BMI (n=45)	151
Figure 28 Scatterplot to show the correlation between mean daily energy density (KJ/100g) and socio-economic status (IMD score) (n=45).....	153
Figure 29 Scatterplot to show the correlation between mean daily intake of saturated fat (% energy) and socio-economic status (IMD score) (n=45)	154

Figure 30 Scatterplot to show the correlation between mean daily intake of fruit (g) and socio-economic status (IMD score) (n=45)	154
Figure 31 Contribution of food source to total eating events, overall and by gender, BMI and SES groups (n=45)	160
Figure 32 Contribution of food source to total eating events for week and weekend days (n=45).....	161
Figure 33 Sankey diagram showing the flow of eating events from food source to eating location.....	163
Figure 34 Mean contribution of food source to total dietary intake (n=45)	165
Figure 35 Energy density (KJ/100g food) by food source	167
Figure 36 Nutrient density: Total fat density per MJ energy by food source ...	167
Figure 37 Nutrient density: Protein density per MJ energy by food source	168
Figure 38 Nutrient density: Total carbohydrate density per MJ energy by food source	169
Figure 39 Nutrient density: Total sugars density per MJ energy by food source	169
Figure 40 Nutrient density: Fibre (NSP) density per MJ energy by food source	170
Figure 41 Nutrient density: Iron density per MJ energy by food source	171
Figure 42 Nutrient density: Vitamin C density per MJ energy by food source	172
Figure 43 Mean proportional contribution of food outlet types to food outlet eating events overall, by gender, BMI and SES groups.....	176
Figure 44 Food photographs taken by participant of food sourced from traditional eateries.....	177
Figure 45 Photographs taken by participants of food sourced from takeaway eateries	178

Figure 46 Photographs taken by participants of food sourced from grocery outlets and convenience outlets.....	178
Figure 47 Energy density (kJ/100g) by food outlet type	179
Figure 48 Nutrient density: Total fat density per MJ energy by food outlet type	180
Figure 49 Nutrient density: Saturated fat density per MJ energy by food outlet type	181
Figure 50 Nutrient density: Protein density per MJ energy by food outlet type.....	181
Figure 51 Nutrient density: Carbohydrate density per MJ energy by food outlet type	182
Figure 52 Nutrient density: Total sugars density per MJ energy by food outlet type	183
Figure 53 Nutrient density: Fibre (NSP) density per MJ energy by food outlet type	183
Figure 54 Nutrient density: Iron density per MJ energy by food outlet type	184
Figure 55 Histogram to show the variation in VFE-Count across the study population (n=45)	185
Figure 56 Flow chart of the Measuring Food Environment Survey completion process	188
Figure 57 Histogram to show the distribution of food outlet MFE scores	189
Figure 58 Histogram to show the variation in VFE-Ratio across the study population	193
Figure 59 Correlation between VFE-Ratio and mean daily energy density for 'overweight and obese' BMI group (n=9)	195
Figure 60 Histogram to show the variation in EFE-Count across the study population	199

Figure 61 Map to show the calculation of the EFE-Count for a participant representing the 25 th percentile (food outlet n=6)	200
Figure 62 Map to show the calculation of the EFE-Count for a participant representing the median (food outlet n=14)	201
Figure 63 Map to show the calculation of the EFE-Count for a participant representing the 75 th percentile (food outlet n=37)	202
Figure 64 Mean proportional contribution of food outlet types to Exposure Food Environment (EFE) Count overall, by gender, BMI and SES groups	204
Figure 65 Histogram to show the variation in EFE-Ratio across the study population	206

List of Tables

Table 1 Thematic clusters included in the Foresight Obesity Systems Map (Foresight, 2007a).....	9
Table 2 Summary of discussion from Beacon North East workshops with young people and changes implemented	62
Table 3 Number of GPS active hours – total running time calculated using data for participants where raw un-cleaned data available (n=5).....	73
Table 4 Reminder and Ecological Momentary Assessment (EMA) text message content and schedule.....	94
Table 5 Description of the measures included in the Lifestyle Questionnaire (LSQ) and the original source references	96
Table 6 International Obesity Task Force age specific cut-offs for underweight, overweight and obesity, for young adults aged 16-18 years (Cole <i>et al.</i> , 2000) (Cole <i>et al.</i> , 2007)	99
Table 7 World Health Organization waist circumference and waist-hip ratio cut-off points and risk of metabolic complications (World Health Organization, 2011)	100
Table 8 Outline of food outlet classification system categories contained within amalgamated food outlet categories	105
Table 9 Description of the measures included in the MFE-Shop survey	106
Table 10 Description of the measures included in the MFE-Restaurant survey	107
Table 11 Description of the measures included in the MFE-Vending survey ..	108
Table 12 Test re-test reliability of the MFE-Shop and MFE-Restaurant surveys, difference between time point 1 (T1) and time point 2 (T2).....	110
Table 13 Anthropometric characteristics of participants.....	128

Table 14 Prevalence of underweight, healthy weight, overweight and obesity assessed using BMI and International Obesity Task Force cut-offs (Cole <i>et al.</i> , 2000) (Cole <i>et al.</i> , 2007)	128
Table 15 Mean daily dietary intake of all participants and by gender compared to National Diet and Nutrition Survey (NDNS) Rolling Programme figures for 2008/09 – 2010/11 for 11-18 year olds (Department of Health, 2012) (Iron and Vitamin C 2009/10 figures(Department of Health, 2011b)) and UK recommended intakes for young people aged 15-18 years (Department of Health, 1991)	146
Table 16 Mean (SD) dietary intake by week and weekend day (n=44)	148
Table 17 Correlations between mean daily dietary intake and Body Mass Index (BMI)	149
Table 18 Correlations between mean daily dietary intake and socio-economic status (IMD score) (n=45)	152
Table 19 Adolescent Food Habit Checklist (AFHC) score overall and by gender, BMI and SES (n=45)	155
Table 20 Correlations between Adolescent Food Habits Checklist score and mean dietary intake (n=45)	156
Table 21 Total and mean number of Eating Events (EE) by food source over 4 days and per day for total study population and users only	159
Table 22 Food outlet classification category use: total number of users (n), total count (n) and percentage contribution (%) of eating events in each food outlet category; mean, standard deviation (SD), range of food outlet eating events per user of the food outlet category	175
Table 23 Relationship between participants (n=45) mean daily intake of food and nutrients and total number food outlet eating events (VFE-Count)	186
Table 24 Measuring Food Environments Survey score by food outlet classification category	190

Table 25 MFE score by food outlet type and Measuring Food Environment survey type*	191
Table 26 Correlations between Individual Measuring Food Environments (MFE) score and mean daily dietary intake (n=41)	192
Table 27 Relationship between participants (n=43) mean daily intake of food and nutrients and ratio of takeaway/convenience outlet eating events to total food outlet eating events (VFE-Ratio)	194
Table 28 Relationship between participants (n=45) mean daily dietary intake and total number food outlet exposures (EFE-Count)	205
Table 29 Relationship between participants mean daily intake of food and nutrients and ratio of takeaway/convenience outlet exposures to total food outlets exposures (EFE-Ratio)	207
Table 30 Food outlets identified within interview transcripts with regards to eating with friends, family and alone	212

List of Boxes

Box 1	The influence of friendship groups on food outlet choice	214
Box 2	Friendship groups and the selection of new food outlets to visit	215
Box 3	Making food choice decisions and repeat orders in chain restaurants.....	217
Box 4	Cost of food and meal deals	219
Box 5	Eating out and cinema visits	221
Box 6	Young peoples' views on alcohol	223
Box 7	Eating out in restaurants with family	225
Box 8	Reasons for and frequency of use of takeaway food outlets for home consumption.....	228
Box 9	Takeaway food outlet selection with family	230
Box 10	Takeaway food outlet selection with friends	232
Box 11	Selection of meals from takeaway outlets	233

Abbreviations

AFHC	Adolescent Food Habits Checklist
BMI	Body Mass Index
DH	Department of Health
DRV	Dietary Reference Value
EFE	Exposure Food Environment
FFQ	Food Frequency Questionnaire
FSA	Food Standards Agency
GIS	Geographic Information System
GPS	Global Positioning System
HFEQ	Home Food Environment Questionnaire
IMD	Index of Multiple Deprivation
IOTF	International Obesity Task Force
LSQ	Lifestyle Questionnaire
MFE	Measuring Food Environments
MVPA	Moderate to Vigorous Intensity Physical Activity
NDNS	National Diet and Nutrition Survey
NHS	National Health Service
NSP	Non-starch polysaccharide (dietary fibre)
PFEI	Physical Food Environment Indicator
RFEI	Retail Food Environment Index
RNI	Reference Nutrient Intake
SD	Standard deviation
SES	Socio-economic status
UK	United Kingdom
USA	United States of America
VFE	Visited Food Environment
WC	Waist Circumference
WHO	World Health Organization
WHR	Waist to Hip Ratio

Chapter 1 Introduction

This research was funded by the Food Standards Agency (FSA) under their 2009 postgraduate funding scheme. At the time of application, nutrition policy in the UK was the responsibility of the FSA, although this has since been transferred to the Department of Health (DH). This research was designed to address the topic of 'social science of food' and fit within Chapter 4 'Eating for Health' of the FSA's strategic plan for 2005-2010 (Food Standards Agency) which focused on making healthier food choices easier for consumers.

The project used a multi-disciplinary approach to assess the food environment of young people in the UK assimilating novel methods with tried and tested techniques. In 2009, Global Positioning System (GPS) and Geographic Information System (GIS) methods were emerging in the health research literature, particularly within studies investigating the physical activity environment (Krenn *et al.*, 2011). This project aimed to use this technology in the food environment context, linking the exposure of food outlets to the individual. Building on previous work (Lake *et al.*, Submitted December 2013; Lake *et al.*, Submitted October 2013a; Lake *et al.*, Submitted October 2013b), this research had the overall aim to explore whether, and to what extent, the food environment to which a young person is *exposed* has an influence on individual dietary intake.

The thesis is structured as follows:

Chapter Two contains a review of the food environment literature. The volume of academic publications on the topic of food environments has increased exponentially over the past few years, in line with increased interest in the possible environmental causes of obesity and the potential to positively change environments,. With this in mind, the literature review briefly discusses the concept of the 'obesogenic environment' before focusing on reviewing current evidence of relationships between the food environment and the health of young people. Where relevant, the methods used to measure the food environment are critically reviewed. At the end of this chapter, there is a statement of the overarching aims for this research.

A number of research methods and protocols used in this research were developed specifically for use with young people. These are detailed in Chapter Three. The main focus of this chapter is the selection of a GPS device suitable for the research and the development of an analysis plan following completion of a full pilot study.

Chapter Four outlines the methods adopted in this study. Each method and protocol is described in detail and the use of each method justified with examples of use from the literature.

Chapter Five is the first of seven results chapters. Participant demographic characteristics such as gender and age are presented alongside socio-economic status and the prevalence of overweight and obesity within the participant group.

Chapter Six presents the results from two questionnaires; the Home Food Environment Questionnaire covering aspects of availability of food in the home and parental rule/controls with regards to food, and the Lifestyle Questionnaire including the assessment of factors such as physical activity, sedentary behaviour and alcohol consumption.

Chapter Seven presents an overview of the dietary intake data, overall and by gender, Body Mass Index (BMI) and socio-economic (SES) groups. Dietary intake data for the participant group are compared with current dietary guidelines. The study population are also compared to National Diet and Nutrition Survey figures to indicate the representativeness of the sample compared to the population average. Results from the Adolescent Food Habits Checklist, a questionnaire assessing usual food choice habits, are also presented within this chapter.

An analysis of the sources of food consumed by participants is the focus of Chapter Eight. This chapter identifies the food source for eating events recorded in the food diary and reports the mean contribution of each food source to dietary intake. Chapter Nine which contains a focused exploration of the *Visited* Food Outlet Environment, identifying the specific food outlet types used by young people and their contribution to total dietary intake. In addition, the consumer food choice environment of the visited food outlets is assessed

for healthiness of food choices available therein using specifically developed Measuring Food Environments surveys.

Chapter Ten describes the *Exposure* Food Environment of individuals. Global Positioning System (GPS) data are used in conjunction with Geographic Information System (GIS) techniques to provide a measure of food outlet exposure experienced by young people, linked to the individual. Relationships between exposure and visited food outlet environment, dietary intake, BMI and SES are investigated.

Chapter Eleven presents results from the qualitative interview phase of the study. Here the factors and drivers influencing the food choice of young people are explored. Analysis of the interview data is focused on two emergent themes; 'eating out' and 'takeaway food'.

Chapter Twelve draws together the research presented in the thesis and discusses the findings in relation to previous research in the field. Final conclusions are presented and recommendations for future obesity prevention strategies in relation to current public health policy regarding out-of-home eating are considered.

Chapter 2 Review of the literature

Chapter overview:

- Literature review approach
- Introduction
- The obesogenic environment
- Exposure food environment
- Visited food environment
- Individual food environment
- Literature review summary
- Research aims and objectives
- Methodology

2.1 Literature review approach

Prior to this PhD research, a number of pilot studies were conducted with the aim of developing a tool kit for measuring the food environment of adolescents (Lake *et al.*, Submitted December 2013; Lake *et al.*, Submitted October 2013a; Lake *et al.*, Submitted October 2013b). A literature review of measures used to assess the food environment was conducted as part of an undergraduate dissertation (Tyrrell, 2008) and this was used as a starting point for the current literature review. A thorough literature search was continued throughout the study.

At first the literature review focussed primarily on methods of assessing the food environment and at this stage the majority of papers included were primary studies. Throughout the course of the research, many systematic and narrative reviews of the food environment literature were published and it is these review papers that form the base of the final literature review presented in this thesis. This resulted in a narrative literature review which was structured based on the Glanz (2005) model of nutrition environments building up from the individual food environment and behaviours through to the visited food environment and finally the exposure food environment. Research papers with a focus on young people, particularly older adolescents took precedence. A search for literature focusing on the specific methods used in this study, such as Global Positioning

Systems and Geographic Information Systems, in relation to any health related research was also completed.

A narrative review was deemed the most appropriate literature review method due to the extent of the topics and methods being investigated across a number of disciplines. Systematic reviews are most commonly adopted in quantitative research where research papers answering a specific question are pooled to give a summary of the research (Grant and Booth, 2009). Due to the broad nature of the research questions in this thesis and the mixed methods used a narrative approach was more appropriate. However, it is acknowledged that the review may therefore be biased in terms of the selection of research papers in the absence of set inclusion, exclusion and quality criteria which would be detailed from the outset of a systematic review.

Databases used for the literature searches included PubMed, Scopus, Ovid and Web of Knowledge. The National Cancer Institute's Measures of the Food Environment website (National Cancer Institute, 2012) was used to explore methods of measuring the food environment. In addition, automatic alerts were set up for specific scientific journals of interest including Health & Place, Public Health Nutrition and the Journal of Adolescence. Key words included: adolescent; young people; food environment; obesogenic environment; global positioning systems; geographic information systems; dietary intake; eating patterns; food choice; and body mass index.

2.2 Introduction

Obesity is a major global health problem, the prevalence of which is continuing to rise world-wide. A number of environmental factors are believed to contribute to the continued global increases in overweight and obesity. These include a shift in diet towards increased consumption of energy dense foods, high in fat and sugars but low in vitamins, minerals and other micronutrients, alongside a decrease in physical activity levels due to increasingly sedentary occupations, changes in modes of transportation and increasing urbanisation (World Health Organization, 2006).

Type-2 diabetes, hypertension, coronary heart disease, stroke and some cancers are just a few of the health conditions associated with overweight and

obesity (Butland *et al.*, 2007). In addition to the health implications to the individual, obesity has wider cost consequences to society and the economy. The direct cost of obesity to the National Health Service (NHS) is estimated to be £5.1bn per year (Department of Health, 2011a). Including the costs associated with dependence on state benefits, loss of earnings and reduced productivity, the wider costs of obesity and overweight are around £16bn per year (Department of Health, 2011a). The Foresight report (Butland *et al.*, 2007) predicted the annual direct cost of obesity to the NHS to be £6.5bn by 2050, with the wider cost to society at around £50bn.

The Health Survey for England 2011 (The Health and Social Care Information Centre, 2012) reported that obesity prevalence in young people aged 16-24 years was 9% for males and 12% for females. For the same age group, a third of young men (32%) and young women (33%) were classified as overweight or obese. It is predicted that 36% of male and 28% of female adults in the UK will be obese by 2015 (Butland *et al.*, 2007). If prevalence continues to rise at the current rate, 60% of males and 50% of females could be obese by 2050 (Butland *et al.*, 2007).

Obesity has been shown to track throughout the life stages. Those individuals who are obese during adolescence are likely to remain obese throughout their adult life (Craigie *et al.*, 2009). This may be due to obesity promoting behaviours such as poor dietary patterns and low physical activity levels developed during childhood or adolescence tracking into adulthood (Baranowski *et al.*, 2000; Larson *et al.*, 2008; Craigie *et al.*, 2011). In their 2003 report on diet, nutrition and prevention of chronic diseases, the World Health Organisation (2003) identified three critical aspects of adolescence (defined as the period of development between childhood and adulthood) that have an impact on chronic diseases:

- 1.the development of risk factors during the adolescent period
- 2.the tracking of these risk factors throughout life
- 3.the development and tracking of healthy or unhealthy habits, such as physical inactivity

Less is known about the diet related lifestyle behaviours of young adults, relative to other age groups (Nelson *et al.*, 2006). Adolescence, particularly the transition period between late adolescence and young adulthood, is a time where a number of life changes occur such as transition into further education or work and moving out of the parental home. During late adolescence many young people start to explore the world, exposing themselves to alternative lifestyle patterns and behaviours which could impact behaviours in later life (Butland *et al.*, 2007). Adolescence could therefore be a critical time point for behaviour change intervention implementation (Butland *et al.*, 2007).

Understanding the relationship between what we eat and the environmental context in which we make food choices is essential to the development of long term solutions for the prevention of obesity and other diet related diseases (Lake *et al.*, 2010).

2.3 The obesogenic environment

Although it is acknowledged that genetics and biology play a role in the aetiology of obesity, the dramatic increase in obesity prevalence over recent years suggests the environment plays the leading role and may be the factor most adaptable to change (Butland *et al.*, 2007). The environment an individual interacts with plays a strong role in how lifestyle behaviours are shaped and subsequently maintained (Alberga *et al.*, 2012). At an individual level, unhealthy lifestyles and lack of self-control may be contributing factors to the obesity epidemic. However, if the environment makes it difficult to make healthy lifestyle choices, the individual may not be fully responsible for the choices they make (Butland *et al.*, 2007). Research interest in exploring the influence of the environment on health behaviours and related outcomes has therefore increased in recent years (McKinnon *et al.*, 2009; Kirk *et al.*, 2010).

The term 'obesogenic environment' is defined as 'the sum of influences that the surroundings, opportunities or conditions of life have on promoting obesity in individuals or populations' (Swinburn *et al.*, 1999, p564). It refers to the role environmental factors may play in determining both energy intake and expenditure and the subsequent development of obesity (Swinburn *et al.*,

1999). The term embraces the entire range of social, cultural and infrastructural conditions that influence an individual's ability to adopt a healthy lifestyle.

There is currently a lack of conclusive evidence on how, and to what extent obesity is encouraged by the environment, although some trends and themes are emerging (Butland *et al.*, 2007). Tackling the obesity epidemic requires a multifaceted approach (Butland *et al.*, 2007); the multiplicity and complexity of the systems operating in obesity development are demonstrated within the Foresight Obesity Systems map (Foresight, 2007a). Within the map, factors that positively or negatively influence the energy balance equation are grouped into seven interlinking thematic clusters, outlined in Table 1.

Table 1 Thematic clusters included in the Foresight Obesity Systems Map (Foresight, 2007a)

Thematic Cluster	Description	Examples
<i>Social psychology</i>	Variables that have an influence at the societal level	Education, watching television (exposure to advertising), peer pressure.
<i>Individual psychology</i>	Variables that describe physiological factors relating to the individual	Self-esteem, food literacy, social interaction, psychological ambivalence
<i>Physical activity environment</i>	Opportunities for individuals to partake in physical activity in either surrounding environment or leisure centres etc.	Access to opportunities for physical exercise, cost of physical exercise, walk-ability of living environment
<i>Individual activity</i>	Activity undertaken by an individual or group	Levels of physical activity including recreational, occupational and domestic activity, levels of active transport e.g. walking, cycling
<i>Physiology</i>	Mix of biological variables including predisposition to obesity and the effect of differences in genetic makeup on an individual's ability to maintain a healthy weight	Degree of appetite control, level of satiety, genetic and/or epigenetic predisposition to obesity, resting metabolic rate
<i>Food Production</i>	Drivers of the food industry and wider social and economic variables impacting demand and purchasing power	Food production and catering, cost of ingredients, desire to maximise volume, pressure to improve access to food offerings.
<i>Food Consumption</i>	Characteristics of the consumer food environment and influences on individual food choice	Force of dietary habits, nutritional quality of food offerings including energy density, portion size, convenience, variety and abundance.

The environment can impact health through mediation of the physical activity environment and the food environment (Lake and Townshend, 2006). The focus of this research is to explore the food environment and therefore the aim of the literature review from this point forward is to explore the impact of different aspects of the food environment on the health of young people.

2.3.1 Defining the food environment

The food environment encompasses all opportunities for an individual to obtain food and the environmental factors that influence food choice (Lake *et al.*, 2010). This environment is complex and multi-level (Glanz, 2009). A number of models have been constructed to conceptualise and map the food environment and the factors influencing individual food choice (Swinburn *et al.*, 1999; Glanz *et al.*, 2005) and dietary intake (Rosenkranz and Dzewaltowski, 2008).

One of these models is the Analysis Grid for Environments Linked to Obesity (ANGELO framework) (Swinburn *et al.*, 1999), which provides a framework for identifying environmental factors influencing health behaviours including food choice (Simmons *et al.*, 2009). The grid itself comprises of two environment sizes on one axis (micro and macro) and four environment types on the other (physical, economic, political or socio-cultural). Two systematic reviews using the ANGELO framework (Swinburn *et al.*, 1999) have identified a lack of research on the physical micro-environment using diet as an outcome measure (van der Horst *et al.*, 2007; Kirk *et al.*, 2010).

Perhaps the most comprehensive definition of the food environment is the model of community nutrition environments developed by Glanz *et al.* (2005) which includes policy, environmental, individual and behaviour factors as influences on food choice. This model has provided the conceptual basis for many studies of the food environment (Ding *et al.*, 2012; Williams *et al.*, 2012; Minaker *et al.*, 2013). Within the model, three types of nutrition environment variables were identified: 'community', 'organisational', and 'consumer' (Glanz *et al.*, 2005). Research measures that might be considered within each environment variable are presented within the model and the need to consider the influence of policy, information and individual factors on behaviour, and therefore health, is acknowledged (Glanz *et al.*, 2005).

Figure 1 presents a model of the adolescent food environment developed using the concepts presented within the community nutrition environment model (Glanz *et al.*, 2005). The concepts presented in Figure 1 are used to form the structure this literature review.

From this point forward the food environment is discussed according to the following three environment types:

- Exposure Food Environment
- Visited Food Environment
- Individual Food Environment

The Exposure Food Environment (EFE) encompasses the food environment to which individuals are potentially *exposed* during everyday life and thus represent the opportunities to obtain food. The EFE identifies the food outlets

individuals have the potential to access but do not necessarily visit. Ecological and individual level exploration of exposure to food outlets in relation to diet and adiposity outcomes are presented within this review. The information environment and relevant Government policy are also briefly discussed.

The Visited Food Environment (VFE) includes the identification and measurement of the 'organisational', 'community' and 'consumer' nutrition environments (Glanz *et al.*, 2005) i.e. the sources of food accessed at the individual level. 'Organisational' environments include those unique to the individual user in terms of access such as home, school and workplace. Food outlets, such as shops and restaurants that individuals use, make up the visited 'community' environment. 'Consumer' environment refers to the food choices and information available within the food outlet environment e.g. availability of fruits and vegetables in convenience stores or healthier options highlighted on restaurant menus.

The Individual Food Environment is defined as the behaviours an individual exhibits with regards to food such as dietary patterns and intake which can lead to diet related health outcomes such as adiposity. It also includes factors which may influence individual food choice such as psychosocial measures e.g. family and peer group influences, and socio-demographics e.g. socio-economic status. Age, gender, and lifestyle factors including physical activity, sedentary behaviour and habitual alcohol intake are also included here.

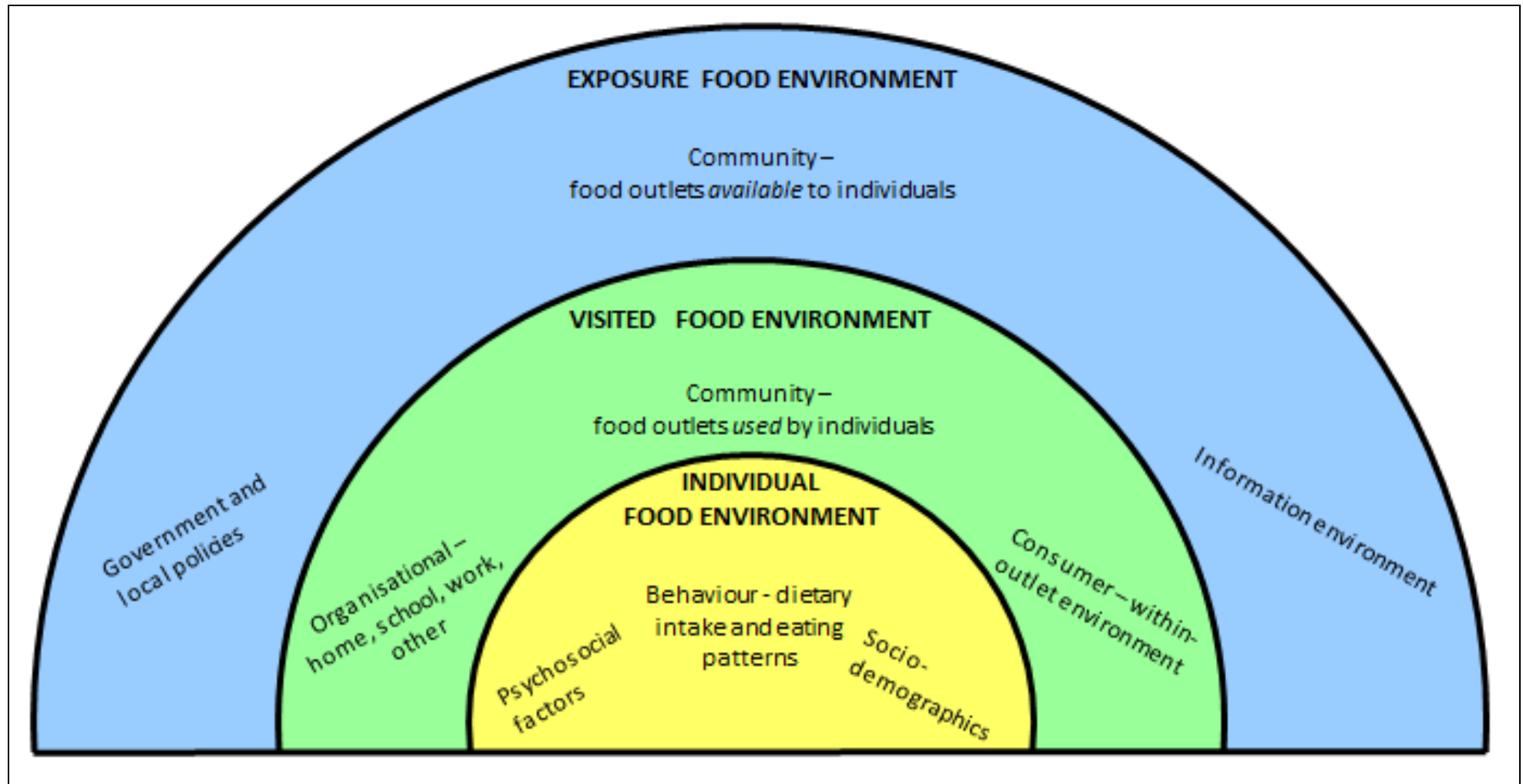


Figure 1 Model of Adolescent Food Environments adapted from Glanz *et al.* (2005) model of Community Nutrition Environments

2.4 Exposure food environment

As outlined in the previous section, the exposure food environment refers to the 'community' nutrition environment depicted in the Glanz *et al.* (2005) model in terms of potential for individuals to access food outlets. This section outlines the process of identifying and categorising food outlets before exploring the commonly used measures of food outlet exposure. The chapter concludes by reviewing the current evidence of relationships between exposure to food outlets and diet and adiposity outcomes in young people at both the population and individual level.

2.4.1 Identifying food outlet locations

The identification of the geographic location of food outlets within a pre-defined area is an important first step for most research exploring the community food environment (Lake *et al.*, 2010). There is a heavy reliance on secondary data sources to collate information with regards to food outlet location (Holsten, 2009). These include local Government department listings (e.g. local council environmental health) (Macdonald *et al.*, 2009; Morland and Evenson, 2009), commercial business directories (Powell *et al.*, 2007; California Center for Public Health Advocacy *et al.*, 2008; Pasch *et al.*, 2009; Seliske *et al.*, 2009b; Lisabeth *et al.*, 2010; Truong *et al.*, 2010), telephone directories (Burgoine *et al.*, 2009; Thornton *et al.*, 2009; Héroux *et al.*, 2012), and Internet derived lists (Paquet *et al.*, 2008; Rossen *et al.*, 2012).

The reliability and validity of secondary data sources is questionable (Fleischhacker *et al.*, 2013), with these sources found to both over- (Cummins and Macintyre, 2009) and under-estimate (Lake *et al.*, 2010) the number of food outlets located in a geographic area when compared to primary data collected through 'ground truthing' or 'fieldwork' methods. A number of validation studies have been conducted to assess the accuracy of secondary sources in identifying the location of food outlets (Sharkey and Horel, 2008; Cummins and Macintyre, 2009; Lake *et al.*, 2010; Rossen *et al.*, 2012; Svastisalee *et al.*, 2012; Liese *et al.*, 2013).

Focusing on UK studies, in Newcastle upon Tyne Lake *et al.* (2010) compared the accuracy of secondary methods; online and print Yellow Pages directories

and local council environmental health lists, to primary fieldwork identifying all outlets selling food products. The majority of outlets recorded in the field dataset were also listed by the council (83.6%) but a much lower number were present in the Yellow Pages (51.2% online and 50.9% in print) indicating an underestimate of the secondary data to identify the presence of food outlets. In contrast, Cummins and Macintyre (2009) reported that one in nine food store outlets present on a list obtained from Glasgow City Council, Scotland were not present on the ground (i.e. not trading, closed for business) suggesting that council lists may overestimate the number of food store outlets. Studies conducted in the USA have reported similar findings highlighting the need to use fieldwork methods to identify food outlets wherever possible (Sharkey and Horel, 2008).

Combining secondary datasets has been shown to increase the accuracy with which food outlets are identified. Lake *et al.* (2010) reported that 92.9% of outlets identified through the fieldwork were identified through a combined council and yellow pages list.

The accuracy with which data can be mapped is also a consideration when choosing a data source. Liese *et al.* (2010) demonstrated increased accuracy of locating and mapping food outlets through primary geo-tagging methods compared to secondary data sources. Although 80% of outlets identified through secondary data sources were coded to the correct census tract¹, less than 40% of outlets were allocated to a location within 100 metres of the fieldwork geo-coded location. The accuracy required for food outlet locations is dependent on the type of outcome measures being sought and the geographic area the outlets are linked to. Linking food outlets to individuals at high resolution geographic areas such as street level require more accurate measures of food outlet location than studies using larger but less detailed areas such as census tracts.

The question of timeliness in data collection was highlighted by Rossen *et al.* (2012) who compared Google Street View data to Government information and fieldwork. Data was collected by Google in 2007 whereas the Government and

¹ Geographic area sectioned for the purpose of taking a census. These can be described as tracts, wards, districts and areas. Liese *et al.* (2010) completed measures in 8 countries in South Carolina, USA.

fieldwork data were acquired in 2010. The food environment is constantly evolving with food outlet openings and closures therefore some inaccuracies in secondary data are to be expected. Prior to adopting an identification method, the size of the study area, researcher time and costs, and the accuracy of the data required to address the research question should be considered to select the most appropriate approach (Wang *et al.*, 2006; Sharkey and Horel, 2008). Relying solely on secondary data to identify food outlets is likely to result in substantial error and fieldwork verification is the preferred method (Liese *et al.*, 2013).

Following the first step of identifying food outlets, the second step in community food environment research often involves classifying the different types of food outlets. Existing classification systems and methods are described in the next section.

2.4.2 Classification of food outlets by type

Food outlets are often classified according to the type of outlet based on characteristics such as the type of food sold, the manner in which the food is served, services offered, and the size of the outlet premises (Lake *et al.*, 2010; Powell *et al.*, 2011). Secondary data are often classified according to limited details, for example via business name, and therefore there is potential for outlets to be incorrectly or inconsistently categorised.

The systems used to classify different food outlets are inconsistent across studies (Holsten, 2009). In the USA, all registered businesses are listed according to the North American Industry Classification System (NAICS) codes and definitions (U.S. Census Bureau, 2007) and this is therefore the most commonly used system to identify (search) and classify food outlets in local Government datasets and commercial business directories (Wang *et al.*, 2006; Powell *et al.*, 2007; California Center for Public Health Advocacy *et al.*, 2008; Spence *et al.*, 2009; Bader *et al.*, 2010; Lisabeth *et al.*, 2010; Truong *et al.*, 2010).

In the UK, classifications of food outlets are more sporadic with studies adopting their own classification methods with varying detail (Burgoiné *et al.*, 2009; Lake *et al.*, 2010). Within commercial directories such as the Yellow Pages,

businesses themselves choose the classification categories they are listed under and this may differ to the researcher perspective of classification. Businesses may also be classified under multiple categories, to maximise business potential. Definitions for food outlet categories can vary according to culture, country and between directory types with the same terms, for example the term “fast food” can incorporate a range of outlet types depending on the research setting (Sharkey *et al.*, 2011). Few studies attempt to identify or classify all food outlets within the community food environment (Lake *et al.*, 2010), but focus on those thought to have the greatest impact on health, for example fast food/takeaway restaurants or supermarkets. As food outlet classifications are inconsistent, researchers should be cautious and check definitions when interpreting individual studies. Lake *et al.* (2012) reported 83% agreement between desk and field based classification of food outlets, although concluded that secondary methods of classification should be used with caution.

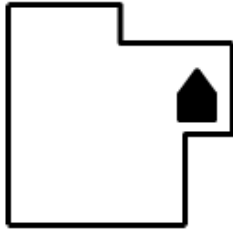
Having outlined the methods available for identifying and classifying food outlets making up the exposure food environment, the next section identifies the methods available to measure the exposure food environment and investigates the relationship between the food environment and health.

2.4.3 Measures of exposure to food outlets

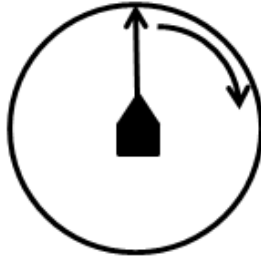
In terms of measurement, the community food environment is defined as the observed distribution and characteristics of food outlets within specified geographic boundaries (Glanz *et al.*, 2005). The majority of studies use Geographic Information System (GIS) to link potential food outlet exposure to health outcomes for individuals or populations.

The main characteristics of food environment exposure measures are the presence, density, proximity and variety of food outlets within a specified geographic boundary such as a neighbourhood tract or researcher defined buffers (Thornton *et al.*, 2011). These terminologies are depicted in Figure 2 and Figure 3 and defined below.

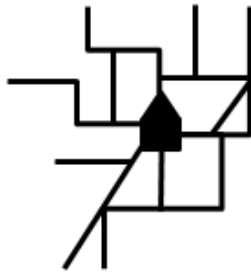
Geographic areas



Neighbourhood: Government or historically defined areas such as census tract, ward boundary, city/county limits, super output areas



Euclidean (circular) buffer: a radial distance buffer applied around a point of interest such as home or school postcode. Usually measured in miles or km.



Road network buffer: a distance buffer based on the linear road network from a point of interest such as home or school postcode. Can be measured in miles/km or time (minutes).

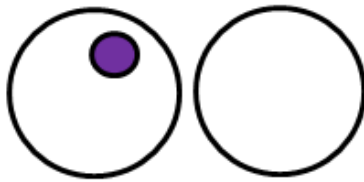
Figure 2 Terminology used in identifying geographic areas of measurement

Neighbourhood or census tracts tend to depict availability of food outlets at a population level for example comparing the number of food outlets present in areas of differing socio-economic status. Tracts are set boundaries, and where a home is located on the edge of a boundary, food outlets contained within a neighbouring boundary may be more accessible (in terms of road networks etc.) but would not be included in the analysis.

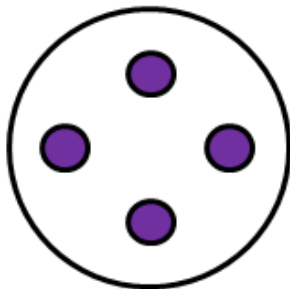
Buffers are the most commonly adopted method of assessing potential access to food outlets from a static geographic point such as home or school (Charreire *et al.*, 2010). There is much variation in the buffer sizes employed by researchers and the most appropriate size is a topic of debate (Burgoine *et al.*, 2013). Most buffers define an area that is considered to be within 'walking distance e.g. between 500m-1km' (or 0.5-1 mile) (Laska *et al.*, 2010a). Road network buffers are thought to be more accurate than Euclidian buffers as land use and access are taken into account. However, road network buffers may

miss footpaths and 'shortcuts' important when assessing access via walking routes.

Availability measures



Presence: the presence (yes or no) of a food outlet or specified type of food outlet within a geographic area.

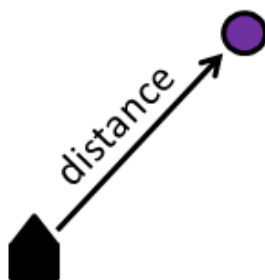


Density: total number (count) of food outlets or a type of food outlet present within a specified geographic area.



Variety: a measure of the different types of food outlets present within a geographic area, may be presented as a count or ratio.

Accessibility measures



Proximity: distance to the nearest food outlet or type of food outlet from point of interest. May be straight line or road network.

Figure 3 Methods for measuring food outlet exposure

The presence of a food outlet or specified type of food outlet is the simplest measure of availability at the population level. Density of food outlets contained within a set buffer is the most commonly used method of assessing access to food outlets. The density of fast food outlets, convenience stores and supermarkets have been assessed; rarer are studies counting the total number

of all food outlets contained within an area. The proximity to food outlets has been reported according to straight-line distance and road network distance, and, as with density, can be examined in terms of closest food outlet (any type) or a specified type of food outlet e.g. fast food.

Finally, for studies exploring access to more than one type of food outlet, the variety of food outlets within a specified area is often explored. Food outlet categories are commonly used to calculate proxy measures of food environment 'healthiness' usually through the calculation of ratios indicating the presence of presumed 'less healthful outlets' to the presence of 'more healthful' outlets. Examples of such ratios include the Retail Food Environment Index (RFEI) (California Center for Public Health Advocacy *et al.*, 2008; Spence *et al.*, 2009) and the Physical Food Environment Indicator (PFEI) (Truong *et al.*, 2010). With the RFEI, a higher proportion of fast food outlets and convenience stores to full service restaurants and supermarkets are taken as an indication of a less healthful community food environment (California Center for Public Health Advocacy *et al.*, 2008). The PFEI expands on the RFEI concept by taking a ratio of fast food restaurants, convenience stores and small food stores to all food stores (the aforementioned plus supermarkets and produce vendors), again a higher ratio is taken to indicate a 'less healthful' food environment (Truong *et al.*, 2010).

However, evidence suggests that an analysis based purely on food outlet categories cannot give the full picture of the 'healthiness' of the community food environment (Kelly *et al.*, 2011). A measure of the consumer food environment in conjunction with community measures is preferable in order to assess the healthiness of the food choices available within an outlet (further discussed in section 2.5.4). For example, a study by Farley *et al.* (2009) found that in all store types a greater amount of shelf space was allocated to displaying "less healthful" foods than "more healthful" foods and therefore supermarkets were not necessarily more conducive to healthy food choices than convenience stores as is often assumed. In addition, traditional fast food outlets were found to offer healthier food choices than convenience stores (Creel *et al.*, 2008). It has also been reported that food from Subway contains as many calories as food from McDonalds despite the former often being perceived to be the healthier choice (Lesser *et al.*, 2013).

The following section outlines the current evidence for a relationship between the community food environment assessed via the exposure to food outlets surrounding school and the home of young people and health outcomes such as dietary intake and/or adiposity.

2.4.4 The relationship between exposure to food outlets and health outcomes

In a systematic review of the relationship between obesity and measures of the community and/or consumer food environment, Holsten (2009) reported mixed results. Focusing on access to fast food and obesity, Fleischhacker *et al.* (2011) also reported mixed evidence of a relationship. Of 15 identified studies including a measure of BMI in adults or children, seven reported an increase in obesity with increased access to fast food outlets and eight studies reported no association.

In a systematic review of local food environment and diet Caspi *et al.* (2012) identified 34 studies using GIS methods to assess community food environment. Sixteen studies found a positive association between the environment and diet, the most commonly employed measures were store density (availability) and distance to store (accessibility). However, 15 of the studies reported null associations and three reported results in the unexpected direction. This suggests that the evidence of a potential relationship between exposure to food outlets and diet exists, although the evidence varies according to the population and exposure measures used.

2.4.4.1 Relationship between exposure to food outlets surrounding schools and health

The food outlet environment surrounding schools has also been referred to as the 'school fringe' (Sinclair and Winkler, 2008). Spatial clustering of food outlets around schools has been reported worldwide (Sturm, 2008; Zenk and Powell, 2008; Seliske *et al.*, 2009b; Day and Pearce, 2011; Ellaway *et al.*, 2012), and the majority of school fringe studies investigate the opportunities students have to obtain food within a buffer distance of the school grounds.

A large scale spatial analysis of food outlet access in relation to USA secondary schools (n=31,434) reported that 37% of all schools had one or more fast food

outlets within 0.5 mile buffer and 33% had at least one convenience store within the same distance (Zenk and Powell, 2008).

Differences in the density of food outlets have been found in relation to area level socio-economic deprivation although results vary. Schools in more deprived areas have been reported to be surrounded by a higher number and proportion of fast food and convenience outlets than schools in less deprived areas (Day and Pearce, 2011). In contrast, Ellaway *et al.* (2012) found no clear relationship between levels of socio-economic deprivation and access to food outlets located within 400m of secondary schools in Glasgow.

Although the body of research indicates a possible tendency for food outlets, particularly fast food outlets, to cluster around schools, the evidence linking access to food outlets surrounding schools with health outcomes in young people is less clear.

Investigations into the relationship between school fringe outlet exposure and BMI have shown mixed results. A Canadian study (Seliske *et al.*, 2009a) found that attending a school with at least one food outlet within a 1km buffer was associated with a lower odds of being overweight (odds ratio [OR]=0.70, CI: 0.61-0.81), opposite to the hypothesised effect. A strength of this study is that Seliske *et al.* (2009a) accounted for the total food outlet environment and with this in mind, repeating the same analysis focusing only on one type of outlet such as fast food could draw different results. For example, Davis and Carpenter (2009) found that students attending high schools with a fast food restaurant located within 0.5 miles were more likely to be overweight (OR=1.06, CI: 1.02-1.10) or obese (OR=1.07, CI: 1.02-1.12) than those who attended schools without a fast food restaurant present, although the effect sizes in this case were small. Similarly, the reported relationship between exposure to school fringe food outlets and dietary outcomes are ambiguous. The reported food outlet use at lunchtime in adolescents attending a Canadian school with two or more food outlets within a 1km circular buffer was higher than for those who had zero food outlets present within the same buffer distance (Seliske *et al.*, 2013). The likelihood of food outlet use increased with food outlet density, 1-2 outlets, OR=1.10 (CI: 0.57-2.11), ≥5 outlets, OR=2.94 (CI: 1.71-5.09). The same analysis using road network buffers showed stronger relationships

(OR=1.20, CI: 0.74-1.95 and OR=3.54, CI: 2.08-6.02, respectively). In this study, food outlets were defined as convenience stores, fast food restaurants and coffee/donut shops. These were matched with student questionnaire data from the Health Behaviour in School Children (HBSC) survey regarding obtaining lunch at a “snack-bar, fast food restaurant or café”. It is therefore possible that the measures of exposure and outlet use may not match up as the terminology is open to interpretation.

Also using HBSC survey data from the USA, Canada and Scotland, Hérroux *et al.* (2012) found that almost half (43.7%) of students in Scotland reported routinely eating their lunch at a food retailer during the school week, much higher than the rates seen in both Canada (7.7%) and the USA (2.6%). No relationship between chain food retailer density surrounding schools and BMI was found for any of the three countries and increased density of outlets was found to be related to lunchtime use in Canada only. Using access to chain food outlets can have restrictions, particularly across countries. Only 1.5% of all food outlets in Glasgow are chains although 39% of food outlets are takeaways (Ellaway *et al.*, 2012). This highlights the importance of defining and differentiating between food outlet types and taking into account cultural factors when classifying food outlets.

In the USA, An and Sturm (2012) found no robust relationship between access to food outlets (density and variety) from school with adolescent reported intake of fruits, vegetables, juice, milk, soda, high-sugar foods and fast food (n=5236, age 12-17 years). Similarly in the UK, Smith *et al.* (2013) found only weak associations between access to school fringe food outlets and unhealthy diet score (calculated based on reported frequency of consumption of six food items).

In a Canadian study, younger adolescents (n=632, aged 11-14 years) who attended schools in close proximity to convenience and/or fast food outlets had lower Healthy Eating Indicator (HEI) scores, an indication of lower diet quality (He *et al.*, 2012b). The same study found that a high density of fast food outlets within 1km also had lower HEI scores (He *et al.*, 2012b). Davis and Carpenter (2009) reported a decrease in fruit and vegetable intake and an increase in

soda intake with higher fast food density within a 0.5 mile buffer of middle and high schools in California, USA.

The above studies all assess diet using proxy measures such as general questionnaires or food frequency questionnaires. No studies to date have investigated the potential relationship between use of school fringe food outlets and total dietary intake.

2.4.4.2 Relationship between exposure to food outlets surrounding the home and health

The home food environment has been identified as an important factor in shaping food choice (Pinard *et al.*, 2012). As such, the relationship between exposure to food outlets surrounding the home and dietary behaviours has been investigated.

A large study (n=33,594) in Leeds, UK found a higher density of fast food outlets within residential Lower Super Output Area (LSOA)² (Fraser and Edwards, 2010) was significantly associated with child overweight and obesity. However, proximity to fast food outlets measured using straight line distance was not significantly associated with overweight and obesity. These findings were reported for children aged between 3 and 14 years. It is possible that the food environment surrounding the home has a greater impact on older adolescents (14+) than younger age groups as older age groups are likely to make more food choice decisions and purchases for themselves. Using a road network measurement of proximity may also impact the results; the closest outlet via straight line may not be the most accessible in terms of travel time.

Thornton *et al.* (2009) investigated the use of chain fast food outlets for home consumption in relation to access to the same outlets surrounding the home in an Australian adult population (n=2547, 18+ years). Increased variety of fast food chains within a 3km buffer of the home was associated with reported monthly purchasing of fast food; however this association disappeared when adjusted for co-founding factors such as age and socio-economic

² Super Output Areas are the output geographies used in the UK Census. A Lower Super Output Area (LSOA) refers to a geographic area with a population between 1000-3000 people or 400-1200 households. There were 32,844 LSOAs included in the 2011 Census (Office for National Statistics, 2011).

characteristics. The findings have limited application beyond this population as only five fast food chains were included in the study. The highest frequency of fast food purchasing was reported in the younger age groups.

As with schools, the relationship between access to food outlet surrounding the home and dietary intake is unclear. An and Sturm (2012) found no significant relationship between food environment surrounding the home and intake of fruits, vegetables, juice, milk, soda, high-sugar foods and fast food for American children or adolescents.

Ding *et al.* (2012) explored the perceived food environment and asked adolescent participants (n=171) to estimate the distance (in minutes) to the nearest food outlet from their home. Both more-healthy (supermarkets, grocery markets and restaurants) and less-healthy (fast food and convenience stores) food outlets were assessed although no significant relationship was found between the perceived proximity of food outlets to the home and mean daily fruit and vegetable intake.

Some studies have investigated the use of food outlets in relation to food environment exposure. Almost two thirds (65%) of 11-14 years olds (n=810) in a Canadian study (He *et al.*, 2012a) reported self-purchasing from fast food outlets or convenience stores. Proximity of less than 1km from home to either a fast food or convenience outlet was found to increase the likelihood of visiting these outlet types at least once per week (He *et al.*, 2012a). However, this study did not indicate whether the outlets visited were those located around the home or in another location entirely.

Recent evidence suggests that food outlets used by individuals are often located outside of the residential buffers commonly applied in food environment research (Kerr *et al.*, 2012; Burgoine and Monsivais, 2013). Food outlets visited for out-of-home eating events and food shopping trips for home consumptions were recorded by young people aged 18-23 years in a study by Laska *et al.* (2010a). The majority of out-of-home eating events occurred at geographic locations beyond GIS buffers around residential addresses, at a mean of 6.7 miles from home. Fifty-eight percent of shopping trips were contained within a 2 mile buffer of home. Only 12% of reported shopping trips and out-of-home eating events were contained within 0.5 mile buffer zone.

With activities often conducted outside of the immediate residential area, using neighbourhood area measures has the potential to underestimate access to food outlets. Identifying travel routes or other spaces frequently used by individuals such as workplaces or relatives homes may open up opportunities to further explore exposure to food outlets at the individual level (Laska *et al.*, 2010a). With this in mind, the next section investigates the use of Global Positioning System (GPS) technology in health research to link individual environmental exposures to health outcomes.

2.4.5 Using Global Positioning System and travel routes to investigate exposure to food outlets

Further to the methods of identifying geographic spaces such as buffers, neighbourhoods etc. discussed in the previous section, GPS technology has more recently been used to measure travel routes and activity spaces, which can be linked in a GIS to food outlets to measure the food environment.

Such approaches indicate that the individual activity space covers a greater geographic area than neighbourhood (Zenk *et al.*, 2011) or geographic census tract (Christian, 2012). Whilst GPS is commonly used in physical activity research (Maddison and Ni Mhurchu, 2009; Wheeler *et al.*, 2010; Krenn *et al.*, 2011; Rainham *et al.*, 2012; Rodríguez *et al.*, 2012), it has become more prevalent within the food environment literature in recent years (Christian, 2012; Chaix *et al.*, 2013).

Kestens *et al.* (2010) used travel survey data to identify geographic spaces frequented by individuals (n=159,514), expanding on research of the home or workplace/school. Locations where an activity had taken place were counted as 'anchor points' and food outlet exposure was calculated using kernel density estimations³. The density of food outlets surrounding identified anchor points was significantly higher than that surrounding the home. Children (under 20 years) were exposed to the lowest density of food outlets, with young adults (20-29 years) exposed to the greatest density of all food outlet types. Although

³ Kernel density estimations involve the transformation of geographic reference point data into a smooth continuous surface. Similar to a buffer it estimates the number of 'cases' (e.g. food outlets) within the radius of a specified point (e.g. home). The calculation is weighted so that those 'cases' closer to the point of interest are weighted more heavily than those close to the edge. (Kloog *et al.*, 2009; Charreire *et al.*, 2010)

this study added to the evidence base by exploring the activity space surrounding anchor points, the travel routes and mode of transport used between the home and these destinations were not examined.

Burgoine and Monsivais (2013) explored the food environment surrounding home, workplace and travel routes for UK adults (n=2696, 29-60 years). They found that the residential food environment accounted for only 30% of food outlet exposures with workplace and commuter travel routes each contributing to at least proportion. In terms of proximity to food outlets, with the exception of convenience stores, individuals were likely to be closer to food outlets when at work than at home. Using the shortest road network distance to estimate commuting routes does not take into account the possibility that individuals will not always use the same travel route or the shortest route available to them. This study did consider modes of transport when estimating exposure via travel routes and applied different buffer sizes accordingly (100m for walking/cycling and 500m for car use). These were considerably smaller buffer sizes than used by others employing similar methods.

In a pilot study by Zenk *et al.* (2011), American participants (18+ years, n=120) carried GPS loggers for a 7 day period; a 0.5 mile buffer was applied to the GPS points to determine activity space. Greater activity space fast food density was associated with increased saturated fat intake and decreased whole grain intake ($p < 0.05$ in each case) although no significant relationship was reported for fruit and vegetable intake. Presence of a supermarket within the activity space was not significantly associated with these three dietary outcomes.

Gustafson *et al.* (2013) also used a 0.5 mile buffer around GPS points (recorded over 3 days) to explore the relationship between food outlet exposure and diet. The authors found no associations between food outlet density and variety (assessed using RFEI) within the GPS based activity spaces and six dichotomous dietary intake variables (fruits and vegetables, dairy/calcium, whole grain/ fibre, added sugars, red meat, and processed meat in the past month).

A study by Christian (2012) used GPS to estimate individual exposure to food outlets of individuals and relate this to the diet intake and BMI of adult participants (n=101). A 0.5 mile buffer was applied to GPS track lines, food

outlet variety was assessed using the RFEI. Diet was assessed using a 25 item food frequency questionnaire (FFQ). From five dietary variables examined, the only significant relationship was between whole grain intake and RFEI where individuals with a higher RFEI score (less healthy food environment) were more likely to have lower whole grain intake. In addition, those who had a higher RFEI were significantly more likely to be obese. No other statistically significant results were reported.

Christian (2012) used GPS to collect travel data with less participant burden than handwritten diaries. However, evidence suggests that GPS should be used in conjunction with, and not in lieu of, diary methods (Bricka *et al.*, 2012). Diaries facilitate the recording of contextual details that GPS alone would miss i.e. the use of particular food outlets. Estimating diet using FFQs is common in studies of food outlet exposure and more detailed dietary intake data in relation to purchasing patterns and travel routes are needed to improve the understanding of how individual activity spaces influence food outlet choice, and food choices within those outlets.

The GPS and activity space studies described above were all conducted with adult populations. Although the technology has been used with children and adolescents for physical activity (Jones *et al.*, 2009; Wheeler *et al.*, 2010) and travel studies (Bamford *et al.*, 2008), no previous research has linked activity space with access to food outlets in young people. Neither have studies used a combination of GPS and diary methods to assess the relationship between exposure to food outlets and the use of those outlets.

Having examined the current literature assessing the exposure food environment of young people, the following section focuses on exploring the food sources used by young people.

2.5 Visited food environment

The visited food environment is defined as the food sources used by individuals and includes environments at the organisational level i.e. home, school and workplace, and the community level, and represents the food outlets used by individuals and the food choices available within those food outlets (consumer food environment). These environment types are described below.

2.5.1 Organisational food environment

The organisational food environment is defined by Glanz *et al.* (2005) as those food sources ‘generally available to defined [user] groups rather than to the general population’.

The organisational food environment includes the following environments:

- *Home* - available to the household unit, extended family and friends
- *School* – including cafeterias, vending machines and other food outlets available to students and teachers
- *Work* – canteens, vending machines, food schemes (free fruit, business lunches) available to employees
- *Other* – ‘restricted access’ locations including friends’ and relatives’ homes, healthcare settings and places of worship.

Each of the environments above is discussed in turn within this section with a focus on the relationship between the environment in question and diet and/or adiposity outcome measures.

2.5.1.1 Home food environment

As a nutrition environment concept, Glanz describes the home food environment as “the most complex and dynamic food source” (Glanz *et al.*, 2005, p331). The home food environment is affected by a host of other factors including, but not limited to, availability of food at other source outlets when shopping for home food provision (supermarkets, grocers etc.), frequency of food shopping, and the influence the principal food shopper/ preparer has on the household.

Research has shown that young adults eat a substantial proportion of meals at home. Laska *et al.* (2010a) reported 59% of eating events recorded by 18-23 year olds occurred within the home. In a study of younger adolescents (aged 11-12 years) 72% of total energy was consumed in the home (Adamson *et al.*, 1996) and with this in mind, the contribution of home sourced food to dietary intake should not be overlooked (Lake *et al.*, Submitted December 2013).

Habitual food intake is likely to be highly influenced by the home food environment, specifically food availability in the home (Swinburn *et al.*, 1999; Bryant and Stevens, 2006). Parents and the home food environment have been identified as having the most influence on individual food choice and eating behaviour of adolescents (Walsh and Nelson, 2010). This builds on previous findings from the USA (Neumark-Sztainer *et al.*, 1999), suggesting that although adolescents are influenced by a range of factors such as media, friends and desire for independence, they continue to look to their homes and parents for food availability and guidance in food choices. Assessing the behaviours, socio-economic and personal factors pertaining to adolescent fruit and vegetable intake, Neumark-Sztainer *et al.* (2003b) found two correlates directly impacted intake; home availability of fruits and vegetables and personal preferences.

Most studies of the home food environment have focused on younger adolescents and aspects of parental influence regarding food choice (Briggs and Lake, 2011; Pinard *et al.*, 2012). Campbell *et al.* (2007) reported on the associations between multiple aspects of home food environment and obesity promoting dietary behaviours in 12-13 year olds. The availability of “unhealthy” food (e.g. “junk food”) at home was found to predict the consumption of high energy density foods and drinks, particularly for girls.

Ding *et al.* (2012) assessed the relationship between home food availability and fruit and vegetable intake. A home food environment ratio of more to less healthful foods was generated where adolescents (n=171, mean age 14.6 years) rated the home availability of 16 food items (Campbell *et al.*, 2007) using a 5-point scale (always to never). Mean daily intake of fruit and vegetable portions was estimated from questionnaire responses. A higher ratio of healthier food availability in the home was associated with greater fruit and vegetable intake ($p<0.05$) (Ding *et al.*, 2012) suggesting that a healthier home food environment encourages fruit and vegetable intake.

In addition to availability of food in the home, the social aspects of eating at home may influence dietary intake. Data from Project EAT in the USA (Neumark-Sztainer *et al.*, 2003a) indicated that the frequency of family meals was associated with dietary intake of foods and nutrients. A greater reported frequency of family meal times during the week was associated with higher

intakes of fruits, vegetables, grains, and dairy foods, and lower soft drink consumption. In terms of nutrient intake, frequency of family meals was positively associated with total energy; protein (% energy); calcium; iron; fibre; and a variety of vitamins. Longitudinal data from the same Project EAT dataset has indicated that frequency of family meals in adolescence (age 15 years) is positively associated with intake of fruits and vegetables and negatively associated with soft drink intake in young adults (mean age 20.4 years) (Larson *et al.*, 2007). Recently this association was shown to track further into adulthood with adolescent family meal frequency associated with the frequency of shared meals in young adulthood (age 25 years) (Larson *et al.*, 2013). Shared meals continue to be associated with more preferable dietary intake, a greater frequency of shared meals was associated with less frequent consumption of soft drinks in both males and females and greater intake of fruit in males (Larson *et al.*, 2013).

The contribution of food from the home to total dietary intake is understudied (Adamson *et al.*, 1996). The majority of studies use questionnaires to estimate the frequency of consumption of food in the home and dietary intake from different food sources. Very few use diary methods which would provide a better estimate of dietary intake than questionnaires (Kirkpatrick *et al.*, 2014).

Although the home food environment appears to be an important influence on adolescent food intake, this group have increasing independence in food intake outside the home (Cohen *et al.*, 2012) and therefore food availability and choices made in out-of-home settings needs to be addressed in order to improve the overall quality of dietary assessment.

2.5.1.2 School food environment

The school food environment has a potentially important influence on a young person's food choice both in terms of what is consumed during the school day and the education provided in relation to healthy food and lifestyle choices. In 2011, 76% of 16-18 year olds in the UK were in full time education (Department for Education, 2012a). At the time of the present study, young people were able to leave school and enter the workforce at the age of 16 years. However, from 2013 young people are required by law to remain in some form of education or training until the end of the academic year in which they turn 17 years old

(Department for Education, 2012b). This change gives schools and other educational establishments the opportunity to influence young people's food choice for an increased period of time.

The school food environment is complex and the availability of foods within schools has been subjected to increased scrutiny and change in recent years. In 2006, the UK School Food Trust (now Children's Food Trust) introduced a set of nutrient- and food-based standards for the provision of school lunches and other school food, such as vending machines and tuck shops (Department for Education and Schools, 2006). These guidelines refer only to food sold on the school premises and do not apply to foods brought to school from home (i.e. packed lunches) or from food outlets operating outside of school grounds. Nor do the guidelines apply to independent sixth form colleges, higher education colleges or universities, public schools or academies which make up half of post-16 educational institutes (Children's Food Trust, 2013).

For those older students completing post-16 education within a school setting, there is often an open-gate policy allowing students to leave the school premises during lunch and break times. In the UK, schools with lunchtime open-gate policies have been shown to have a higher proportion of students obtaining their lunch from food outlets located close to school (Sinclair and Winkler, 2008). Similarly in the USA, a closed-gate policy is associated with reduced use of school fringe outlets at lunchtime (Neumark-Sztainer *et al.*, 2005).

Few studies have attempted to investigate the associations between the school food environment and adiposity or dietary intake of young people. Those that have tend to be linked with interventions aiming to improve the healthiness of school food or increase the number of 'healthy' food options available to students at lunchtime and influence healthier food choices (Sallis *et al.*, 2003; French *et al.*, 2004; Lytle *et al.*, 2006; Glanz, 2009).

A US national survey (Terry-McElrath *et al.*, 2009) measured food availability in schools via school administrator/ food service manager completed questionnaire data linked with questionnaire data obtained from students attending the same schools. This was a large study with 78,442 students from 684 schools taking part. The availability of breakfast at school was associated with increased overweight and obesity rates in middle and high schools. Eating

breakfast is often used as a measure of a more healthful diet, although this study did not define what breakfast items were served at school. Nor did the study report rates of breakfast consumption sourced from school, only whether the students consumed breakfast or not.

A common element of the school food environment is the presence of vending machines. Rovner *et al.* (2011) examined the relationship between food sold in school vending machines and dietary intake of students using HBSC data. The availability of the following items was examined: fruit and/or vegetables; chocolates and/or candy; soft drinks; non low-fat salty snacks. The majority of schools had vending machines on site (83%) and the least healthful food groups were more commonly available. In younger adolescents (n=3,692, aged 11-14 years) the availability of fruit/vegetables and chocolate/candy was positively correlated with the dietary intakes of these foods. However, the same relationships were not seen in the older adolescent group (n=2,238, aged 14-16). In addition, students attending schools that offered fruit and vegetable options within vending machines had higher intakes of fruits and vegetables than those schools who did not offer these options (Rovner *et al.*, 2011).

Schools taking part in the US TACOS intervention had a mean of 2.7 snack and 5.3 soft drink vending machines present in each school (Neumark-Sztainer *et al.*, 2005). Participants reported purchasing snacks from vending machines a mean of 0.9 times per week and 1.6 times per week for soft drink purchases.

In the UK, Adamson *et al.* (1996) reported that 75% of children aged 12-13 ate at least one meal from school over a six day study period (n=379), contributing to an average of 14% of the daily intake of energy. In addition, 12% of participants used school tuck shops as a source of food although the contribution to energy intake was less than 1%. The nutritional contribution of food eaten at school to total dietary intake has not been examined in the older adolescent population.

2.5.1.3 Workplace food environment

The most recent employment figures suggest that only 1% of 16-18 year olds are currently not in education, employment or training (Department for Education, 2012a). The listed occupation of the majority of 16-18 year olds will

be full or part time education. Part time employment of individuals in full time education may not be accounted for in the national statistics. As the employment rates of young people are unknown, the workplace needs to be considered in much the same way as the school environment. Young people may spend a considerable amount of time in the workplace although the type of workplace and thus food environment exposure is likely to differ between individuals.

In terms of food availability, workplaces may be similar to schools in that they have their own self-contained canteens, vending machines and small stalls. For others, the workplace itself may be a source of food e.g. restaurants, supermarkets and other food stores. It is important to consider the types of workplaces young people are employed as this has an impact on their food choices and intake. Mulvaney-Day *et al.* (2012) conducted a qualitative study investigating the eating behaviours of student fast food employees (n=14, aged 18-25 years). The authors found that although participants were aware the food they were serving was “unhealthy”, they reported eating those same foods on a regular basis indicating taste, availability and instant access as factors influencing the choice of these foods (Mulvaney-Day *et al.*, 2012). The workplace is therefore a potentially important environment as it is likely that young people working in food outlets will consume foods sold in those outlets.

Similar to the school food environment, many studies of the workplace food environment have been conducted in conjunction with intervention studies aiming to increase the healthiness of the environment for the workforce (French, 2005; Lake *et al.*, 2011).

Although access to food at work has been considered for larger workplaces with canteens (Department of Health, 2013b), the workplace is understudied in term of the nutritional contribution of food obtained from work to the total diet and the nutritional content of foods purchased and consumed at work (Ni Mhurchu *et al.*, 2010).

2.5.1.4 Other organisational food environments

Other organisational food environments have featured in very few studies. These other environments are generally only available to defined user groups

rather than the population as a whole and include churches and healthcare settings (Glanz *et al.*, 2005). Young people may visit a number of 'other' food environments in their day-to-day life through extra-curricular activities such as taking part in or spectating at sporting, artistic or performance events, attending youth groups and churches as well as volunteering and using facilities such as health and social centres.

Perhaps the most noteworthy of these "other" organisational food environments are the homes of friends and relatives. Seventy-four per-cent of 12-13 year olds reported eating at a home other than their own at least once over a six day period (Adamson *et al.*, 1996). Dietary intake from these 'other homes' was shown to be of lower quality than that sourced from home (Adamson *et al.*, 1996). Adding to this evidence, Ayala *et al.* (2008) found that eating food from a friend or relatives' home once per week was related to an increase in obesity in children.

There is evidence to suggest that food related behaviour is different when guests are present. Research by Cohen *et al.* (2012) in the U.S. has highlighted the importance of friends' homes in the consumption of snack foods high in solid oils, fats and added sugars (SOFAS) in adolescent girls (n=303, mean age=16.3). The strength of association between visiting a friend's home and consuming SOFAS foods was shown to be twice that of going to a food outlet and consuming the same foods (Cohen *et al.*, 2012).

Other homes such as those belonging to relatives and friends could provide substantial contributions to dietary intake. Further exploration of the relationship between eating at friends and relative's home and diet/adiposity is required.

2.5.2 Visited community food outlet environment

There is an increasing tendency across all age groups to consume foods prepared outside of the home (The Strategy Unit Cabinet Office, 2008). The nutritional quality of these foods is thought to be less than those consumed at home (Poti and Popkin, 2011; Lachat *et al.*, 2012). Access to food is complex and the pathways through which we obtain and consume food are often blurred. Although all food originates from either retail (e.g. shop) or catering (e.g. restaurant) environments, the food source can be defined as either the site of

food preparation or where the food is consumed. Hot food bought for home consumption has in the past been classified as home food (Adamson *et al.*, 1996; Gregory and Lowe, 2000; Henderson *et al.*, 2002). This highlights a missed opportunity to uncover the impact of 'takeaway' food consumed in the home on total dietary intake. Purchasing data are collected using the same approach with the Family Food survey (National Statistics, 2012) classifying takeaway food consumed at home as 'household purchases'.

A systematic review by Lachat *et al.* (2012) reported on 29 studies examining the relationship between out-of-home eating and energy intake, dietary quality and socio-economic status. The review highlighted the inconsistencies in defining out-of-home eating, with 13 of the studies reviewed defining out-of-home eating as the source and place of food preparation. An additional 13 studies used place of consumption to define eating out-of-home. Therefore, as a method of identifying out-of-home eating, the authors recommend determining the source of food as opposed to the place of consumption (Lachat *et al.*, 2012). The place of preparation determines the nutritional quality of the food and studies adopting the latter method may underestimate the impact of out-of-home eating on diet by excluding occasions such as consuming takeaway foods at home.

Many of the studies included in the review were conducted at national level such as the UK National Diet and Nutrition Survey (Department of Health, 2011b). Although strengthened by large sample sizes, many of these studies used FFQs and 24-hour recalls to assess dietary intake making links to food source more difficult than when diary methods are used. In addition, the studies are also dated and the review authors called for an update to the available evidence linking out-of-home eating to total dietary intake. The review concluded that out-of-home eating is an important risk factor for higher energy and fat intake and a lower micronutrient intake (Lachat *et al.*, 2012). Importantly, out-of-home eating had a greater contribution to daily energy intake in younger populations, 83% in children (Zoumas-Morse *et al.*, 2001) and 43% young adults (Nielsen *et al.*, 2002). In young adolescents in the UK (11-12 years, n=379), 30% of energy intake was attributed to consumption of foods outside the home (Adamson *et al.*, 1996).

In the UK, one in six meals are eaten outside of the home equating to 20% energy intake for women and 25% for men (Office for National Statistics, 2010). Market research reports have estimated that British adults eat out 2.77 times per fortnight (Eat Out Magazine, 2012a), and the majority of meals eaten outside of the home occur at lunchtime (Eat Out Magazine, 2012b). The frequency of eating out in young adults is thought to be greater. Larson *et al.* (2010) reported young American adults (aged 20-31 years) dined out an average of 13.5 times per month at fast food restaurants and 3.8 times per month at sit-down restaurants. Three quarters of 11-18 year olds (n=4746) reported eating at fast food restaurants at least once per week (French *et al.*, 2001). However these data are from the USA, a breakdown of the frequency with which young adults in the UK eat out was not available.

The UK Family Food survey 2012 reported an average of £12.09 per person per week was spent on eating out for all food and alcoholic drinks (Office for National Statistics, 2013a). The survey reported a downwards trend in eating out with 12% less food (grams) consumed per person in 2012 compared to 2009 (Office for National Statistics, 2013a). In addition to the amount spent on 'eating out', an average of £1.79 per person per week was spent on takeaway meals brought into the home (National Statistics, 2012; Office for National Statistics, 2013a). In terms of quantity of food brought into the home as takeaway, the amount (measured in grams) remained similar over the period between 2009 and 2012 (Office for National Statistics, 2013a). Meat-based meals (such as Indian curries and Chinese meals), chips, rice, and pizza made up the majority of takeaway purchases (assessed separately from eating out purchases) (National Statistics, 2012; Office for National Statistics, 2013a). Market research reports have identified Chinese, fish and chips, Indian and McDonalds as the favourite takeaway outlet types in the UK (Eat Out Magazine, 2012a).

Retail outlets such as convenience stores and other food shops have been shown to be an important environment to consider when assessing the food choices of young people (Sinclair and Winkler, 2008; Smith *et al.*, 2013). Kerr *et al.* (2012) used travel survey data to link visits to food outlets on the home to work commute in an adult population (n=4800). Fast food outlets were more likely to be visited on work days by men, younger participants and those who

were obese. However, this study found that the most commonly used food outlet type was grocery stores (31% of trips), and that restaurants were visited more often than fast food outlets (30% and 19% of trips, respectively). For adolescents in the USA, the largest contributor to out-of-home food consumptions shifted from fast food in 1994 to store foods in 2006 highlighting the importance of identifying where food is sourced (Poti and Popkin, 2011). Little research has been conducted on the frequency of out-of-home eating from retail outlets, particularly in younger populations where fast food tends to be at the core of the research. There is a need to explore the impact of foods consumed from all types of food outlets on health.

Having outlined the frequency of out-of-home eating, the following section presents the current evidence of a relationship between consumption of out-of-home meals and health outcomes, with a focus on adolescents and young adults.

2.5.3 Frequency of eating at food outlets and health outcomes

There has been a research focus on out-of-home eating and food outlet use , young adults being highlighted as the most frequent consumers of fast food and food on-the-go (Laska *et al.*, 2010a; Cohen *et al.*, 2012). Meals sourced from outside of the home have been described as having a lower nutritional value than meals prepared at home, often being high in energy, fat and salt (Lachat *et al.*, 2012; Jaworowska *et al.*, 2013).

A review by Jaworowska *et al.* (2013) highlighted the high prevalence of studies focusing on the nutritional quality of food from fast food restaurant chains. The authors indicated a lack of data regarding the nutrient content of takeaway meals from small independent outlets, such as those serving ethnic cuisines, fish and chips, and pizza. There is a need for research considering different types of food outlet sources when assessing the frequency and nutritional content of out-of-home eating (Jaworowska *et al.*, 2013).

Most adolescents purchase some food for themselves and this food tends to be of poor nutritional quality being high in fat and sugars (Walsh and Nelson, 2010). In the US, half of adolescents (n=1796, aged 10-19 years) reported consuming fast food on one or both days of two non-consecutive diet recalls

(Paeratakul *et al.*, 2003). Amongst children and adolescents, those who ate fast food had higher total energy intake, percent energy from fat and saturated fat and sodium in addition to lower intakes of protein, fibre and vitamin A. For those who reported fast food consumption on one day only, paired analysis indicated less favourable energy and nutrient intakes on the fast food consumption days when compared to the day no fast food was consumed (Paeratakul *et al.*, 2003). A later study using longitudinal National Health and Nutrition Examination Survey (NHANES) data spanning from 2003 to 2008 also reported that consuming food from fast food and full service restaurants was associated with higher total energy intake and poorer diet quality (Powell and Nguyen, 2013).

Thompson *et al.* (2004) reported longitudinal tracking of adiposity and consumption of meals from specified outlet types in adolescent girls assessed between baseline (median age=8 years) and follow-up (median age=15 years). Sixty-seven percent of participants consumed meals outside of the home more than twice per week at follow up compared to 39% at baseline. The study found that BMI z-score was more likely to increase over time for girls who ate at quick-service food outlets twice a week or more at baseline, compared to those who ate at these outlets less frequently.

As part of Project EAT, French *et al.* (2001) found an association between frequency of fast food consumption in the past week and higher total fat and saturated fat intake and lower micronutrient intake in adolescents from the USA (mean age=14.9, range=11-18). Frequency of consumption was based on a single question phrased in a way that could suggest fast food chains. The interpretation of the question and the cultural context is an important consideration. In the USA, the majority of fast food outlets are chains whereas in the UK, independent fast food outlets (or takeaways) such as fish and chip shops make up the majority. This single question could therefore miss a multitude of food outlet visits, especially if applied in the UK.

A large UK based cohort study found that frequency of fast food consumption was associated with consumption of less healthy food in adolescents (n=3620, aged 13 years) (Fraser *et al.*, 2011). The study also found that those who ate at fast food outlets most often were more likely to have a higher BMI than those

who consumed fast food less frequently. In contrast, a smaller study conducted in a deprived borough of London (n=193) found that BMI was inversely related to frequency of fast food consumption, with adolescents (mean age=12.8, range 11-14) of higher BMI less likely to consume fast food than those with lower BMI (Patterson *et al.*, 2012). Both these studies assess the relationship in younger adolescent populations; the relationship between BMI outcomes in relation to frequency of fast food consumption in older adolescents is understudied.

It is clear that further work is needed to identify the types of food outlets used by young people and the food choices they make within these environments. The frequency with which these visits are made and the relationship between these environmental factors and total diet and adiposity outcomes need to be explored. The nutritional intake of foods from different food outlet types, not just fast food, is also an area for exploration.

2.5.4 Consumer food environment

The model of nutrition environments (Glanz *et al.*, 2005) defines the community environment as the 'within outlet' food choice environment and as such encompasses the product choices and information that are available in food outlets (stores, restaurants etc.) including; availability of healthy options, marketing (price, promotion and placement) and nutrition information. A variety of methods have been used to measure the sum of these concepts (Glanz *et al.*, 2012). Examples for food stores include checklists/surveys (Glanz *et al.*, 2007; Gloria and Steinhardt, 2010), market baskets (White *et al.*, 2004; Block and Kouba, 2006), and shelf space surveys (Farley *et al.*, 2009; Cameron *et al.*, 2013); and for restaurants include checklists/surveys (Cassady *et al.*, 2004; Saelens *et al.*, 2007; Erdman *et al.*, 2010), menu analysis and promotion counts (Lewis *et al.*, 2005).

A review of community food environment literature by Charreire *et al.* (2010) found only four studies out of 29 that included a measure of the consumer food environment (Baker *et al.*, 2006; Block and Kouba, 2006; Frank *et al.*, 2006; Bodor *et al.*, 2008). These studies linked spatial access to food outlets with the food choice environment available within an outlet. However, the studies in question assessed the theoretical access to food outlet choice and did not link consumer food choice to dietary intake or adiposity of individuals. The authors

suggest that future research in the food environment field would benefit from a combination of GIS analysis and survey methods in order to explore and understand the influence of the environment on individual food behaviours and health (Charreire *et al.*, 2010).

A subsequent review paper Kelly *et al.* (2011) identified methods and measures available to ascertain and measure the food environment. Caspi *et al.* (2012) built on this and included only studies where measures of the local food environment (including consumer level variables) were linked to a dietary outcome.

Developing objective surveys for measuring the consumer food environment is acknowledged as being extremely difficult given that the food choices available within a store can differ greatly from those found in a restaurant. With this in mind, much of the consumer food environment research focuses on the impact food choices within a single type of food outlet, for example fast food, and not the food outlet environment as a whole. In addition, there is a need to consider carefully the food items and groups included in such surveys as they need to be specific to the population group in question and provide an outcome measure that answers the research questions (Minaker *et al.*, 2012).

A study by Creel *et al.* (2008) found that over half of opportunities to obtain fast food in Texas, USA, were through convenience stores and supermarkets. The options offered in these outlets were often less healthy than those found in 'traditional' fast food outlets. This highlights the importance of examining the types of foods served within outlets, a detail often overlooked.

2.5.5 Consumer food environment and health outcomes

Measures of the consumer food environment are rarely conducted at the individual level, most commonly they are linked with studies assessing population level access (or *exposure*) to food outlets with GIS methods. Studies assessing the relationship between the availability of foods within food outlets and dietary intake and/or adiposity are rare, the few existing are discussed below.

2.5.5.1 In-store environment and health outcomes

Studies relating to the consumer food environment within stores generally focus on the investigation of 'food deserts', reporting the state of food access, in particular the availability of a healthy diet, within geographic areas of varying deprivation (White *et al.*, 2004 ; Macintyre *et al.*, 2005). Few studies assess health outcomes in terms of dietary intake or adiposity and those that do report these outcomes are conducted at the household level and focus on the adult population (Gustafson *et al.*, 2012).

A systematic review of measures of the consumer food store environment (Gustafson *et al.*, 2012) found 12 studies (out of 56 in total) that examined dietary intake or weight status in relation to the in-store food content. They found no evidence of an association between fruit and vegetable availability within food stores and consumption of fruits and vegetables. BMI and fruit and vegetable availability was found to have an inverse relationship. The review found that where individuals shop and eat, and not simply their proximity to food outlets, is an important factor in food environment research. Evidence found was mostly based in the USA, with only six of the studies examined conducted in the UK (Cummins and Macintyre, 2002; Guy and David, 2004; Pearson *et al.*, 2005; Cummins and Macintyre, 2009; Cummins *et al.*, 2010; Smith *et al.*, 2010).

Rose *et al.* (2009) investigated the proportion of shelf space given to fruit and vegetables versus snack foods in 307 food stores in Louisiana, USA. An area level analysis was conducted with residents' self-reported BMI collected via a telephone interview (n=1243, aged 18-65 years). A mean of 52.8 metres of fruit and vegetable shelf space was located within a 1km buffer of participants homes, compared with 316.4 metres of snack foods. No significant relationship was reported between fruit and vegetable shelf space and BMI, although an increase of 100m in snack food shelf space was associated with a 0.1 unit increase in BMI. Although in-store measurement strengthens this study, the assumption that residents used the food stores located within 1km of their homes may not hold true.

Many in-store surveys assess availability of foods for home provision and preparation and may not be suitable for use with the adolescent population. It is

important to identify the types of foods purchased from store types used by the population being studied. For example, surveys assessing the presence of healthy food options within food stores often measure raw ingredients such as 'lean beef mince' or 'skimmed milk'. These products are unlikely to be purchased by adolescents who are more likely to be purchasing foods to consume 'on the go' such as sandwiches and snack foods. These are foods commonly assumed to be provided by fast food outlets although many supermarkets and convenience stores also provide these options (Sharkey *et al.*, 2011).

2.5.5.2 Restaurant menu options and health outcomes

Given the large body of literature on the relationship between access to fast food and health, many more studies have been conducted on aspects of the consumer food environment influencing food choice within fast food restaurants.

There has been a particular focus on investigating the potential impact of providing nutritional information on fast food outlet choices. In 2010, it became law for all chain restaurants in New York City to provide nutritional information at the point of purchase. This has led to a number of studies assessing the impact of providing nutritional information on food choice (Vadiveloo *et al.*, 2011; Angell *et al.*, 2012; Downs *et al.*, 2013).

Prior to these regulations being set, Yamamoto *et al.* (2005) reported a lack of adolescent engagement with nutritional information in three fast food restaurant chains. Seventy-one percent of 11-18 year olds surveyed did not change their order after seeing calorie information. Females were significantly more likely to change their order than males, although this effect was only reported for McDonalds with no effect seen for Panda Express nor Denny's. Following the regulations, Block *et al.* (2013) asked consumers purchasing fast food across six chains (89 outlets in four USA cities) to estimate the calorie content of their ordered meal. Identifying the presence of nutritional information had no effect on calorie estimation with adolescents reporting the highest levels of underestimation.

Elbel *et al.* (2011) adopted a natural experiment study design to investigate child and adolescent food choice before and after the introduction of the

mandatory nutritional labelling in New York City. Over half of the study sample was aged between 13-17 years (56%). Older adolescents and those visiting fast food outlets without a caretaker (e.g. parent) purchased food with greater energy content. No adolescents reported noticing nutrition labelling before the legislation began and over half noticed afterwards (57%). However, only 16% of those who noticed the information reported that it subsequently influenced their food choice. There was no significant difference between the calorie intake from fast food before and after introduction of nutritional labelling in children or adolescents, with or without caretakers (Elbel *et al.*, 2011). Similar findings were seen in an adult population with 14.5% reporting both noticing and using calorie information in fast food outlets (Vadiveloo *et al.*, 2011). In this population, those who noticed the calorie labelling (regardless of whether they reported using it) consumed fast food less frequently than those who did not notice the labelling (Vadiveloo *et al.*, 2011).

In a recent study, Lesser *et al.* (2013) investigated the food choices made by American adolescents (mean age=16.7 years, range=12-21) in McDonalds and Subway outlets. Nutrition Environment Measurement Survey for Restaurants (NEMS-R) (Saelens *et al.*, 2007) was completed to provide an objective measure of food outlet healthiness and results indicated that Subway was the healthier outlet. Using the 97 adolescent participants as their own controls, the study found no significant difference between the energy content of meals ordered from McDonalds and Subway (mean 1038kcal and 955kcal, respectively). However, McDonalds provided a significantly greater proportion of calories from drinks and side dishes and fewer vegetable portions than Subway. This study highlights the benefit of including a measure of actual dietary intake linked to food source when investigating the impact of the food environment on health. Although a greater number of 'more healthy' meals options may be available within outlets such as Subway, these foods are not necessarily those chosen by consumers. In reality these 'more healthy' outlets could be contributing to energy intake as much as those outlets perceived to be 'less healthful' (e.g. McDonalds). Visiting both Subway and McDonald's food outlets was part of the study design and therefore the adolescents involved did not choose to visit those particular outlets at free will. It is possible that other outlets, including other fast food chains or independent, unbranded outlets,

could have a greater impact on adolescent dietary intake and as a result their health. The frequency with which these outlets are visited should also be considered. Subway is perceived as a 'more healthy' outlet than individuals may visit this more frequently than McDonalds and therefore the impact of this outlet on health may be greater.

As of November 2013, 49 UK businesses had signed pledges as part of the public health responsibility deal (Department of Health, 2013b) to provide/improve calorie labeling of their out-of-home food offerings. Businesses include traditional restaurants, fast service outlets, takeaways, cafes, pubs, sandwich shops, and staff canteens. At present, there is no evidence to indicate the impact of the initiatives included in the public health responsibility deal on food choice or health.

Having presented the exposure and visited food environments and the evidence linking these to health outcomes in young people, the next section of this review focuses on identifying the individual factors which influence food choice. The section also outlines the methods available to measure individual level outcomes of diet and adiposity.

2.6 Individual food environment

The individual food environment includes the measurement of health related outcomes such as dietary intake, adiposity and physical activity levels in addition to how the influence of the food environment on behaviour can "be moderated or mediated by demographic, psychosocial or perceived nutrition variables" (Glanz *et al.*, 2005, p331).

Having already discussed the relationship between various aspects of the exposure and visited food environments on dietary intake and adiposity, this section aims to define the individual food environment of young people. The section begins by critiquing the methods used to assess dietary intake and adiposity in the food environment literature before investigating other lifestyle behaviours associated with adolescent health. The section goes on to identify psychosocial factors influencing food choice such as individual, family, and peer values, and socio-demographic variables such as gender, ethnicity, age and socio-economic status.

2.6.1 Measuring health related outcomes in adolescents

This section outlines the methods available to assess diet, adiposity and other lifestyle factors in young people.

2.6.1.1 Dietary intake

As discussed in the previous sections, dietary patterns and behaviours may be influenced by the food environment and as such form the outcome measures for a number of studies assessing the impact of the environment on health.

Selecting an appropriate dietary assessment method is perhaps the most important part of designing a nutrition study.

The ‘gold standard’ method in dietary assessment is the use of doubly labelled water as a biomarker of energy intake. However, this method is expensive and requires specialised equipment and expertise and as such is seldom used in public health research (National Obesity Observatory, 2010). Self-report measures of diet are more commonly used, and the different types of self-report measures available and their pros and cons are discussed below.

Prospective methods collect data about current dietary intake and as such provide a ‘good standard’ method of estimating nutritional intake in the absence of biological markers (Collins *et al.*, 2009). Food diaries completed over a period of 3-7 days give a snapshot of eating behaviours at a particular time point. They require participants to be literate and as such are not suitable for use with younger children although can be used with adolescents. Household measures or estimated food diaries are more common place than weighed diaries as they are less burdensome on participant and elicit similar accuracy (Bingham *et al.*, 1994).

Food diary methods are not without flaws however and it has been reported that individuals may change their eating behaviour when completing a diary. This can be in the form of intentional or subconscious changes in order to reduce the burden of diary completion or participants recording a diet they perceive to be more socially desirable via the inclusion or exclusion of particular foods (Goris *et al.*, 2001). Food diary methods therefore often involve a researcher completed interview following diary completion in order to verify recorded information.

Despite the validity of this approach, very few food environment studies use diaries to collect dietary intake data (Kirkpatrick *et al.*, 2014). In a systematic review of the association between dietary intake and eating out, Lachat *et al.* (2012) found only eight of the 29 studies identified used diary methods. Four of these studies were large cohort studies of nationally representative samples such as the National Diet and Nutrition Survey (Henderson *et al.*, 2002). Diary methods can be time consuming from a research perspective with entries needing to be coded for analysis by a trained researcher. However, being a prospective method, diaries benefit from being able to record contextual information with regards to eating behaviour such as the source of food.

Retrospective methods such as recalls and FFQs are much more commonly used in public health research and measure the usual intake of foods over a longer period of time (Collins *et al.*, 2009). The recall method requires a trained interviewer to collect the data, much like the diary interview. Repeated recalls can give an estimate of usual intake over time. FFQs are quicker and less expensive to administer than food diaries or recalls as they can be self-administered making them ideal for larger studies (Collins *et al.*, 2009). FFQs assess the intake of a limited number of foods over a specified time point (week/month/year) to give an estimate of usual intake. They can be used to determine desirable and undesirable dietary intake patterns such as fruit consumption (more healthy) and soft drink consumption (less healthy) (Haerens *et al.*, 2007). Although they can be used as a proxy for dietary intake, they cannot be used to link dietary intake to the source of food and therefore analysis using FFQ data is limited to investigating associations with environmental variables.

In food environment research, dietary intake is often estimated using responses to single measures within questionnaires such as questions assessing the intake frequency of a food type (e.g. fast food or fruits and vegetables) or frequency of eating at a particular outlet type (e.g. fast food outlet) (Caspi *et al.*, 2012). Questionnaires benefit from being easy and quick to complete and are therefore more likely to attain higher participant response rates particularly from hard to reach population groups such as adolescents. Although they provide a cost effective way of assessing dietary habits, questionnaires do not measure total dietary intake. Although it is assumed that fast food is consumed at fast

food outlets, without actual dietary intake data linked to food source this cannot be concluded.

Dietary intake can be described in a number of ways depicting a less healthful or a more healthful diet. In terms of nutrient intakes, high levels of energy, fat, saturated fat, sugars and salt indicate less healthful diets. Lower levels of these nutrients, alongside higher intakes of dietary fibre and micronutrients such as vitamins and minerals, indicate a more healthful diet. Food groups are often used as proxy measures of nutrient level dietary intake. Fast foods are thought to be high in energy, fat, sugar and salt and therefore frequency of consumption of these foods is often used to indicate diet healthfulness. Similarly fruit and vegetable consumption is used to indicate degrees of healthful eating.

To summarise, food diaries are the preferred method of assessing dietary intake in nutrition studies although few adopt this method especially in hard to reach populations such as adolescents. Use of these methods is needed to move forward in the field of food environment research investigating total dietary intake in relation to the source of food (Kirkpatrick *et al.*, 2014).

2.6.1.2 Adiposity

The assessment of adiposity, or body fatness, is a much debated topic. The 'gold standard' methods of assessing body composition include Bod Pod air displacement, hydro-densitometry and dual-energy x-ray absorptiometry (Wagner and Heyward, 1999). However these methods are expensive and time consuming to use in larger populations and therefore the most commonly employed measure of adiposity is Body Mass Index (BMI; kg/m^2). This is calculated based on the height (m) and weight (kg) of an individual, measures which are relatively unobtrusive to obtain (Foresight, 2007b). BMI cut-offs are used to assess overweight and obesity. A healthy adult BMI lies between 20 and 25 kg/m^2 , 25 to 30 indicates overweight and a BMI above 30 is classified as obese (World Health Organization, 2006).

BMI is only a proxy measure of adiposity as it does not give an indication of where fat is distributed within the body. For some groups, such as professional athletes, BMI is a poor measure of body fatness due to higher weight being due

to increased muscle mass. At a population level, BMI provides an adequate estimation of obesity levels (Foresight, 2007b).

The BMI cut-offs for adults do not take into account continuing growth and therefore lower thresholds are set for children and adolescents. In particular, adolescence is a period when the composition of the body undergoes changes including in the location and amount of fat located in the body (Alberga *et al.*, 2012). With this in mind, the International Obesity Task Force (Cole *et al.*, 2000) provide specific age and gender related cut-offs to be used up to age 18 years.

Where fat is stored in the body is an important indication of health. Central adiposity is associated with increased health risks. Waist circumference and waist to hip ratio can be used to assess central adiposity. Cut-offs for increased-risk and substantially increased risk are indicated by the WHO (World Health Organization, 2011).

Anthropometric measures are often self-reported, and therefore susceptible to reporting bias. In adolescents, height is often over-reported and weight under-reported, thereby underestimating BMI which in turn may underestimate the prevalence of overweight/obesity (Brenner *et al.*, 2003). Anthropometric data collected by trained researchers and averaged from repeat measures is preferred.

2.6.1.3 Other lifestyle factors

Obesity is the result of an energy imbalance with increased energy intake and lower energy output resulting in weight gain. High energy intake in the diet is therefore only one side of the equation. Levels of physical activity and sedentary behaviours influence the output side of the energy equation and therefore should not be overlooked.

Current guidelines for health in the UK suggest that all children and young people (aged 5-18 years) should engage in moderate to vigorous intensity physical activity (MVPA) for at least 60 minutes every day (such as playing sport) and reduce the amount of time spent in sedentary activities such as watching television and playing computer games (Department of Health, 2011c). The physical activity guidelines for adults over 19 years are lower,

recommending at least 30 minutes of MVPA on five days per week (Department of Health, 2011c).

In a UK study of 176 young people (aged 12-16 years), Pearson *et al.* (2009) found that overall only 22% of young people completed over 60 minutes MVPA per day. Boys were more likely than girls to meet the guidelines and older adolescents (mean age 15.6 years) engaged in significantly less MVPA per day than younger adolescents (mean age 13.3) ($p < 0.001$). In this study, accelerometers (the gold standard approach) were used to measure levels of physical activity. Studies using self-report methods for assessing physical activity levels often overestimate activity levels.

In a review of the relationship between physical activity levels and adiposity in children and adolescents, Jimenez-Pavon *et al.* (2010) concluded that there was a strong evidence base to suggest that greater adiposity was related to lower levels of physical activity. Eighteen studies assessing the relationship in adolescents (aged 10.5-18 years) reported a negative relationship between physical activity and adiposity (out of a total of 21 studies) (Jimenez-Pavon *et al.*, 2010).

Sedentary behaviours including television viewing, playing video games and computer use are associated with adiposity and dietary intake. Rey-Lopez *et al.* (2008) found mixed results when assessing the relationship between sedentary behaviour and adiposity in children and adolescents although concluded this was likely due to methodological issues, with studies relying on self-report data on sedentary behaviour levels and BMI as a proxy adiposity outcome. Stronger relationships between SB levels and dietary intake were reported in a review by Pearson and Biddle (2011), where higher levels of sedentary behaviour were associated with less favourable dietary intake in all age groups.

Having identified methods of assessing individual outcomes of dietary intake and adiposity and discussed the influence of physical activity and sedentary behaviour on these outcome variables, the next section investigates the psychosocial factors influencing food choice in young people.

2.6.2 Psychosocial factors influencing adolescent food choice

Psychosocial variables account for the way in which an individual's psychological being develops and interacts with the social environment, both consciously and unconsciously (Neumark-Sztainer *et al.*, 1999). This section aims to identify the psychosocial factors that can influence food choice in adolescents at the individual, family and peer levels and how these factors can act as barriers and facilitators for healthy eating.

2.6.2.1 Individual level psychosocial factors

A number of individual level psychosocial factors have been identified in relation to their influence on adolescent food choice. Story *et al.* (2002) developed a comprehensive conceptual model of the individual and environment influences on adolescent eating behaviours. Individual influences identified within the model included food preferences, taste and sensory perceptions, health and nutrition, self-efficacy, knowledge, hunger, time and convenience, cost and meal patterns. Exploring individual influences on food choice is important; these factors perhaps having a greater effect on the diet of young people than environmental factors (de Vet *et al.*, 2011).

Qualitative analysis of focus groups conducted with young people aged 12-19 years (n=141) found hunger, taste and appeal of food, time and convenience were the individual factors perceived to be most important for food choice (Neumark-Sztainer *et al.*, 1999).

Young people often place taste and preferences above healthfulness when making food choices. A systematic review of the facilitators and barriers to healthy eating in young people identified personal preference, particularly for fast food, as a key factor for food choice (Shepherd *et al.*, 2006). In a study of fast food purchasing in adolescents, taste was rated above nutrition as the factor influencing food choice (Elbel *et al.*, 2011) and in the school food environment, (Contento *et al.*, 2006) cited personal taste as an important factor influencing the lunchtime food choice.

Price and convenience are factors that have been often reported as important factors for adolescent food choice (Wills *et al.*, 2005; Share and Stewart-Knox,

2012). In a review by Shepherd *et al.* (2006) the price of healthy options was a perceived barrier to healthy eating, young people indicating that they would be more likely to choose healthy foods if they were more readily available and cheaper. Adolescents give less importance to sensory aspects of food choice than adults and were concerned more with price and convenience (Share and Stewart-Knox, 2012).

Stevenson *et al.* (2007) conducted focus groups with young people aged 12-15 years (n=73) in order to identify barriers to healthy eating. Through thematic qualitative analysis, four barriers were identified: physical and psychological reinforcement of eating behaviour; perceptions of food and eating behaviour; perceptions of contradictory food-related social pressures; and perceptions of the concept of healthy eating itself. The authors found the goal of 'healthy eating' to be absent within the data with competing pressures to eat unhealthily and to lose weight of greater importance to the young people.

Obesogenic eating patterns have become a 'normal' feature of youth culture with individuals interacting with and making food choices within an environment that encourages the consumption of energy rich foods (e.g. fast food) and the media promotion of these foods (Stevenson *et al.*, 2007).

In addition to taste, findings from one-to-one qualitative interviews with 11-18 year olds (n=108) suggested that other important factors influencing school food choice were; familiarity/habit, health, dieting and 'fillingness' (Contento *et al.*, 2006). This work was conducted referring to the school lunch choice environment and therefore these influencing factors may not transcend to other food choice situations.

Wills (2005) conducted qualitative interviews with disadvantaged 13-14 year olds in Scotland evaluating the factors influencing food choice during the school day. The speed of food acquisition was a feature of food outlets highly valued by the young people, the perceived fastest outlets being fast food and high street bakery outlets. The cost of food was also considered, with young people demonstrating the ability to obtain the best value option for their budget and preferences.

Croll *et al.* (2001) investigated the meaning of the terms 'healthy' and 'unhealthy' in relation to diet with adolescent girls in the USA (n=208). Identified barriers to healthy eating were time limitations, lack of healthy options provided at school, and an unconcerned view towards health. Overall the study found that the girls had a good knowledge of healthy eating and diet but persisted in consuming foods the participants themselves deemed to be 'unhealthy'.

Having identified the individual level factors influencing food choice, the next section focuses on the family and parental factors that may influence the food choice of young people.

2.6.2.2 Familial and parental influences

Familial influences on food choice include family structure (single/two parent families, number of siblings), frequency of family meals, and the provision of food within the home. Parental factors include parenting styles (such as authoritative, indulgent etc.) and the influence of parental dietary intakes on child intakes in terms of role modelling.

Evidence suggests that traditional family mealtimes are important in encouraging adolescents to consume a healthy balanced diet (Larson *et al.*, 2007). Who meals are consumed with appears to have an influence on the amount and types of foods consumed. Videon and Manning (2003) found a positive association between parental presence at an evening meal and adolescent (mean age 16 years) consumption of fruits, vegetables and dairy foods.

The same study reported that four in five adolescents are allowed (by parents) to make their own food choice decisions (Videon and Manning, 2003) and having this autonomy did not increase the likelihood of selecting less healthful foods. It did however impact breakfast behaviours with those adolescents who made their own food choice decisions 25% more likely to skip breakfast.

Utter *et al.* (2013) found that in young people (n=9,107, aged 13-17 years) eating family meals more frequently was associated with more healthful eating behaviours (greater fruit and vegetable consumption and eating breakfast) and a more healthy home food environment in terms of the types of foods available. However, the same study found no association between family meals and BMI.

The influence of parenting styles and family structure on adolescent dietary intake was investigated by Pearson *et al.* (2010). In this study more favourable dietary intakes were reported by those adolescents who also reported their parents to have an authoritative parenting style. They reported eating more fruit, breakfast more frequently and snack foods less frequently compared to individuals who reported authoritarian, neglectful and indulgent parenting styles (Pearson *et al.*, 2010).

Bassett *et al.* (2008) presented evidence that suggests autonomy of food choice is a co-construct between the adolescent and their parents. Breakfast, lunch and snack choices were mainly made by the adolescents but where the meal was family based (i.e. evening meal) individual food choice by the adolescent was restricted. The mother or household food preparer would make decisions on behalf of the family unit.

A review of environmental correlated of obesity related dietary behaviours on children and young people (van der Horst *et al.*, 2007) found consistent positive associations between parental and sibling intake and adolescent energy intake. For example, parents who perceive their children, particularly older children, to be less likely to be influenced by the home food environment when making food choices, often obtaining high fat/high sugar foods away from the home (Gattshall *et al.*, 2008). Adolescents are likely to make autonomous food choices outside of the home, a study conducted in the USA reported that 61% of adolescents (aged 13-17 years) attended fast food outlets without their parents and therefore chose what they ate themselves (Elbel *et al.*, 2011). With this in mind, although parents and families influence the intakes and habits of adolescents, peer group factors may also affect food choice decisions particularly when outside of the home.

2.6.2.3 Peer influences

Peer norms and fitting in are often cited as key factors influencing adolescent health behaviours (Story *et al.*, 2002). Outside of the home, friends influence more 'risky' food choice behaviours such as alcohol and fast food consumption (Walsh and Nelson, 2010).

“Food is frequently interwoven in social interactions and during adolescence, making, keeping and impressing friends becomes an important developmental task” (Cohen *et al.*, 2012, p968). Results from focus groups with young people (13-15 years) in the North East of England suggested ‘healthy eating’ was bad for an adolescents’ social development (Stead *et al.*, 2011). The authors suggested that food choices were used by adolescents as ways to develop self-image in accordance with peer norm conformity (Stead *et al.*, 2011). Showing an interest in healthy eating would be judged by others in a negative way and therefore socially risky as the young person would not ‘fit in’.

There is evidence for peer modelling of eating behaviours where individuals consume more when their eating companions also consume greater amounts (Salvy *et al.*, 2012). Supporting this view, Wouters *et al.* (2010) found that adolescent individual consumption of snack food and soft drinks was associated with friendship group consumption of the same items.

The social context within which food choices are made may be important. In a laboratory study (Péneau *et al.*, 2009) with normal weight teenagers aged 15-16 years, more soft drinks were consumed when eating a standard meal whilst watching television than in control conditions (eating alone, listening to music, eating in a group). In the same study, males were found to eat more solid food than females and ingested more soft drinks (soda).

It is apparent from the literature that no single psychosocial factor is influential in adolescent food choice, but rather a combination of factors is working in tandem. Although some factors may have greater influence and the importance of each factor could vary by individual.

2.6.3 Socio-demographic factors influencing food choice

It is important to consider the influence of socio-demographic factors including gender, age, ethnicity and socio-economic status on food choice.

Differences in the health behaviours of males and females have been reported; mostly the differences have been reported regarding the use of food outlets. For example, Larson *et al.* (2010) identified the frequency with which young adults (aged 20-31 years) ate out at fast food and sit-down restaurants. Men reported

dining at fast food restaurants more frequently than women, a finding which has also been reported by others (Kerr *et al.*, 2012).

There is evidence to suggest differences in the influences on behaviour and autonomy shown by younger and older adolescents. Younger adolescents, 13-15 years, may be more reliant on parental influence and the home food environment whereas older adolescents, 16 years and over, may exhibit a greater degree of freedom in terms of food choices and access. For example, eating at fast food outlets and convenience stores during the school lunch break was more commonly reported by older than younger students (Neumark-Sztainer *et al.*, 2005). High school students reported significantly lower frequency of family meal times than middle school students (3.9 per week compared with 5.4) (Neumark-Sztainer *et al.*, 2003a).

The stage of adolescence may be important to food choice motivation and behaviour, with younger and older adolescents being influenced by differing factors (Share and Stewart-Knox, 2012). Share and Stewart-Knox (2012) indicated the presence of a “sensitive period” in middle adolescence (14-17 years) where less healthful habits have a greater potential to develop. To prevent the development of unhealthy eating habits, nutrition education and interventions may be best targeted at this age group although how and where to intervene is unclear. The 16-18 year old phase of adolescence appears to be understudied in the literature.

Socio-economic status (SES) takes into account the social and economic background of individuals and can be assessed in a number of ways including income, education level and occupation in addition to area level measures such as the Index of Multiple Deprivation (IMD) scores and rank. Those of lower socio-economic status are more likely to have multiple risk factors for obesity (Buck and Frosini, 2012; Hardy *et al.*, 2012). Hanson and Chen (2007) conducted a systematic review of the relationships between socio-economic status and health outcomes including substance use (alcohol, smoking and marijuana) alongside lifestyle factors such as diet and physical activity. Focusing on dietary intake, SES was consistently associated with poorer dietary intakes in adolescence, regardless of the methods of assessing SES or diet. Twenty five of the 31 identified studies (81%) reported a negative association between SES

and diet. For example, those individuals with lower SES have lower intakes of fruits and vegetables and higher intakes of fat and sugars.

2.7 Literature review summary

- The definition of adolescence varies and there is a lack of research focusing on the 16-18 year age range with many studies investigating the impact of the food environment on younger teenagers (under 16) or young adults (18-25 years)
- There is mixed evidence of a relationship between the exposure (or community) food environment and dietary intake or adiposity, with many studies using proxy measures of dietary intake (questionnaires) and exposure (secondary data and buffers).
- There is emerging use of GIS and GPS methods to explore exposure to environmental factors, but few studies apply these techniques to the food environment and none to study the food environment of adolescents.
- Many studies of food outlet use focus solely on frequency of fast food consumption. There is a need to investigate the types of food sources actually used by the adolescent population, particularly the different types of food outlets used (visited food environment).
- The literature notes the importance of the organisational, especially the home and school, food environment to the adolescent age group.
- The nutritional contribution of food from different food sources and food outlets to total dietary intake is seldom investigated. Few studies link actual dietary intake to food source.
- Measures of the consumer food environment are required to assess the healthiness of the food choice environment young people are faced with when making decisions within food outlets. These should be tailored to the population being studied and no study to date has investigated the relationship between the consumer food environment and dietary intake in adolescents.
- The impact of the individual level factors influencing food choice should not be overlooked. Using qualitative techniques in combination with quantitative methods could help to unpack the drivers of food choice and help understand the process of food choice in the adolescent population.

This research aimed to address these gaps in the literature by conducting a mixed method study identifying and exploring the food choices made by young people. The specific aims and objective addressed are presented in the next section, leading into the methods chapters.

2.8 Research aims and objectives

The overarching aim of this PhD research was to explore whether, and to what extent, the food environment to which a young person is 'exposed' has an influence on individual food intake. This was achieved by addressing the following four research objectives:

1. To identify the physical food environment of 16-18 year olds living in Newcastle upon Tyne using a mixed method approach to 'map' and record *use of* and *exposure to* food environments at an individual level.
2. To rate the *healthiness* of the food outlet environments that young people visit and calculate individual food environment ratings.
3. To examine relationships between individual dietary intake, anthropometric and socio-demographic measures and *visited* and *exposure* food environment variables.
4. To use qualitative methods to explore and understand the drivers of food choice in terms of the food environment of young people.

2.9 Methodology

A mixed method research methodology which utilises both quantitative and qualitative methods was considered the most suitable to achieve the aims and objectives of this study. Individual methods were employed from across disciplines linking together methods traditionally used in nutrition research with methods from geography (Geographic Information Systems) and the social sciences (qualitative interviewing). Both quantitative and qualitative methods have their own strengths and limitations however it is thought that when combined they can help to provide a better understanding of a research question than either methodological approach can alone (Bryman, 2006).

An explanatory sequential research design was used whereby quantitative information from a first phase is further explored using qualitative methods in a second phase (Creswell and Plano Clark, 2007). Based on the explanatory model, qualitative methods (individual interviews) were used to seek more in-depth findings with a subsample of participants based on data collected via quantitative methods (food diaries and GPS). Although quantitative methods are useful in determining the behaviours of individuals, the results do not provide any insight into the individual motivations behind preferences and behaviours. This approach results in the generation of complimentary data sets which together help to give a more comprehensive answer to the research questions (Nau, 1995).

Some of the methods adopted (including a food diary, text messaging, photographs, receipt collection, anthropometric measurements and Measuring Food Environments surveys) were established prior to this PhD study (see Chapter 4, Methods). Others were newly introduced and therefore required development and testing for use in the current study. Chapter 3 describes the development of these new methods including questionnaires, use of GPS/GIS to identify food outlet exposure, and the acceptability of the data collection methods to the target population. In addition, a pilot study was completed in order to trial and streamline the data collection process and generate data to develop an analysis plan for the main study.

Chapter 3 Methods development

Chapter overview:

- Introduction
- Acceptability of methods
- Lifestyle questionnaire development
- Questionnaire database development
- Global Positioning System device testing and selection
- Pilot study
- Analysis plan development
- Development of a topic guide for individual interviews
- Summary

Following completion of the literature review, it was clear that although there was an abundance of research identifying the “place-based” environmental influences of food choice (using GIS methods to study exposure), little work focused on “people-based” environmental influences (Kestens *et al.*, 2010). GPS technology has been used in a number of studies measuring physical activity in relation to the environment in children and young people (Jones *et al.*, 2009; Wheeler *et al.*, 2010). However, only now are studies beginning to emerge using the method to identify the food environment relating to individuals (Christian, 2012; Thornton *et al.*, 2012). Because a limited number of studies used GPS at the start of this research process, the feasibility of using this method to assess the food environment needed to be explored.

This chapter presents the methods development process including acceptability testing of methods, the development of a lifestyle questionnaire (LSQ), and the trialling and selection of a GPS device. A full pilot study was conducted with young people in Durham (UK) results from which are reported in Section 3.5. Data collected in the pilot study were used to guide development of methods for identifying and assessing the *visited* and *exposure* food environments of individuals.

Some of the methods adopted in this PhD research were developed as part of a programme of work entitled “Combating the Obesogenic Environment” led by Dr Amelia Lake as part of an NIHR post-doctoral fellowship (2006-2008). An outline of the methods development process can be seen in Figure 4.

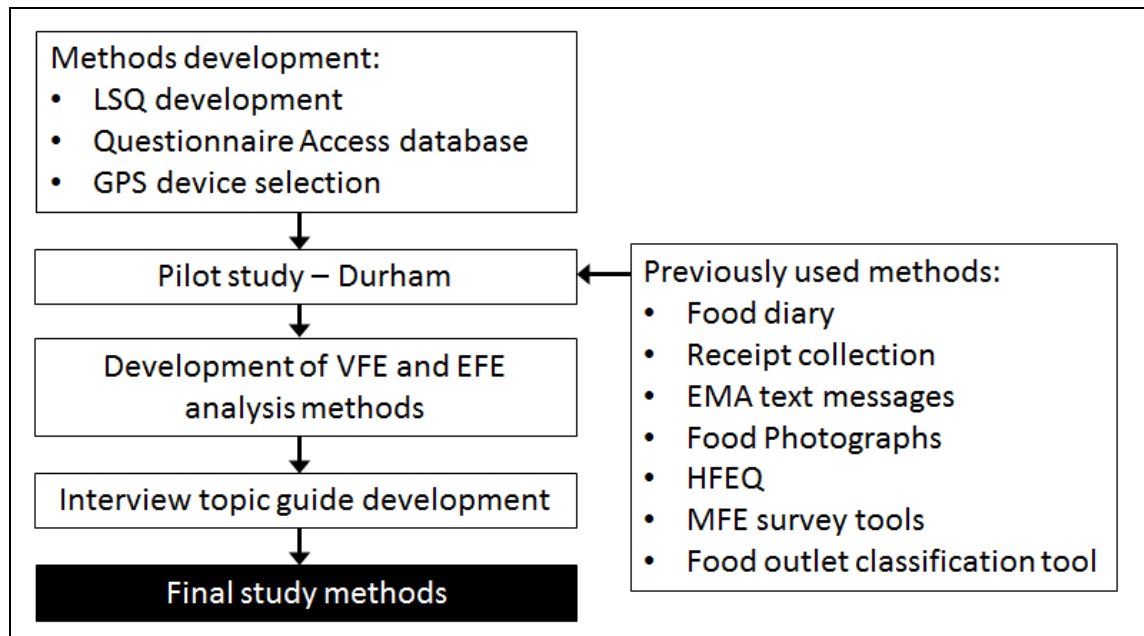


Figure 4 Flowchart of methods development process

The development of a food diary used in conjunction with receipt collection, Ecological Momentary Assessment (EMA) text messaging and photography is reported in Lake *et al.* (Submitted October 2013b). The development and testing of three Measuring Food Environments (MFE) survey tools for assessing the healthiness of the consumer food environment (shop, restaurant and vending MFE surveys), and a questionnaire assessing factors relating to food availability and choice in the home food environment (HFEQ) is reported in Lake *et al.* (Submitted October 2013a). A modified version of the published food outlet classification tool (Lake *et al.*, 2010; Lake *et al.*, 2012) was used to classify and categorise food outlets in the pilot and main studies. A full description of each of these previously developed methods (food diary, receipt collection, text messages, photographs, HFEQ, MFE surveys and food outlet classification tool) used within the current study is presented in Chapter 4.

The remainder of this chapter focuses on the development of methods unique to this PhD research study.

3.1 Acceptability of methods

As part of the initial research development, three Beacon North East workshops were conducted with young people (n=34, mean age 17, range 16-20 years) in order to generate discussion and allow a targeted review of the proposed research methods (Tyrrell *et al.*, 2010; Newcastle University, 2012).

Four potential methods: text messaging, photographs, social networking websites, and GPS monitoring; were discussed during the workshops. Groups of 3-4 individuals were provided with posters illustrating the methods and active discussion was encouraged. Table 2 contains illustrative quotes from young people involved in the workshops; these are presented under the four method headings presented with a discussion of the factors identified in the data generated during the workshop sessions. Research methods were revised in line with workshop comments and suggestions.

Table 2 Summary of discussion from Beacon North East workshops with young people and changes implemented

Method	Factors	Example comments	Change implemented
Text messaging	Length and number of texts	<i>"Quite an effort to reply"</i> <i>"too annoying"</i> <i>"people wouldn't take this seriously"</i>	Investigated the minimum number of text messages needed to obtain required study data.
	Time constraints	<i>"not going to do if already with other people – busy"</i>	
	Personal expense	<i>"Would they be getting their phones topped up?"</i> <i>"What if we had no credit?"</i>	
Photographs	Personal feelings	<i>"self-conscious"</i> <i>"uncomfortable"</i> <i>"feeling stupid"</i>	Option to use personal mobile phone to take photographs rather than study digital camera in order to reduce feelings of embarrassment. Provided example sheet to encourage adoption of method.
	Increasing acceptability – support of others	<i>"[if] they told people they were with why they were taking photographs"</i>	
	Time factors/ forgetting	<i>"if I had time, too busy"</i> <i>"eat & go, not think"</i>	
Social network websites	Familiarity	<i>"a well-known network"</i> <i>Facebook</i>	Explored options for social networking use in relation to participant comments. ⁴
	Online safety concerns	<i>"anyone could add you and ask you out when you don't know the person"</i>	
	Positive feedback	<i>"good idea"</i> <i>"something that people would come across and more likely to give their views"</i> More likely to succeed <i>"if it was interesting [using] multimedia, photo, sound [and be] interactive"</i>	
GPS monitor (specifically a Garmin wrist watch device)	Dislike of watch	<i>"Is everyone going to want to wear it?"</i> <i>"It's not fashionable"</i> <i>"you would look weird wearing it"</i>	GPS device options explored including mobile phone applications and small GPS devices. Use term 'logging' instead of 'monitoring' Ensure participant awareness of data use including security and anonymity protocols.
	Suggestions	<i>"attractive accessory"</i> <i>"so you can't see it"</i>	
	Privacy concerns	<i>"It's wrong and stalkerish and you wouldn't have no privacy"</i> <i>"It's a bit like being a criminal with a tag on"</i>	
	Need for more information	<i>"would like to know where the signal is going to"</i>	

⁴ A number of websites were considered and Facebook was believed to be the most popular and frequently used. However, the use of Facebook for data collection purposes was not pursued. The use of Facebook or similar websites, particularly in a context where participants may interact, could impact the nature of the data collected, and may act as an intervention strategy rather than an observational study. In addition, a website used in this context would require strict monitoring of content by researchers which may be time intensive. The aim of the study was to observe behaviour, not to influence or encourage behaviour change and therefore online social networking was deemed inappropriate in the context of the study.

3.2 Lifestyle Questionnaire development

The Lifestyle Questionnaire (LSQ) was designed to measure psychosocial factors including preferences, attitudes, self-efficacy and social support in respect of food (Haerens *et al.*, 2007), and other relevant health behaviours, such as smoking, alcohol intake, and physical activity (Currie *et al.*, 2008). Individual questions were pooled from existing validated tools (Currie *et al.*, 2004; Campbell *et al.*, 2007; Lake *et al.*, 2009) within one questionnaire under ten sub-headings; ethnic origin, your family, jobs and transport, food, television and computers, physical activity, dieting behaviours, smoking and alcohol, family activities, and friend activities.

Questions were chosen based on evidence of lifestyle behaviour sharing a tendency to cluster (Pearson *et al.*, 2009). The current study did not have the scope to collect primary data on physical activity for instance and therefore the LSQ asked questions to allow an estimate of physical activity levels to be calculated. These were based on methods used in other studies (Currie *et al.*, 2004).

The LSQ was first administered in the pilot study (Section 3.5.4). A copy of the LSQ including citations for individual questions can be found in Appendix A.

3.3 Questionnaire database development

Three questionnaires were used in this study; Home Food Environment Questionnaire (HFEQ) (see section 4.3.6.2 and Appendix B) (Briggs and Lake, 2011; Lake *et al.*, Submitted October 2013a), Lifestyle Questionnaire (LSQ) (see section 4.3.6.1 Appendix A) and the Adolescent Food Habits Checklist (AFHC) (Johnson *et al.*, 2002) (ref section 4.3.6.3 and Appendix C). With the aim to streamline the data collection and subsequent data entry process, the questionnaires were integrated into an online Microsoft Access Database. This enabled participants to enter information directly into the online database, minimising the risk of errors occurring during data entry. Use of the database was trialled in the pilot study (see section 3.5).

3.4 Global Positioning System device testing and selection

Using GPS data in conjunction with GIS analysis techniques is an emerging method in health research linking individuals to the environment they experience (Wiehe *et al.*, 2008a; Christian, 2012; Gustafson *et al.*, 2013). In the current study, the aim was to explore the food environment to which young people are exposed by linking participant collected GPS data with food outlet locations. It was important to select a GPS device that would yield the best data in relation to the study requirements. GPS recorded using mobile smartphones has previously been used with adolescents (Bamford, 2008 #1689) and traditional type GPS devices have been used with children (Jones *et al.*, 2009; Wheeler *et al.*, 2010). Results from Beacon North East workshops (section 3.1) indicated that the acceptability of using a traditional GPS device, particularly in terms of appearance, with young people needed to be explored.

Two GPS logging devices, QStarz BT-Q1000XT and i-gotU GT-600, were selected for testing based on advice from other researchers employing GPS in health research (Appendix D). The devices were tested for suitability according to seven identified factors; accuracy and sensitivity of data, battery life, fix time, data storage capacity, ease of use, appearance, and affordability. Specifications for the 'ideal' device and detailed results from the testing period can be found in Appendix E. The QStarz device was selected for use in the pilot and main study, out-performing the i-gotU device in most criteria, particularly in terms of accuracy and sensitivity of data, and battery life (Appendix E). The QStarz device was also considered acceptable by the target population. Young people aged 14-15 years who took part in workshops were agreed that the method was acceptable and showed no preference between the two GPS devices in terms of appearance and wear-ability⁵.

⁵ Informal survey conducted as part of a STEM (Science, Technology, Engineering and Mathematics) Horizon Careers engagement event at a secondary school in Durham, UK (November 2010). Five classes of Year 9 students (aged 14-15) were asked to state their preference of two GPS devices via a show of hands. Preference was evenly split with a trend for girls to prefer the white coloured 'i-gotU' device and boys preferring the black 'QStaz' device. Workshops conducted by Rachel Tyrrell and Rachel Gallo, Newcastle University.

The next section outlines the results from the pilot study, describing the recruitment approach, advantages and disadvantages of working with schools, and the fine-tuning of the data collection protocol.

3.5 Pilot study

A full pilot study was conducted to integrate the newly developed methods with a study protocol used within previous pilot studies assessing the food environment of young people (Lake *et al.*, Submitted December 2013; Lake *et al.*, Submitted October 2013a; Lake *et al.*, Submitted October 2013b). The aims of the pilot study were:

1. To trial recruitment of participants through the school environment
2. To test the data collection process and modify this where necessary
3. To collect food diary and GPS data in order to develop methods to identify the visited and exposure food environments of individuals

This section outlines the new methods tested in the pilot study and identifies where changes to the protocol were made to these methods prior to the main study. The section pays particular focus to the inclusion of GPS methods and collecting questionnaire data via the Access database. The advantages and disadvantages of recruiting participants through the school environment are also discussed.

3.5.1 Ethical approval and incentives

The pilot study was approved by Newcastle University Ethic Committee. Three researchers involved in the pilot study held enhanced Criminal Records Bureau clearance. Volunteers received an incentive for their contribution (£10 shopping voucher), details of which were included on the posters and information leaflets advertising the study and reiterated by researchers during recruitment presentations.

3.5.2 Study sample

Young people attending a school-based sixth form college located in Durham were invited to take part in the pilot study. Use of another city in the North East

of England avoided exhausting the main study recruitment pool whilst ensuring the food environments of the two samples were not too dissimilar.

The head of sixth form acted as a 'gatekeeper' to organise meetings between the researcher and study volunteers. Students studying for AS level qualifications (school year 12) in 'Sports Science' and 'Health and Social Care' attended one of two short recruitment presentations. The gatekeeper had control over who was invited to take part in the pilot study, potentially selecting students studying courses where this health research study tied in with curriculum requirements. This may have limited the range of experiences and characteristics of participants.

Eleven individuals were invited by teacher gatekeepers to take part in the pilot study and ten participants completed the pilot study in its entirety (91% participation rate). Of the ten participants, six were male and the group had a mean age of 17 years (range 16-19 years). One individual was excluded from the pilot study due to foreign travel plans during the study period. As the study was designed to assess 'usual' behaviours, a new eligibility criterion was established for the main study: participant plans to remain within the study area (within reason) for the duration of the study period. One participant was above the age cut-off criteria of 18 years but was included in the pilot study as they met all other set criteria. The pilot study sample size was sufficient to thoroughly test the recruitment and data collection processes and provide data with which to develop an analysis plan.

3.5.3 Pilot study timeline

The pilot study was completed over a two week period in March 2011. All meetings with participants took place during school hours and on the school premises. There was a period of five weeks between initial contact with the gatekeeper and the researchers' first visit to the school for recruitment. This was mainly due to scheduled school holidays and exam periods. This demonstrated the need to allow for time in the data collection schedule for arranging suitable recruitment dates with schools. The pilot study school was accessed via a personal contact and it was expected that the time between initial contact and the start of recruitment would be similar or longer when 'cold calling' schools to recruit participants for the main study.

3.5.3.1 Group recruitment and collection

Two group recruitment sessions were conducted during the pilot study. Interested students attended a short researcher-led presentation outlining the requirements of the pilot study where volunteers received a leaflet containing study information and were given the opportunity to ask questions. Written informed consent was obtained from those wishing to take part (Appendix F).

Group recruitment was the ideal approach for recruiting within the school environment. Delivering a PowerPoint presentation ensured all volunteers received the same explanation of the study requirements, and volunteers had the benefit of hearing answers to questions posed by others in the group setting. Researcher contact details were provided on information leaflets for participants use should any questions arise during the study period.

Consenting participants were each given a study pack at the recruitment meeting and asked to begin collecting study data on the following day. The study pack contained the following items:

- Information leaflet/ parent letter (Appendices G and H)
- Food diary and pen (Appendix I)
- QStarz GPS logger
- Food photograph guidance (Appendix J)

The QStarz GPS devices were configured to record waypoints at 10 second intervals and the power saving function was active. The devices were fully charged and switched to 'LOG' by the researcher before distribution.

Participants were asked to carry the QStarz GPS device for the same 4-day period they were completing the food diary. They were instructed to carry the GPS device at all times in a clothes pocket or the outside pocket of a bag and were asked not to turn the device off at any time.

Unlike other health studies using GPS technology (Maddison *et al.*, 2010; Oliver *et al.*, 2010), participants were not required to wait for the GPS device to acquire a 'fix' when leaving buildings or to re-charge the device. This was to ensure participant burden was kept to a minimum and to avoid interference with

usual behaviour. All loggers were returned with food diaries at the collection meeting.

Seven GPS devices were available for use in the pilot study. This limited the number of young people that could be recruited and start the study at one time point. Recruitment sessions were therefore staggered over a two week period in order to allow a rollover period and all interested volunteers the opportunity to take part.

In order to effectively manage the logistics of the study, a recruitment timetable was established. Dates for recruitment and collection sessions were selected to best suit the gatekeeper and participant schedules. The aim was to complete collection interviews within five days of food diary completion.

The data collection period was relatively short and ran efficiently. A rolling programme for data collection was completed over a two week period with a team of two trained researchers visiting the school on four occasions to conduct recruitment and data collection sessions. A private room was made available for the food diary collection interviews and anthropometric measurements. Some meetings were conducted with pairs of participants completing the interview in tandem although efforts were made to keep body measurement and diary details confidential.

During the pilot study, a checklist was developed to aid the researcher when preparing for and completing individual measures (e.g. equipment and task lists for meetings). This was also a place for the researcher to make notes of any feedback obtained from the participants (Appendix K).

3.5.4 Questionnaire administration

Pilot participants completed three study questionnaires; Home Food Environment Questionnaire (HFEQ, Appendix B), Adolescent Food Habits Checklist (AFHC, Appendix C), and Lifestyle Questionnaire (LSQ, Appendix A). Pen and paper versions of the HFEQ and AFHC had been used in previous studies (Johnson *et al.*, 2002; Briggs and Lake, 2011; Lake *et al.*, Submitted October 2013a). The pilot study aimed to test their administration via a Microsoft Access database. The LSQ was also assessed for understanding and ease of completion. To administer all three questionnaires in one sitting risked

introducing questionnaire fatigue and therefore the LSQ was completed at recruitment with the HFEQ and AFHC completed during the collection interview.

Participants completed all three questionnaires electronically, directly into the database using a laptop. Completing the LSQ electronically posed a logistical problem in the group recruitment setting. Participants in recruitment group 1 (n=6) waited up to 50 minutes for laptop access. A pen and paper version of the LSQ was developed for use in subsequent group recruitment sessions thereby streamlining the data collection process. Data were then entered into the database by the researcher.

Participants were asked to raise any problems they had completing the questionnaires with the researcher. Overall, participants reported that the electronic questionnaire was easy to use. There was some confusion regarding the 'your family' section of LSQ, particularly where participants wished to report living at more than one address. The question was not changed following the pilot study however help was provided with completion of this section where required. A researcher was present to check all sections of the questionnaires were complete and to ensure the database was saved correctly reducing the risk of data loss.

3.5.5 Working with schools and gatekeepers

There were a number of advantages and disadvantages to working with schools and gatekeepers. Schools have the potential to provide researchers with access to a large recruitment pool of young people. However, there may be specific security and ethical requirements a researcher needs to meet before being provided with that access (Morrow, 2008). Although parental consent was not required for participation in the study, the pilot school requested an information letter be sent to the parents of consenting volunteers. The parent letter (Appendix H) contained the same information as the participant information leaflet (Appendix G). Provision of a parental letter was a simple solution to address the schools request and ensure responsibility of the study process and materials was attributed to the researcher and Newcastle University, not the school. Organising collection interviews in school time was challenging due to the time commitment involved for both the school and participants. An hour long one-to-one appointment was required with each participant to complete the food

diary collection, questionnaires and anthropometric measures. These sessions needed to fit into student timetables in order to avoid disruption to teaching time. Text messages were sent to all consenting participants to inform of the researcher visit and remind participants to bring their study packs to school. However, the decision of when and with whom the interviews took place was made by the gatekeeper.

3.6 Analysis plan development

The collection of food diary and GPS data in the pilot study was essential to allow for development of a method for identifying the visited and exposure food environments of individuals. This section describes the extraction of data from the food diary and GPS device and the subsequent development of an analysis plan for the main study. The first section outlines the method for identifying and measuring the source of food with particular focus on food outlets (Visited food environment; VFE), including results from the pilot study. This is followed by the development of a method for identifying the food outlets individuals were exposed to (Exposure food environment; EFE), again with pilot study results. The final section discusses the strengths and limitations of the pilot VFE and EFE analysis methods alongside modifications to the data collection and processing methods that were applied in the main study.

3.6.1 Identifying and measuring the Visited Food Environment

The visited food environment (VFE) is defined as the food outlets individuals use as a source of food during the study period. Eating events were identified within the food diaries according to the time of consumption reported by participants. The eating events were coded into two food source categories; 'home/ friends/ relative' and 'out-of-home' based on the assumption that food sourced from outside the home is of lower nutritional quality (Lachat *et al.*, 2012; Jaworowska *et al.*, 2013).

For 'out-of-home' eating events, the name and location details of food outlets were extracted from the food diaries, supplemented with descriptions obtained during collection interviews. A Google search was conducted in order to obtain complete business names and addresses. Where necessary, the Royal Mail postcode finder (Royal Mail Group Ltd) was used to obtain postcodes for the

food outlets. GeoConvert (UK Data Service Census Support) was used to convert postcode data into latitude and longitude coordinates (postcode centroid) for mapping.

Seventy-nine percent of the food outlets identified through the food diaries were visited in person by a researcher, 21% (n=6) were not identified by the participant within the food diary or were not publicly accessible e.g. schools. At this visit, the food outlet was classified using a 15 point classification tool (Appendix L, adjusted from Lake *et al.* (2010)) and, where appropriate, a Measuring Food Environments (MFE) survey was completed (Appendices M and N).

A total of 231 eating events were recorded by pilot study participants; a mean of 5.8/ person/ day. The home (including friends' and relatives' homes) was the main source of food (74.9% of eating events), while for 25.1% of eating events food was sourced outside of the home. Of these, food was most commonly sourced from 'supermarkets' (n=11), 'closed/ private food outlets' (including school/ workplace) (n=11), and 'takeaway & fast food' (n=10). Four of the 15 food outlet categories were not visited by the participants; 'specialist', 'mobile food', 'vending machine', 'health & leisure'. The high number of 'closed/ private food outlet' eating events highlighted the need to investigate school food as a separate out-of-home food source to food outlets.

All participants used out-of-home food outlets at least twice over 4-days (range 2–11 eating events per person) with a mean of 1.5 food outlet eating events/person/day. Note that the same food outlet may have been visited more than once throughout the food diary period and food from one food outlet visit may be the source for multiple eating events; this is not reflected in the results.

A number of changes were made to the methods used to identify the food source and VFE following the pilot study. The food source classification was expanded to give five categories; 'home/friends/relatives' was split to give two categories (home and friends' and relatives' homes) and 'out-of-home' was split into three categories (school, work, and food outlet). The 15 point food outlet classification tool was amalgamated to form five groups for analysis, details of which can be found in the methods chapter (Chapter 4). The food diary layout worked well in the pilot study however there was a need for researchers to

probe for additional details regarding the names and addresses associated with food outlet eating events to ensure the best possible dataset was attained.

3.6.2 Identifying and measuring the Exposure Food Environment

The Exposure Food Environment (EFE) is defined as the food outlets to which an individual is exposed during their day-to-day activities and represents the opportunities individuals may have to obtain food outside of the home. This section describes the use of Geographic Information System (GIS) techniques to develop a method linking GPS data to food outlet location information in order to estimate the number and type of food outlets to which individuals are exposed. Considerations for GPS device battery life and quality of data are presented here along with details of modifications made to the GPS data collection protocol following analysis of pilot study data.

3.6.2.1 *Extraction and cleaning of Global Positioning System data*

Data were extracted from the QStarz GPS device using QTravel™ V1 software (QStarz International Co. Ltd., 2006). Data were presented in the form of waypoints, a reference point to a geographic space, with each recorded waypoint containing date, time, latitude, longitude, altitude, and speed measurements. Waypoint data were automatically cleaned for GPS error by the QTravel software. Errors in waypoint recording can occur where the GPS signal is altered by atmospheric effects, for example adverse weather (e.g. cloud and rain) or urban canyons (tall buildings and infrastructure). Waypoint data were exported to a Microsoft Excel CSV spreadsheet where manual cleaning and coding was completed.

Any waypoints recorded either side of the 4-day study period were removed. Longitude figures were transformed to give negative values in order to make the data compatible with ArcGIS. Data columns were added to the spread sheet to link waypoints to participant ID, study day and weekday and track number⁶.

⁶ Track number – the QStarz GPS device starts a new GPS ‘track’ recording each time the device loses signal or exits the sleep mode function. The track number is a record of the number of track recorded for each participant.

3.6.2.2 QStarz Global Positioning System device performance: results from pilot study

Raw ‘un-cleaned’ data are only available for five out of ten pilot study participants. This is a result of researcher error in the process of extracting, saving and cleaning of GPS data using the QTravel software. A standardised protocol was subsequently developed and followed to eliminate the potential risk of this error re-occurring in the main study.

For these five participants, a total of 108.94 hours of data were recorded, a mean of 21.8 hours per person. The GPS data were date matched to the start of the food diary recording resulting in a total of 79.46 hours data (Table 3). This equates to a GPS recording rate of 16.6% of the potential total of 480 hours (24hours x 4 days x 5 participants). The GPS device was not expected to record waypoint data continuously over the study period. The power saving function allows data recording to cease when the device is static i.e. when participants are indoors at school/home and overnight. With this in mind, the collection rate of 17% seen in the pilot data was considered acceptable considering other ‘exposure’ research suggests around 80% of time is spent indoor where GPS signal is likely to be lost (World Health Organization, 1999; Kornartit *et al.*, 2010).

Table 3 Number of GPS active hours – total running time calculated using data for participants where raw un-cleaned data available (n=5)

<i>ID</i>	<i>Total number waypoints^a</i>	<i>Number study waypoints^b (%)</i>	<i>Number active hours^c</i>
515	10162	7291(72)	20.25
516	8646	7156 (83)	19.88
517	62	56 (90)	0.16
518	14968	11362 (76)	31.56
519	5378	2738 (51)	7.61
Total			79.46
Mean			15.89

^a Total number waypoints recorded by GPS device

^b Total number waypoints recorded on study days (total waypoints trimmed to study period)

^c Active hours=study waypoints /6 /60 presented in decimal hours, data recorded at 10 second intervals

A travel study by Oliver *et al.* (2010) reported that only 11% of potential trips were recorded by GPS. The authors allocated this data loss to participants’ inability to meet with researchers to change the device battery. Similarly, in this

pilot study it appears battery life is the main reason for GPS data loss. All ten participants had some data recorded on the first two study days. Supplying the GPS logger powered on prior to the study start date resulted in waypoints being removed to time match the data to the food diaries. This data loss equated to 27% of the total hours of GPS data recorded. Short battery life, shake awake function failure and participant non-compliance to carry the GPS device are all potential explanations for the data loss seen here.

In order to reduce this data loss in the main study, the protocol was adapted to give participants responsibility for powering on the GPS device at the start of study day 1. Verbal and written GPS device instructions (Appendix J) were provided at recruitment in addition to a reminder text message on the first study day.

3.6.2.3 *Adjusting for speed of travel and data trimming*

It is thought that the influence of food outlet exposure and the likelihood of making food purchases will be greater when passing outlets at a lower speed or using active transport such as walking or cycling (Laska *et al.*, 2010b).

Interviews conducted as part of the UrbanDiary London study (Neuhaus, 2011) indicated that “perception of space changes with time, mode of transport and especially with speed”. This research highlighted the lack of attention paid to the surrounding area when travelling on passive transport. For example, when travelling on buses, individuals “...ignore the route and concentrate on a book, the music playing through their headphones or simply just sit and look out the window...” (Neuhaus, 2011). In contrast, Christian (2012) noted that although exposure to food outlets in moving transport might not provide opportunities to obtain food it would contribute to an individuals’ knowledge of the food environment in the active space.

Oliver *et al.* (2010) reported the average speed of travel by transport-related physical activity e.g. walking and cycling for travel purposes, to be 8.4mph (SD=4.0). This was significantly different to figures reported for motorised transportation (mean=20.6mph, SD=9.3, $p>0.01$). However, data from the National Travel Survey (Department of Transport, 2013) indicated that only a minority of cycling trips made by 17-20 year olds (0.02%). Time spent in motorised transport add complication when measuring time append outdoors

(Cooper, 2010). In a study investigating the time spent outdoors in physical activity by UK children (PEACH project), data recorded above 15 km/h (approximately 10mph) was excluded from the time outdoors calculation (Cooper, 2010). However, slow moving traffic data was not removed via this approach (Wheeler *et al.*, 2010).

As the current study aimed to assess exposure to food outlets and opportunities to obtain food, a cut off of 5mph was deemed appropriate. Speeds recorded above this were likely to indicate motorised transport such as car, bus or metro. A speed cut-off of 5 mph (8.05km/h) was therefore applied to the GPS data and any waypoint with a recorded speed above 5mph was removed from the data (5838 waypoints (61.5%) remained in the pilot study dataset).

When travelling, the mode of transport cannot be determined directly from the GPS data. There is a need to establish some context when using GPS in health surveys and GPS devices should be used in conjunction with, not in lieu of, diary methods (Bricka *et al.*, 2012). Using a food diary and face-to-face collection interview alongside GPS did allow for some contextual information regarding travel methods used when visiting food outlets to be obtained. In addition, the possession of a driving licence and motor vehicle access was reported in the LSQ (section 4.3.6.1). However this data was not comprehensive enough to identify travel methods within the GPS data and therefore no attempt was made to remove waypoints where individuals were using motorised transport such as cars or buses and travelling at less than 5mph (i.e. slow moving or stationary traffic, or bus stops). This has been identified as a limitation in other studies using GPS to record activity (Wheeler *et al.*, 2010).

The number of GPS waypoints recorded (post cleaning) varied greatly by individual with a range of 30–1963 waypoints recorded over 2–4 days. To allow a fair comparison between pilot study participants, GPS data were trimmed to include study day 1 only. The mean number of GPS waypoints recorded on study day 1, following adjustment for speed of travel, was 212 (range of 4–451).

3.6.2.4 Identifying Exposure Food Environment outlets using Geographic Information System

Many studies use secondary data sources to identify and locate food outlets in a given geographic area. Data were collected on the food outlet locations in the North East of England from local council databases as part of a study mapping the food outlet provision in the North East (Burgoine, 2010).

Pilot study GPS data were layered with the food outlet location data in order to estimate the EFE of individuals. Distance buffers have commonly been used to characterise the food environment surrounding geographic points such as individuals' homes or schools. Buffer sizes reported in the literature vary greatly and no standard size has been established. Many studies rely on a buffer of approximately 800m around a participants' home or school, representing about half a mile in distance or a 10 minute walk. As this study collected data on actual routes taken, the application of a smaller buffer to the GPS points was considered more appropriate to capture exposure to food outlets. It should be noted that studies have been recently published using 0.5 mile buffers around travel routes although these were not available at the time of method development for the current study (Christian, 2012; Burgoine and Monsivais, 2013).

Using ArcGIS software, circular distance buffers were applied to each recorded GPS waypoints. These waypoint buffers were merged to form one EFE-buffer area unique to the participant. The EFE-buffer was layered with the food outlet location data (Burgoine, 2010); the outlets contained within the EFE-buffer formed the EFE-count for individual participants.

A variety of buffer sizes were applied to the data for study day 1 only. Figure 5 shows the EFE-count for a variety of potential EFE-buffer sizes for the pilot study participants.

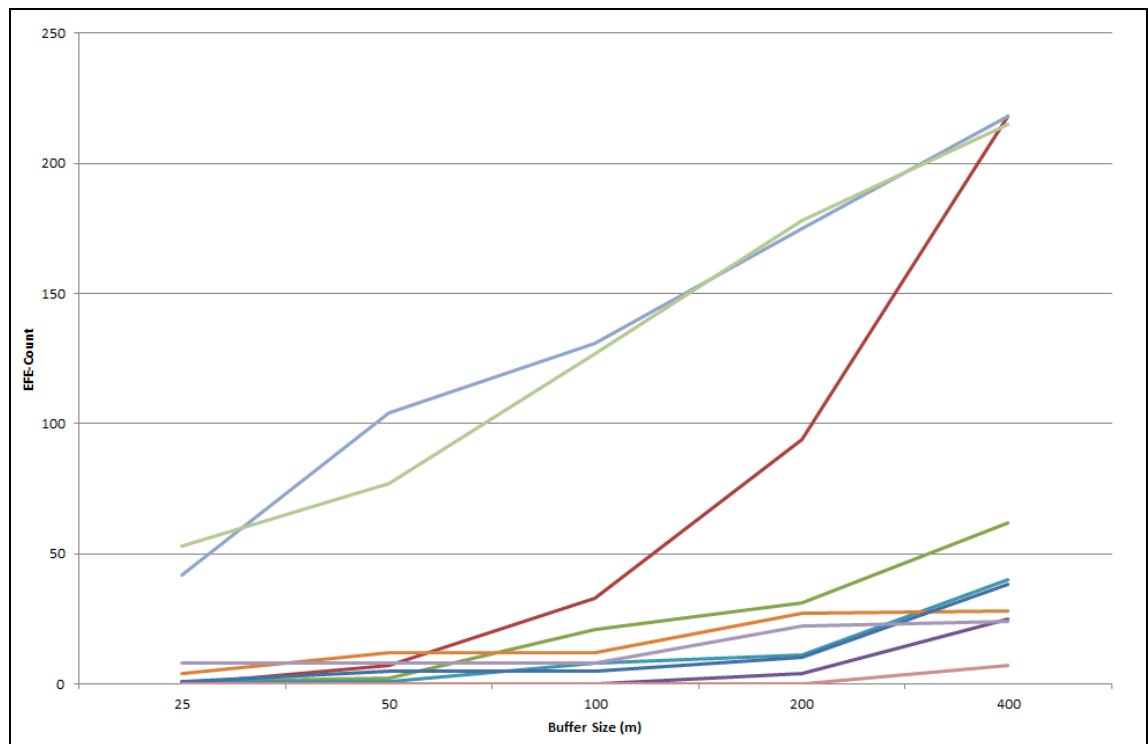


Figure 5 Exposure Food Environment Count for pilot study participants (n=10) at 25, 50, 100, 200 and 400 metre buffer sizes surrounding GPS waypoints. The data lines represent the individual pilot study participants (n=10).

An example of the GPS data can be seen mapped in Figure 6. This demonstrates the variation in the number of food outlets contained within each buffer size, and highlights how food outlet count increases with increasing buffer size.

The GIS analysis of the pilot data was used to estimate the potential workload for completing MFE surveys (section 4.4.4) in the main study. Based on the results presented in Figure 5, a buffer size of 50 metres was selected for use. A mean EFE-Count of 22 food outlets per person were present within the 50 metre buffer for study day 1. Over 4 days and 50 individuals, it was estimated that the total EFE could contain around 4320 food outlets. Although this figure was thought to be an over-estimation of the number of unique exposure food outlets that would be identified, the decision was made for MFE surveys to be completed only for the visited food outlets recorded in participant food diaries.

The decision was also made to retrace routes to enable the collection of primary data on the locations of exposure food outlets (Figure 7). A data collection exercise was completed in an area of high food outlet density. Outlets were geo-tagged by the researcher and this primary data was compared to secondary data collated by Burgoine (2010) using postcode centroid. The 50

metre buffer encompassed both sides of the road recorded using the GPS device (Figure 7). The primary data gave a more accurate depiction of food outlet location.

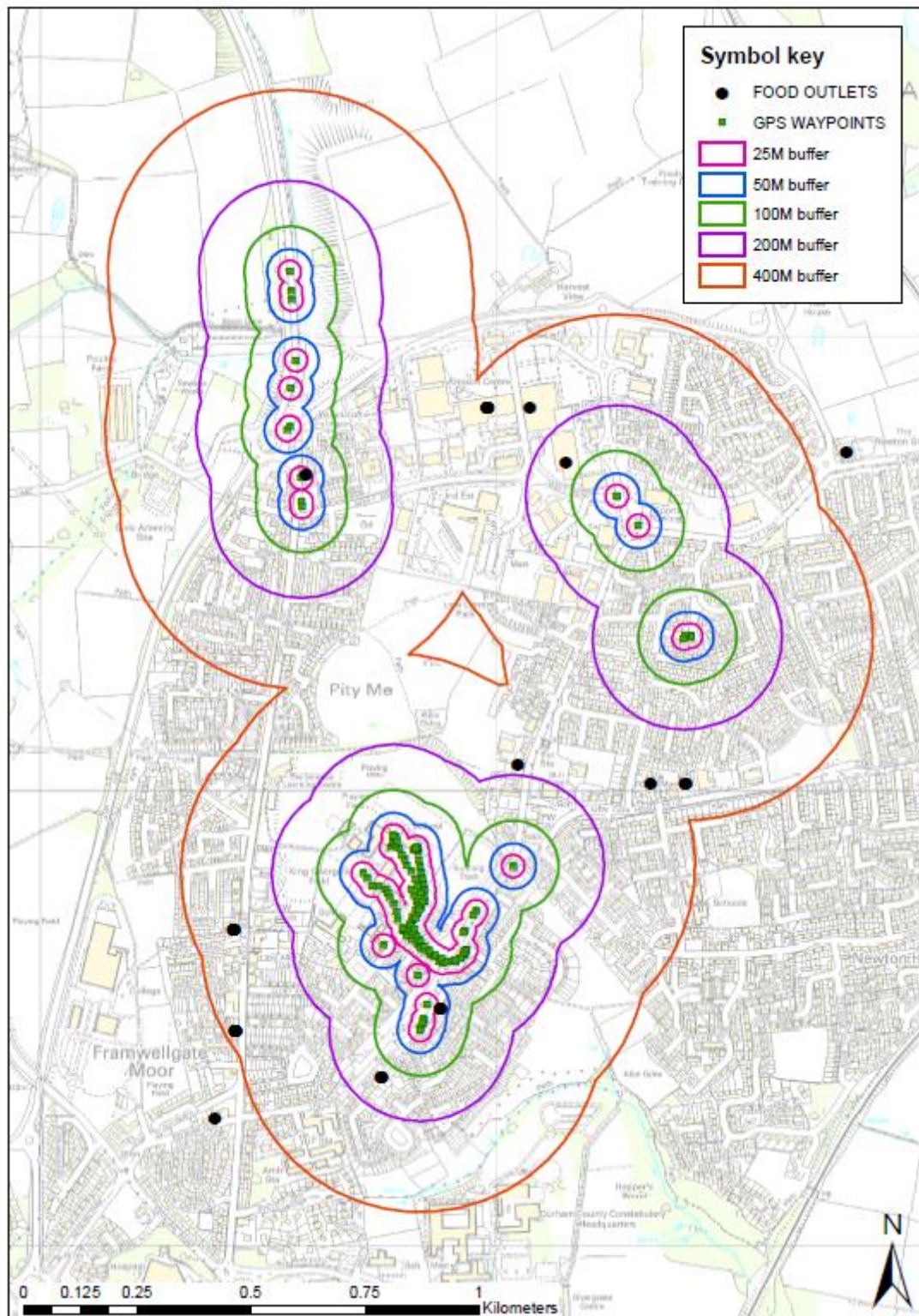


Figure 6 Map depicting GPS waypoints, food outlet locations (Burgoine, 2010) and range of buffer sizes tested in pilot study (ID515)

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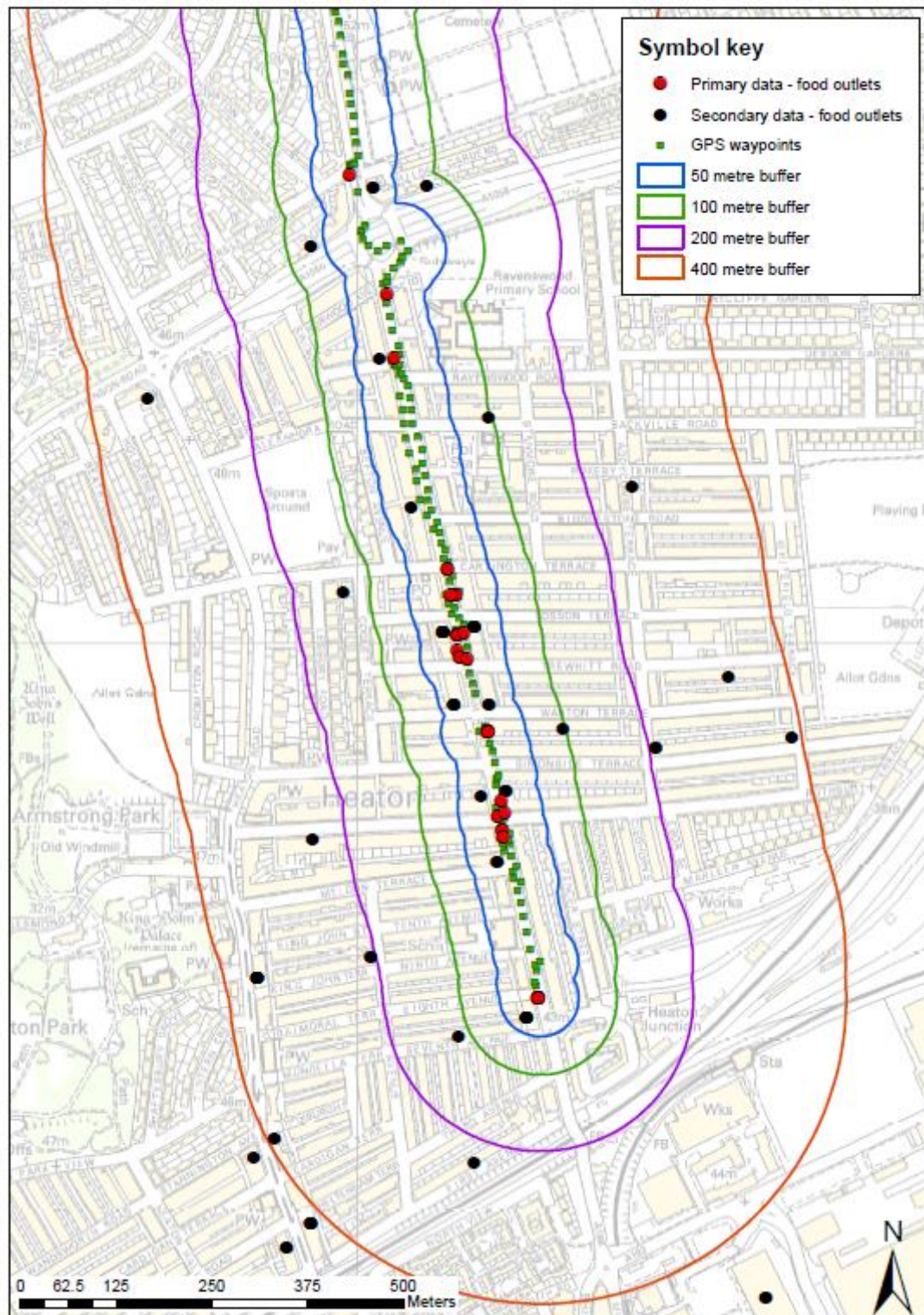


Figure 7 Map depicting primary and secondary data collection of food outlet locations and the use of varying buffer sizes in relation to GPS waypoints located on a single road.

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3.7 Development of a topic guide for individual interviews

A topic guide for the individual interview was developed guided by the findings from the pilot study. In addition, a number of topic guides used in other studies exploring the food behaviours of young people were obtained and used to inform the topic guide development (Wills *et al.*, 2005; Wills *et al.*, 2008; Wills *et al.*, 2011). A pilot interview was conducted with one 16 year old female to trial the topic guide and interview process. No changes were made following the pilot interview. Further details can be found in section 4.7.2 and a copy of the final topic guide in Appendix O.

3.8 Summary

- GPS and GIS techniques were introduced to the study protocol to identify the Exposure Food Environment of individuals.
- The acceptability of proposed methods was established through workshops conducted with young people with particular focus on the GPS techniques.
- QStarz BT1000XT GPS device was selected following testing and the use of this device was trialled during a full pilot study.
- Data collected during the pilot study helped to develop the analysis plan and further work on measuring the food environment was completed.
- The method for identifying food outlet locations in the main study was modified following the pilot study, to include the collection of primary data, increasing the accuracy with which the individual exposure to food outlets could be estimated.
- A lifestyle questionnaire was developed and the administration of all questionnaires electronically was tested and the protocol was modified accordingly.
- A topic guide for individual qualitative interviews was developed based on pilot study data. This was tested for concept and was used in the main study unchanged following the pilot interview.

Chapter 4 Methods

Chapter overview:

- Introduction
- Funding and ethics approval
- Recruitment, consent and incentives
- Individual Food Environment – Data collection
- Visited Food Environment
- Exposure Food Environment
- Quantitative data analysis
- Individual qualitative interviews
- Summary

This chapter describes the methods used in this PhD research. This multi-disciplinary study combines methods used in nutritional science, geography and social science to assess relationships between the food environment, nutrient intake and adiposity in young people. Figure 8 outlines the methods used to identify and measure the individual, visited and exposure food environments. The following sections describe each of these methods and the recruitment of participants in detail.

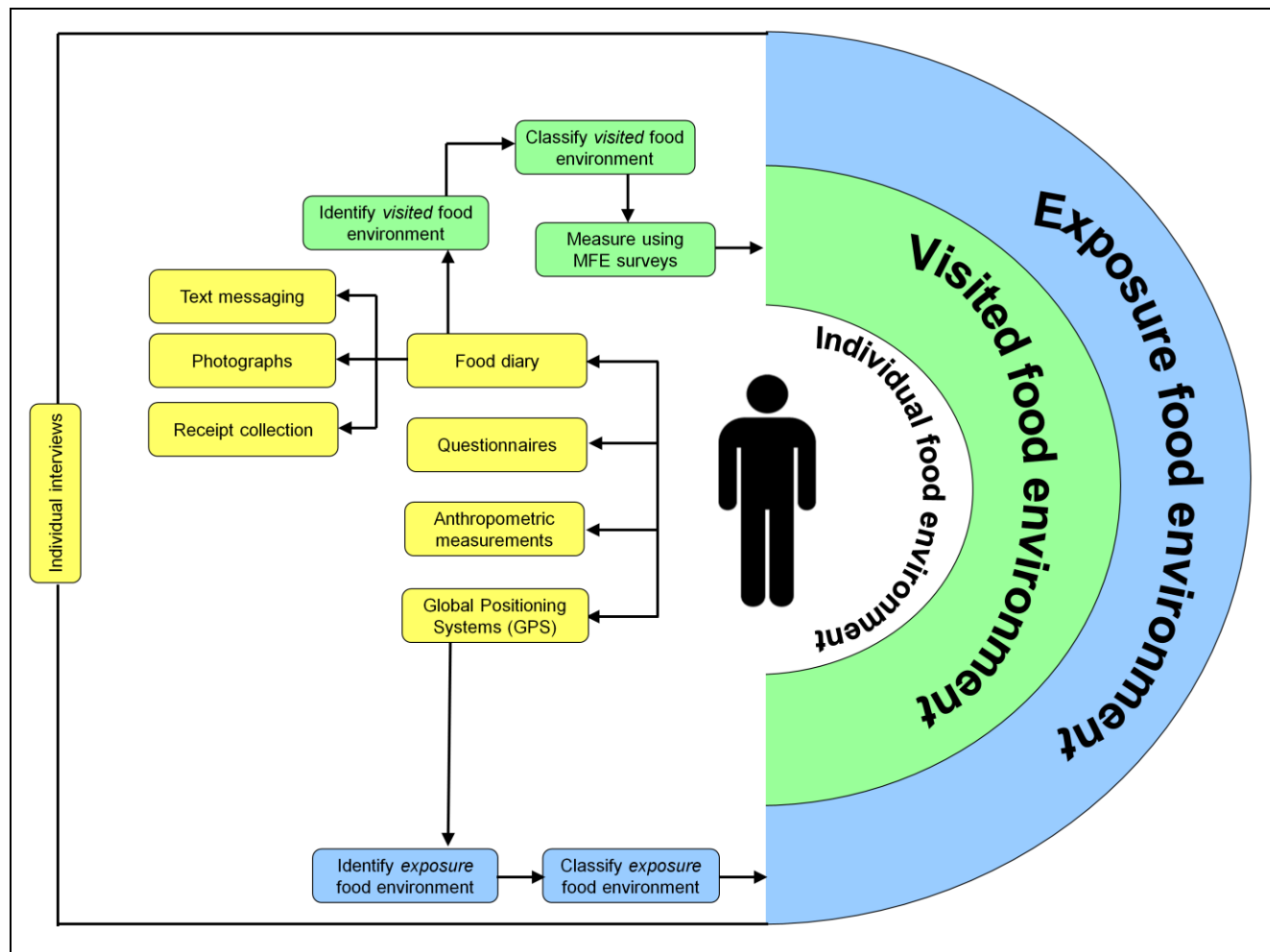


Figure 8 Overview of methods used⁷

⁷ MFE surveys = Measuring Food Environment surveys discussed in section 4.4.4.

4.1 Funding and ethics approval

This study was funded through the Food Standards Agency Postgraduate Scholarship Scheme (PG1024). The study method was approved by Newcastle University Ethics Committee on 27th September 2010 (Application number: 000322/2010). The researchers who worked with the young people in this study were in possession of enhanced Criminal Records Bureau (CRB) clearance.

4.2 Recruitment, consent and incentives

Participants were recruited between August 2011 and March 2012. Contact details for secondary school sixth form centres and colleges in Newcastle upon Tyne were obtained from the Newcastle City Council website (n=16). This list was supplemented with personal and professional contacts from previous work with young people. Initial contact was made via email and/ or telephone, which was followed by a postal pack containing a covering letter (Appendix P), recruitment posters (Appendix Q) and information leaflets (Appendix G).

School gatekeepers (predominantly teachers) were encouraged to distribute study information to young people fitting the recruitment criteria. In addition to schools, representatives at community centres (n=16), youth groups (n=12), sports and leisure centres (n=8), apprenticeship providers (n=7), and youth sports teams (n=3) were also contacted and encouraged to disseminate the study information to potential recruits. Posters were displayed in a number of city centre retail store staff rooms (n=19) for the attention of young people themselves and to encourage word of mouth recruitment through family and friends.

4.2.1 Recruitment criteria

The following recruitment criteria were set for the study:

- Aged between 16-18 years on recruitment
- Currently living with parent and/or legal guardian
- Resident in Newcastle upon Tyne or immediate surrounding area
- Participants planned to remain in Newcastle upon Tyne area for the study period

This was an exploratory study and a target sample size of 50 participants was chosen as a practical, manageable sample.

4.2.2 Study contact details

A number of communication routes were provided for participants to contact the research team. Following standard research procedures, office address and telephone contact details for the primary researcher (Rachel Tyrrell) and responsible supervisor (Prof. Ashley Adamson) were provided. In addition, a designated email address (food.environment@newcastle.ac.uk) and mobile phone number were active contact routes throughout the study period. Work previously conducted with this age group (Lake *et al.*, Submitted December 2013; Lake *et al.*, Submitted October 2013a; Lake *et al.*, Submitted October 2013b) indicated that SMS text messaging and email were preferred and more effective than telephone calls and therefore these were the communication methods predominantly used. Contact details were included on the recruitment poster, information sheet, consent form and food diary.

4.2.3 Information leaflet

An information leaflet was developed with guidance from a youth worker⁸ to be both appealing and appropriate to the target audience (Appendix G). The information leaflet was handed out during presentations or meetings with potential participants.

4.2.4 Consent form

A consent form was developed to collect contact details and personal information from participants including full name, home address including postcode, home telephone number, mobile telephone number, email address and date of birth (Appendix F). Participants were informed of their right to refuse to participate and told they could withdraw from the study at any point without giving a reason to the research team.

⁸ Catherine Purvis-Mawson, Enterprise and STEM (Science, Technology, Engineering and Mathematics) Enrichment Manager

4.2.5 Incentives and reimbursement

Participants received a £10 shopping voucher following completion of all aspects of the study. This incentive was used to encourage participation in the study and was advertised on the posters and information leaflets and discussed by the researcher during recruitment. The voucher was given during the food diary collection interview when the food diary and GPS device were returned. Any travel costs incurred by the participants in attending the study meetings were reimbursed.

4.3 Individual Food Environment – Data Collection

This section describes the methods used with participants following recruitment, including an assessment of dietary intake using a food diary, receipt collection, text messaging and photographs and the collection of anthropometric measures. Data on home food availability and parental rules, usual food habits and a range of non-food related behaviours such as smoking and physical activity were assessed via questionnaires. A GPS logging device provided data on the routes travelled by participants. This section also describes how diet and adiposity outcome measures were assessed.

4.3.1 Participation timeline

Each participant completed the study over a one week period. This included an initial meeting, either one-to-one or group based, to hand out the study pack and instructions (Figure 9), four data collection days, and an hour long data collection interview. A timeline of the methods is presented in Figure 10.



Figure 9 Photograph of a study pack which contained the following: information leaflet; photograph example sheet; QStarz GPS device and instructions; food diary; and a pen.

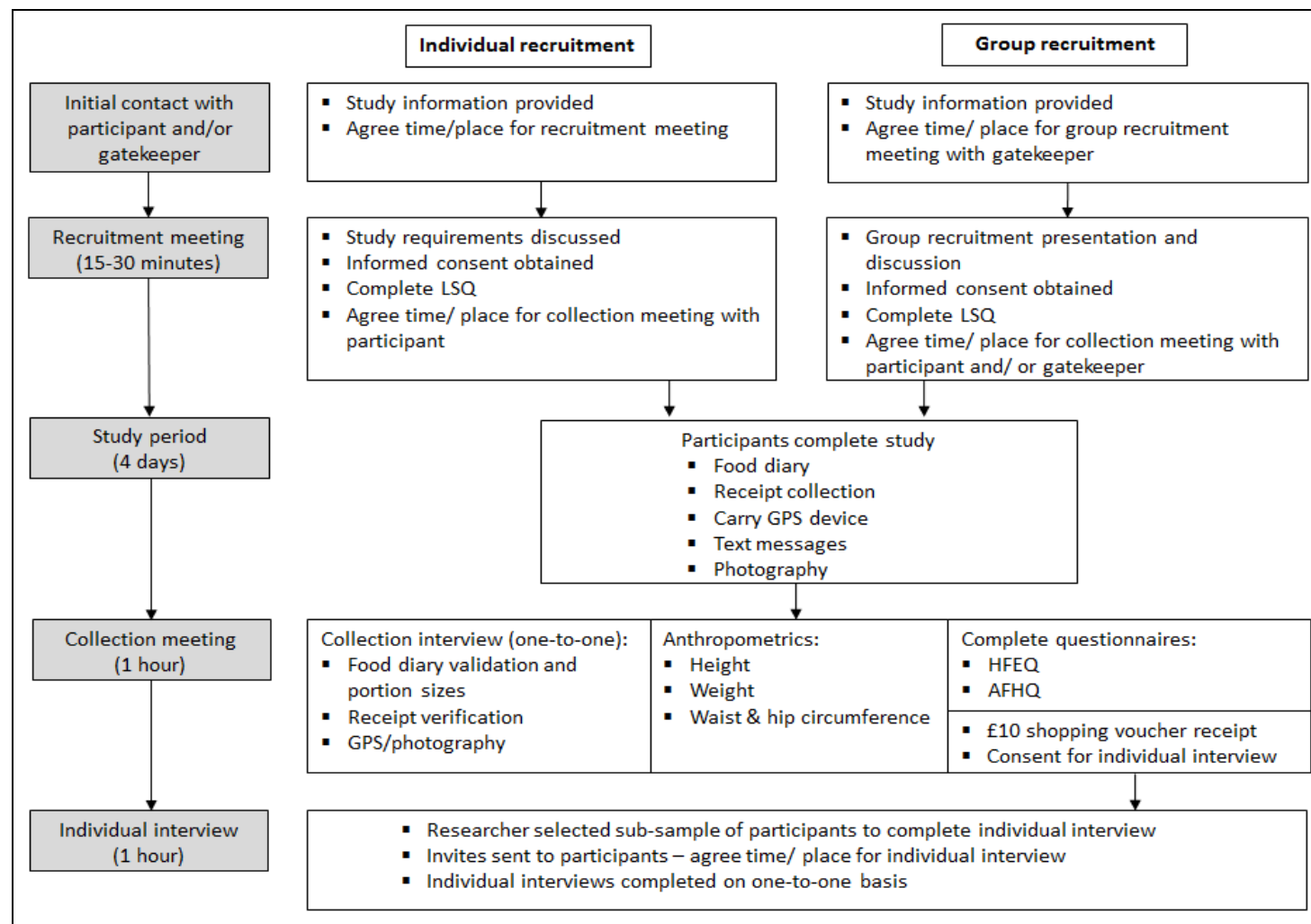


Figure 10 Timeline for participant data collection

4.3.2 Food diary

This section describes the food diary used by participants to record their food and drink intake. Coding of the data is described in terms of identifying the visited food environment of individuals and the assessment of dietary intake as an outcome measure.

Participants recorded their dietary intake in a 4-day food diary specifically designed for the purpose of this study (Appendix I). The food diary was designed based on formats previously used within the Human Nutrition Research Centre (HNRC) at Newcastle University. In addition, the diary incorporated methods used in the National Diet and Nutrition Survey Food and Drink Diary (Gregory and Lowe, 2000) and the Expenditure and Food Survey (National Statistics & Office for National Statistics, 2001). The diary was tested during pre-PhD methods development (Lake *et al.*, Submitted October 2013b). Following participant feedback, minor modifications to the format were made for this PhD project.

Four consecutive days were recorded including at least one weekend day. Recruitment of participants was staggered to allow representation of each day of the week from across the sample, although the start and finish dates were arranged to be those most convenient to the individual participants.

Each page of the diary included space to record the following information:

- Day and date of dietary record
- Time food or beverage consumed
- Detail of food or beverage item consumed; including brand name and flavour
- Amount of item consumed (excluding leftovers)
- Food source: where the item was obtained prior to consumption e.g. shop, restaurant, home
- How much the item cost to purchase (if applicable)
- Eating location: where the item was consumed e.g. home, school canteen
- With whom the item was consumed e.g. on own, with family, with friends
- How the participant travelled to obtain the item e.g. car, walk, cycle

- Any supplements and/or non-prescription medication taken

Towards the back of the food diary, five single pages were available for participants to record any recipe details. On the back cover page, participants noted any comments they had about what they had eaten over the study period and whether they thought it reflected their usual food intake.

4.3.2.1 Food diary collection interview

As soon as possible after completion of the food diary, participants met with a trained researcher to complete a food diary collection interview. This was usually conducted within three days of food diary completion in order to minimise problems with recall. However, in order to maximise response rates and enable time-flexibility with the young people this was not always possible. Eighty-seven percent of participants completed the collection interview within three days, 97% within five days and 100% within nine days. The single participant who completed within nine days had missed appointments with the researcher. Collection interviews were conducted on a one to one basis in a private room either at the participants' school or in the Human Nutrition Research Centre (HNRC) at Newcastle University. The diary entries were reviewed in detail in order to estimate portion sizes consumed and minimise missing data. This included checking for commonly missed food items such as spreads and sauces, missing beverages, as well as confirming and adding detail to food items, food source and eating location information.

4.3.2.2 Portion size estimation

Participants' estimated their food and beverage portion sizes using a food photograph atlas developed at Newcastle University for use with young people aged 11-16 years (Foster *et al.*, 2010). This atlas contains a series of seven portion size photographs for each of 104 food and beverage items that are likely to be consumed by the adolescent population. Participants were introduced to the atlas at the beginning of the food diary collection interview and asked to identify the photograph which best represented the amount they consumed of each food item listed at the particular time point recorded in their diary. The researcher documented the portion size codes which were later entered into a database containing the associated food weights. The food weights were

extracted and linked with food composition tables to calculate individual nutrient intakes.

4.3.2.3 Food composition tables

The food diary data was coded and analysed using McCance and Widdowson's Composition of Foods (Food Standards Agency, 2008). For recipes or products made up of several components, each individual food ingredient was allocated to the appropriate food code and weight calculated as a proportion of the complete product weight. Ingredients were either that reported in participant food diaries or obtained from manufacturer's data. The majority of foods were assigned to existing food codes. Sports drinks such as 'protein shakes' and 'energy drinks' were frequently consumed by young people however no suitable food codes were present in the composition tables. New food codes were generated for these products.

4.3.2.4 Identifying 'eating events'

Participants recorded the time each food or drink item was consumed. An 'eating event' consisted of either a single item e.g. 'crisps' or a number of food items consumed at the same time point e.g. 'tuna sandwich (bread, tuna, mayonnaise), crisps and orange juice'. No attempt was made to define meals (e.g. breakfast, lunch, dinner) or snacks within the data. Each new time recorded in the food diary by the participant was used to define a new eating event. Where food events were timed very close together (within 15 minutes) or where the food source was consistent over a period of time when eating out-of-home. For example, where separate times were recorded for different courses of a meal e.g. starter, main and dessert consumed in a restaurant, these were counted as a single eating event. Where food for a single eating event was obtained from multiple sources (e.g. food outlet and home), each individual food item was assigned to a food source.

4.3.3 Receipt collection

Participants were asked to collect till receipts for any food purchases they made for themselves over the 4-day study period. An envelope was provided for this purpose in the back of the food diary. Receipts provided information on the products bought, and the amounts spent on food outside of the home. The

receipts also assisted researchers when identifying the exact location of food outlets visited by participants.

4.3.4 Text messaging

Text messaging was used for two purposes: reminders, and Ecological Momentary Assessment (EMA) (Stone and Shiffman, 2002). Personal mobile phone numbers were extracted from the consent forms of agreeing participants and used within text message campaigns sent using Text Anywhere (www.textanywhere.net), an online text messaging service⁹. The methods used are described in the following two sections.

4.3.4.1 Reminders

Reminder texts were sent to participants to confirm meeting times and places. They indicated the start of the study period, encouraging food diary completion and use of the GPS device (see section 4.3.9). A maximum of four reminder text messages were sent to participants. The text messages were personalised and sent via either Text Anywhere or the study mobile phone. An example of the timing, content and purpose of these reminder texts is outlined in Table 4.

4.3.4.2 Ecological Momentary Assessment

Ecological Momentary Assessment (EMA) are “methods using repeated collection of real-time data on subjects’ behaviour and experience in their natural environments” (Stone and Shiffman, 2002; Shiffman *et al.*, 2008, p3). Using text messages to collect EMA data provides a snapshot of eating behaviour. This assisted in the validation of food diary entries in terms of what was eaten, the time at which it was eaten and the context of the eating event.

EMA text messages were introduced during pre-PhD development, where the method was tested for acceptability and modified accordingly during pilot work (Lake *et al.*, Submitted October 2013b). Participant feedback indicated a need to reduce the number of text messages sent in order to obtain and maintain

⁹ Text Anywhere (<http://www.textanywhere.net>) is an online text messaging service which allows researchers to set up personalised text messages to be sent out at specified time points to multiple users. Reply messages are collected within the online system reducing researcher burden in sending, tracking and collating outgoing and incoming messages from multiple participants at one time.

response rates and quality of the data throughout the study period (originally three text messages per day as reported in Lake *et al.* (Submitted October 2013b)). Participants found the text messages “*irritating*” and any more than one text message was deemed too burdensome in both time and monetary commitment. A reduction to one text message per day was trialled and a higher text message response rate was reported, 54.8% non-response with three texts per day compared with 34.5% when reduced to one text per day (Lake *et al.*, Submitted October 2013b).

In the current study, a total of four personalised EMA messages were sent to each participant, once per day throughout the study period (the content and timing of these texts can be seen in Table 4). Participants replied to these messages stating where they were, what they were doing, and what they last ate and/ or drank. Participant were reminded that there were no right or wrong answers to the questions and to keep this in mind when reporting their behaviour. The messages were sent at specific times, based on meal time estimates collated from 20 food diaries (80 days) collected as part of the ASH17 study at Newcastle University (Hossack, 2010).

Following study completion, replies to EMA text messages were downloaded from Text Anywhere into an Excel spread sheet. Replies for each participant were collated, printed and discussed during the food diary collection interview, cross-validating the text data with information recorded within the food diary.

Table 4 Reminder and Ecological Momentary Assessment (EMA) text message content and schedule

Text number	Text type*	Text content	Day	Time	Participant reply required?
1	R	Hi [Name]. Thanx 4 taking part in the MFE study. Ur meeting 2 collect ur study pack is @ [time] @ [venue]. Call [study mobile number] if u need directions.	Prior to meeting 1	10:00	No
2	R	Hi [Name] jst to remind u that u r to start ur food diary 2moz so plz dnt forget to fill it in, carry GPS, take lots of pics & reply to our txts. Good luck!	Prior to study day 1, following meeting 1	20:00	No
3	R	Hi [Name]. Please switch ur GPS to LOG as soon as possible & remember to carry it with u for the next 4 days. Thanx!	Study day 1	07:00-10:00 – sent at time agreed with participant	No
4	S	Hi [Name]. Thanx 4 taking part in this research. Where r u? Who r u with? What r u eating &/ drinking? Or when & what did u eat last? Ur replies r important!	Study day 1	19:00	Yes
5	S	As text number 4S	Study day 2	14:00	Yes
6	S	As text number 4S	Study day 3	19:00	Yes
7	S	As text number 4S	Study day 4	14:00	Yes
8	R	Hi [Name]. Thanx 4 taking part in the MFE study. Plz remember to bring in ur study pack 2 our meeting 2moz. I will see you @[time] at [venue] :)	Prior to food diary collection meeting - day 4/5	20:00	No

*R= reminder text message, S= study text message using EMA method

4.3.5 Photography

Participants were asked to take photographs during the study period in the following contexts:

- any food/ beverage items they ate, before they consumed it
- where the food was obtained e.g. shop, home etc.
- with whom/where they were when eating the food (if appropriate)

An instruction sheet was provided in the study pack depicting examples of food environment photographs (see Appendix J). If available, participants used their personal mobile phone with integrated camera to take the photographs.

Previous work with young people indicated the need for discretion when taking photographs of their food and therefore individuals preferred to use their own mobile phone rather than a digital camera (see section 3.1). A digital camera was offered to those individuals who either did not have access to a mobile phone with integrated camera or did not want to use it for whatever reason. These photographs were used during the food diary collection interview to aid dietary recall and portion size estimation. Researchers uploaded photographs onto a secure, encrypted laptop during the food diary collection interview. A content analysis of the photographs may be conducted at a later date but was beyond the scope of the current study analysis.

4.3.6 Questionnaires

Participants completed three questionnaires to assess the home food environment, lifestyle factors and usual food choice habits. All three questionnaires were available in both pen and paper and electronic format (MS Access 2010 database) in order to suit individual and group data collection scenarios. Effort was made to use the electronic format wherever possible for ease of completion for the participant and reduction in data entry burden for the researcher. Content and administration routes of each questionnaire are discussed in the following sections.

4.3.6.1 Lifestyle Questionnaire

As outlined in the methods development section, the Lifestyle Questionnaire (LSQ) was designed to measure psychosocial factors including preferences, attitudes, self-efficacy and social support in respect of food (Haerens *et al.*, 2007), and other relevant health behaviours, such as smoking, alcohol intake, and physical activity (Currie *et al.*, 2008). The questionnaire was divided into ten sections as described in Table 5 and a copy of the LSQ can be found in Appendix A.

Table 5 Description of the measures included in the Lifestyle Questionnaire (LSQ) and the original source references

Section heading	Description of measures	Question source
Ethnic origin	Ethnic origin of participant	My Place, My Plate, My Perspective (Lake <i>et al.</i> , 2009)
Your family	Family structure including who lives in their home and details of second homes	Health Behaviours in School Aged Children (Currie <i>et al.</i> , 2004) My Place, My Plate, My Perspective (Lake <i>et al.</i> , 2009)
Jobs and transport	Data on employment status, working hours and voluntary work. Family and personal access to private transport.	Health Behaviours in School Aged Children (Currie <i>et al.</i> , 2004) Neopean Kids Growing Up – Students Questionnaire (Campbell <i>et al.</i> , 2007)
Food	Questions about food purchasing habits outside of the home and how often fast food and other restaurants are visited with family and friends	My Place, My Plate, My Perspective (Lake <i>et al.</i> , 2009) Neopean Kids Growing Up – Students Questionnaire (Campbell <i>et al.</i> , 2007)
Television and computers	Hours spent watching television and/ or using a computer	Health Behaviours in School Aged Children (Currie <i>et al.</i> , 2004)
Physical activity	Hours spent over past 7 days in moderate to vigorous physical activity	Health Behaviours in School Aged Children (Currie <i>et al.</i> , 2004)
Dieting behaviours	Weight loss diet behaviours and assessment of body image perception	Health Behaviours in School Aged Children (Currie <i>et al.</i> , 2004)
Smoking and alcohol	Current tobacco smoking behaviour and past month alcohol behaviours	Health Behaviours in School Aged Children (Currie <i>et al.</i> , 2004)
Family activities	Frequency of activities done with friends	Health Behaviours in School Aged Children (Currie <i>et al.</i> , 2004)
Friend activities	Frequency of activities done with family	Health Behaviours in School Aged Children (Currie <i>et al.</i> , 2004)

Participants completed the LSQ during the recruitment meeting. This was the longest and most demanding of the three questionnaires in terms of number of questions and time taken to complete. The LSQ was administered separately to the other questionnaires in order to reduce risk of questionnaire fatigue. The LSQ contained few questions addressing food related issues and was therefore

thought to be unlikely to influence food diary recording if administered prior to completing the other study measures.

When participants were recruited as a group, the pen and paper version of the LSQ was completed by participants as only one laptop was available for the purpose of questionnaire completion. The data were later entered into the Access database by researchers. Where participants were recruited singly, the LSQ was completed electronically directly onto the database.

Data were extracted from the Access database and a descriptive analysis of each question was performed.

4.3.6.2 Home Food Environment Questionnaire

Development of the Home Food Environment Questionnaire (HFEQ) is reported in two papers (Briggs and Lake, 2011; Lake *et al.*, Submitted October 2013a). The HFEQ was designed to capture information about the 'usual' availability of a range of foods in the home, food related behaviours conducted within the home, and details of any parental enforced food rules (see Appendix B). Individual questions were identified and pooled from existing questionnaires (Currie *et al.*, 2004; Campbell *et al.*, 2007; Gattshall *et al.*, 2008; Lake *et al.*, 2009). Some adaptations were made to reflect the availability of foods identified as commonly consumed by young people in the UK (Gregory and Lowe, 2000; Foster *et al.*, 2008).

The question and response format and phrasing remained mostly unchanged from the original questionnaires. However, some descriptions of foods were changed to reflect UK definitions e.g. USA term 'potato chips' changed to UK 'crisps'.

The HFEQ was completed by participants at the beginning of the food diary collection interview. All participants completed the HFEQ using the Access database format. Previous analysis of the HFEQ had involved scoring a number of the HFEQ questions to give a score indicative of the healthiness of the home food environment (Lake *et al.*, Submitted October 2013a). However, in the current study all HFEQ data were analysed and presented descriptively.

4.3.6.3 Adolescent Food Habits Checklist

The Adolescent Food Habits Checklist (AFHC) (Johnson *et al.*, 2002) is a validated tool for assessing usual food choice habits of adolescents in the UK (see Appendix C). No changes were made to the wording or ordering of questions from the original questionnaire. The questionnaire was delivered in an electronic format (Access 2010), which was developed and tested during the pilot study (section 3.3). The AFHC was administered following the HFEQ during the food diary collection interview.

A total score was generated for each participant using the original formula presented in Johnson *et al.* (2002). One point was allocated for every 'healthy' response to a question. Final scores were adjusted for 'not applicable' options and missing responses.

$$\text{AFHC Score} = \text{Number of healthy responses} \times \frac{\text{Total number of questions (n=23)}}{\text{Number of questions completed}}$$

4.3.7 Anthropometric measurements and calculations

Measures of height, weight, waist circumference and hip circumference were taken by a trained researcher during the food diary collection interview. In order to comply with the study risk assessment, two researchers were present when body measurements were being taken. Duplicate measurements were taken to increase the accuracy of results, there were recorded on the back page of the participant food diaries.

4.3.7.1 Height

Height was recorded to the nearest 0.1cm using a Leicester Height Measure placed on a level surface and supported by a wall. Participants were asked to remove their shoes for this measurement and adopt the position depicted in Figure 11. Duplicate measurements were taken; a third measurement was recorded if the first two were not within 0.2cm. An average was calculated from the recorded figures.

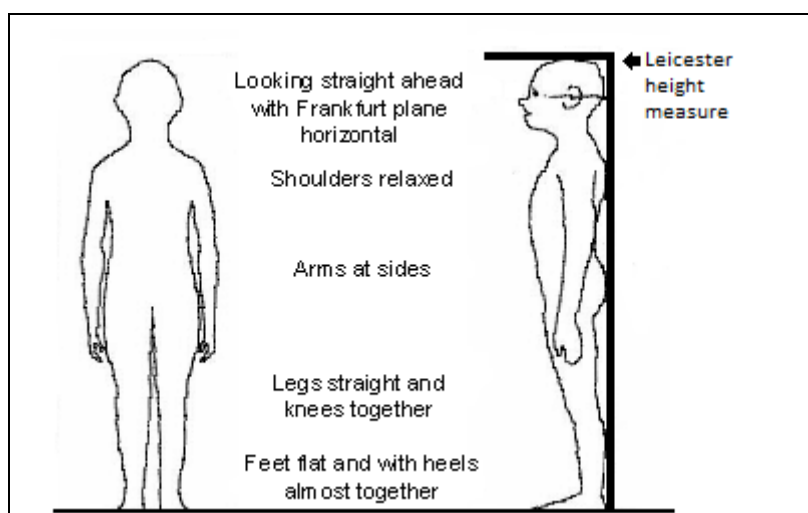


Figure 11 Position adopted for height measurement

4.3.7.2 Weight

Tanita electronic bio impedance scales were used to measure weight to the nearest 0.1kg. Participants were asked to remove shoes, socks, bulky jumpers and items from their pockets. A 1.0kg allowance for remaining clothing was applied to the weight measurements (McCarthy *et al.*, 2003). Duplicate measurements were taken and the average weight calculated.

4.3.7.3 Body Mass Index

Mean height and weight measurements were used to calculate Body Mass Index (BMI) with the formula $BMI = \text{weight (kg)} / \text{height (m)}^2$. International Obesity Task Force age and gender specific cut-offs for underweight (Cole *et al.*, 2007), overweight and obese (Cole *et al.*, 2000) were applied to the BMI data (Table 6). BMI data were used to establish two adiposity groups; 'healthy and underweight' where $BMI < 25$ and 'overweight and obese' where $BMI \geq 25$ (or equivalent age related cut-off).

Table 6 International Obesity Task Force age specific cut-offs for underweight, overweight and obesity, for young adults aged 16-18 years (Cole *et al.*, 2000) (Cole *et al.*, 2007)

Age (years)	BMI cut-off for underweight		BMI cut-off for overweight		BMI cut-off for obese	
	Males	Females	Males	Females	Males	Females
16	17.54	17.91	23.90	24.37	28.88	29.43
16.5	17.80	18.09	24.19	24.54	29.14	29.56
17	18.05	18.25	24.46	24.70	29.41	29.69
17.5	18.28	18.38	24.73	24.85	29.70	29.84
18+	18.50	18.50	25	25	30	30

4.3.7.4 Waist and Hip Circumferences

Waist and hip circumference were measured to the nearest 0.1cm using a tape measure over light clothing. Participants were asked to remove any items from their pockets and stand with their hands by their sides with their feet hip distance apart. For the waist measurement, participants were asked to locate their waist by placing their thumb on their lowest rib and their forefinger on the iliac crest (National Institute of Health, 2000). The tape measure was passed between the thumb and forefinger to measure the waist. For hip circumference, the tape measure was placed horizontally around the hips over the fullest part of the buttocks. The reading was taken from the side, to the nearest 0.1cm.

Measurements for waist and hip circumference were completed in duplicate for all participants and average measurements were calculated. Where the first two measurements differed by more than 0.2cm, a third measurement was taken.

4.3.7.5 Waist to hip ratio (WHR)

Waist to hip ratio was calculated using mean measurements of waist and hip circumference using the following formula:

$$\text{WHR} = \frac{\text{Mean waist circumference}}{\text{Mean hip circumference}}$$

Using World Health Organization (World Health Organization, 2011) cut-offs for risk of health complications were applied to establish two groups; 'healthy' and 'increased risk' (Table 7).

Table 7 World Health Organization waist circumference and waist-hip ratio cut-off points and risk of metabolic complications (World Health Organization, 2011)

	<i>Increased risk</i>		<i>Substantially increased risk</i>	
	Males	Females	Males	Females
Waist circumference (cm)	>94	>80	>102	>88
Waist-hip ratio (cm)			≥0.90	≥0.85

4.3.8 Socio-economic status

The Index of Multiple Deprivation (IMD) is a measure of area-level deprivation. There are seven IMD domains are measured: income, employment, health, education and training, access/barriers to services, living environment/housing, physical environment, and crime. Each of these domains is weighted and the

overall IMD score is the combination of the weighted individual domain scores presented at the Lower Super Output Area level (LSOA) (Payne and Abel, 2012).

Home postcode recorded on the consent form was used to establish the socio-economic status (SES) of participants using IMD score. A higher IMD score is indicative of higher area level of deprivation. IMD score was used as a continuous variable for correlation analysis. Due to the small sample size, for all analyses comparing groups, participants were grouped into two social groups comprising those above and those below the group median IMD score (31.5).

Participants were categorised into two SES groups above and below the median IMD score. The 'low SES' group contains those individuals living in an area of higher deprivation, and the 'high SES' group contains those individuals living in an area of lower deprivation.

4.3.9 Global Positioning System device

In this study GPS data were used to identify the geographic space used by individuals, to allow the assessment of individual food environment exposure (see Chapter 3). Participants carried a QStarz BT-Q1000XT Bluetooth Data Logger GPS Receiver (QStarz International Co. Ltd., 2006) over the same 4-day period during which they completed the food diary. Both verbal and written instructions regarding device operation were provided during the recruitment meeting (Appendix J). Participants were instructed to activate the device on the morning of study day 1 and were reminded to do this via text message.

Participants were not required to recharge the GPS device and were encouraged to carry the device on their person, in a trouser or jacket pocket or in the outer pocket of a bag for the duration of the 4-day study period. Prior acceptability testing with young people showed a preference for a device hidden from view (see Table 2, p62). The risk of reduced accuracy of GPS recording was accepted in return for a potential good rate of compliance.

QStarz BT-Q1000XT GPS devices were programmed to record latitude, longitude, and local time at ten-second intervals. The integrated vibration sensor was activated which initialised a 'sleep' mode following 10 minutes without movement. The device was reactivated when movement was detected.

This allowed the logger to conserve battery life at times participants were not moving, for example overnight whilst sleeping, and other stationary periods such as time at home or school. This method also reduced participant burden in relation to the GPS device in that they were not required to turn the logger off/on at any point following initial activation. Many studies require participants to wait for the GPS device to obtain a satellite fix when leaving buildings (Badland *et al.*, 2010). However, a potential loss of data was accepted in this instance as waiting for a fix might cause participants to alter their behaviour thus not recording their 'usual' behaviour or not to carry the device as sought by the researchers.

The GPS data were extracted from the devices, cleaned, adjusted and used to calculate individual exposure to food outlets. Details of this process can be found in section 4.5. The following sections present the methods used to identify and quantify the *visited* and *exposure* food environments at the individual level using data extracted from food diaries and GPS devices in conjunction with researcher collected data.

4.4 Visited Food Environment

This section describes the process of identifying and measuring the visited food environment (VFE) of individuals. This process was conducted in three steps. The first step involved identifying food sources linked to eating events recorded in participant completed food diaries. The second involved linking the eating events to an eating location. The final step involved further classification and measurement of those eating events where the food source was a food outlet. Here the process of classifying the food outlets is described and the methods used to measure the objective 'healthiness' of the environment at the consumer level is explained. The section closes with a description of the VFE measures used for descriptive and statistical analysis at the individual and group levels.

4.4.1 Identifying and categorising the source of food

The food source for each eating event identified in the food diaries was coded to one of the following six options;

- 1.Home – where the participant lives with parent and/or guardian
- 2.Friend – homes of friends and relatives such as grandparents

3. Work – outlets identified by participants as their place of employment
4. School – including other educational establishments such as colleges
5. Food outlet – includes shops, restaurants, vending machines etc.
6. Other – food source not specified in the food diary

Where an eating event was sourced from multiple locations, e.g. takeaway fish and chips purchased from a food outlet and a drink taken from home, each food item was coded to the relevant source. Where there was not enough information recorded in the food diary to assign a food source, the 'other' category was used. However, this was used for only seven eating events overall and was therefore excluded from further analysis.

4.4.2 Identifying and categorising the eating location

The eating location for each eating event identified in the food diaries was coded to one of the following seven options;

1. Home – where the participant lives with parent and/or guardian
2. Friend – homes of friends and relatives such as grandparents
3. Work – outlets identified by participants as their place of employment
4. School – including other educational establishments such as colleges
5. Food outlet – includes shops, restaurants, vending machines etc.
6. In transit – consumed whilst travelling e.g. in a car or on a bus
7. Other – outdoor locations such as parks or the beach or no location recorded

4.4.3 Identifying and classifying visited food outlets

Where the food source was identified as 'food outlet', additional detail was sought. Business names of food outlets were extracted from the completed 4-day food diaries. Participants were asked to provide as much detail as possible about the location of food outlets they had visited during the study and were probed for further detail in the food diary collection interview.

Food outlet address and postcode details were found via an internet search (see section 3.6.1). All identified food outlets were visited by a trained researcher (Rachel Tyrrell or Victoria Cox) in order to classify the outlet type and assess for outlet 'healthiness' using the appropriate Measuring Food

Environments (MFE) survey tool (Appendices M and N). To enable geographic mapping of food outlets, latitude and longitude data were recorded using a handheld GPS device Garmin eTrex Vista HCx.

A detailed 15 category food outlet classification system was used in this study, adapted from a 21-point tool developed by Lake *et al.* (2010) (Appendix L). The adapted tool has 88 subcategories and groups together similar food outlet types for analysis. Each food outlet was allocated a unique identification number and assigned a classification category and sub-category dependent on the type of foods sold and services offered as observed during the visit by a researcher.

Although no formal validation of the classification system was completed, the food outlet classification system was developed using a ground up approach as a direct result of fieldwork conducted in the geographical area in which the tool was to be used. Developing the system in this way enabled a full and comprehensive list of food outlet classifications to be included and allowed for modifications to the category descriptions to be made for new types of food outlets. Two research papers have been published using the system (Lake *et al.*, 2010; Lake *et al.*, 2012) and it has been included in a systematic review of the validity of food outlet secondary data sources (Fleischhacker *et al.*, 2013).

The 15 category system was amalgamated to give five broader food outlet categories. Table 8 contains a description of the food outlet categories contained within each of the broader categories.

Table 8 Outline of food outlet classification system categories contained within amalgamated food outlet categories

Amalgamated food outlet category	Food outlet classification system categories (code number)
Traditional eateries	Traditional/pub/hotel restaurant (1) Sit-in café/coffee/sandwich shop (3) Health and Leisure (14)
Takeaway eateries	Takeaway café/coffee/sandwich shop (4) Retail baker (5) Takeaway and fast food outlet (6) Mobile food and market (10)
Grocery outlets	Supermarket (7) Specialist supplier (9)
Convenience and incidental outlets	Convenience store (8) Vending machine (11) Non-food store (12) Entertainment (13)
Closed/private/age restricted outlets	Pub (no food) (2) Closed/private outlet (15)

4.4.4 Assessing the ‘healthiness’ of food outlets using Measuring Food Environment surveys

The development of the Measuring Food Environment (MFE) surveys through the completion of three pilot studies is documented in Lake *et al.* (Submitted October 2013a). Three MFE surveys were developed and tested, revised and validated to measure the “healthiness” of the consumer food environment. These surveys were specifically designed to assess the presence of “more healthy” and “less healthy” food and menu options relating to foods commonly consumed by young people within shops (MFE-S), restaurants (MFE-R) and vending machines (MFE-V) (Appendix N).

The surveys were based on the USA developed Nutrition Environment Measures Study (NEMS) surveys of stores (Glanz *et al.*, 2007) and restaurants (Saelens *et al.*, 2007) alongside a number of UK based surveys (Gregory and Lowe, 2000; White *et al.*, 2004; Newcastle City Council and Trust, 2008; Hossack, 2010). A user guide was developed to aid the training of researchers in using the tools and ensure consistency and reliability in their use (Appendix M).

The MFE surveys were used to assess and score food outlets making up the visited food environment of participants. Each unique food outlet identified through the participant food diaries was visited by a researcher who completed

the most appropriate MFE survey on site. Each on-site visit took approximately 20 minutes to complete. A description of the measures making up each of the tools and examples of the types of outlets assessed by each tool are discussed in the following sections.

4.4.4.1 Measuring Food Environments Shop survey (MFE-S)

The MFE-Shop (MFE-S) survey aimed to assess the healthiness of the 'in-store' food environment (Appendix N). The MFE-S survey was used to assess a variety of retail type food outlets, including supermarkets, convenience stores, and takeaway sandwich shops.

MFE-S measures were presented within five headings described in Table 9. The number of checkouts was recorded to give an indication of the size of the shop outlet. Outlet business hours were also logged within the MFE-S survey. Space was available on the survey sheet to allow the researcher to add other contextual details.

Table 9 Description of the measures included in the MFE-Shop survey

Measure heading	Description
Facilitators and supports to healthy eating	Measured the presence of store features thought to encourage and promote 'more healthy' food choices e.g. nutrition labelling, promotions for healthier products and meal deals and the prominent location of 'more healthful' products.
Barriers to healthy eating	Measured the presence of barriers to healthy food choices such as promotions for 'less healthy' food items and meal deals.
Comparative pricing	Designed to assess the cost of a 'more healthy' option to its 'less healthy' or 'regular' counterpart. If available, the retail price of two similar products was compared.
Beverages	Recorded the availability and variety of a number of population specific beverage categories e.g. 'carbonated soft drinks, not diet' and 'carbonated soft drinks, diet'. Responses were two fold (1) was a product meeting the category description present in the store? (2) If yes, how many varieties were available?
Food Items	Recorded the availability and variety of a number of population specific food item categories e.g. fruit, savoury snacks. Responses were two fold (1) was a product meeting the category description present in the store? (2) If yes, how many varieties were available?

Categories included in the beverages and food items sections were selected to represent food groups popular with the young adult population. National (Gregory and Lowe, 2000) and local (Hossack, 2010) level data were used to

inform the selection of food groups. Selections of 'more healthy' and 'less healthy' foods were based on measures used by White et al (White *et al.*, 2004) and the Heart of Newcastle Award (Newcastle City Council and Trust, 2008).

4.4.4.2 Measuring Food Environments Restaurant survey (MFE-R)

The MFE-Restaurant (MFE-R) survey tool aimed to assess the healthiness of the menu options available in the restaurant food environment (Appendix N). The MFE-R survey was used in the assessment of a variety of restaurant outlets, including traditional waiter service sit-down restaurants, fast-casual restaurants, sit-in cafes, fast food and takeaways.

In line with the MFE-S tool, the MFE-R measures were presented within the five headings described in Table 10. The number of tables and/ or seating capacity was recorded to give an indication of the size of the restaurant outlet and food service opening hours (breakfast, lunch and dinner) were noted. A copy of the menu was obtained if available and a record made of availability of food to takeaway. Space was available on the survey sheet to allow the researcher to add other relevant contextual details.

Table 10 Description of the measures included in the MFE-Restaurant survey

Measure heading	Description
Facilitators and supports to healthy eating	Measured the presence of factors thought to encourage healthy eating in the restaurant environment e.g. nutritional information on the menu, indicators of healthier choices, and reduced portion size options.
Barriers to healthy eating	Measured the presence of promotions for 'less healthy' menu items or combination deals such as buy one get one free and 'upgrade' to large portion size.
Comparative pricing	Assessed the cost of 'healthier' menu options compared to 'less healthy' or 'regular' options. This is only applicable to those restaurants with clear indicators of healthier menu options. The cost of a combination meal is compared to the cost of the items if purchased separately.
Food menu options	Recorded the availability of 'healthier' food items and the number of options present. Healthier food menu options included: the use of 'more healthy' cooking methods; vegetables served with main dishes, main dish salad options; oily fish; and healthier desserts.
Beverage options	Recorded the availability and variety of a number of population specific beverage categories e.g. 'carbonated soft drinks, not diet'. Responses were two fold (1) was a product meeting the category description present in the store? (2) If yes, how many varieties were available? Similar to the MFE-S categories with the addition of hot drinks and alcohol.

4.4.4.3 *Measuring Food Environments Vending survey (MFE-V)*

The MFE-Vending (MFE-V) tool aimed to assess the healthiness of the food and beverage options available within the vending machine food environment (Appendix N). Where more than one vending machine was located in the same space, only one MFE-V survey was completed for each vending machine area, not each individual vending machine. The survey was split into three sections assessing the presence of hot beverages, cold beverages and food items (Table 11). Each section was only completed when a machine serving those items was present in the vending machine area.

Table 11 Description of the measures included in the MFE-Vending survey

Measure heading	Description
Hot beverages	Measure of the presence of tea, coffee, hot chocolate and soup options in addition to the option to add extra sugar to hot drinks.
Cold beverages	Recorded the availability and variety of a number of population specific beverage categories e.g. 'carbonated soft drinks, not diet'. Responses were two fold (1) was a product meeting the category description present in the store? (2) If yes, how many varieties were available?
Food items	Eight categories of food items commonly available in vending machines (e.g. savoury snacks and confectionery) were assessed for availability and variety.

The brand or company ownership of the vending machine was recorded and the type of machine depending on the product categories sold e.g. hot or cold beverages, or food items. Some contextual information regarding the vending machine area was recorded including the number of each type of vending machine present, the queue size (average if more than one machine) and the presence and number of tables and/or seating provided in the area.

4.4.5 **Measuring Food Environment survey scoring**

A points scoring systems was developed for each of the three MFE surveys and used to assign a score to each individual food outlet. For all surveys, points were awarded for the availability of 'more healthful' options and unavailability of 'less healthy' options. A higher percentage score indicates a 'more healthy' food environment. The score sheets can be seen with the corresponding surveys in Appendices M and N.

Food outlet scores were used to assess the healthiness of the food outlet categories. The scores were also used to generate an individual MFE score, details of which can be found in section 4.4.6.3.

4.4.5.1 Reliability of the Measuring Food Environment surveys

It is important to test measures of the food environment in order to ensure the tools selected and used measure the concept relevant to the research questions and do so in a reliable manner (Minaker *et al.*, 2012). Inter-rater and test re-test reliability was explored for the MFE-Shop and MFE-Restaurant surveys using the methods outlined in the following sections. Due to a lack of vending machine food outlet visits, the MFE-V survey was not assessed for these qualities.

4.4.5.2 Inter-Rater reliability

Prior to the present study, the MFE surveys were tested for inter-rater reliability in two ways:

1. Outlet assessment reliability – the ability to complete the tool consistently between researchers
2. Researcher scoring reliability – the ability to score the tools consistently

The MFE-Shop and MFE-Restaurant surveys showed good inter-rater reliability; detailed results are reported in Lake *et al.* (Submitted October 2013a).

4.4.5.3 Test Re-Test reliability

The test re-test reliability of the MFE surveys was explored. A list of food outlets visited by a sub-sample of study participants (n=10) was extracted from completed food diaries (Cox, 2012). These food outlets (n=30) were visited by the same researcher on two separate occasions, where the appropriate MFE survey was completed and scored for each time point (MFE-S n=12, MFE-R n=18). Percentage agreement was used to determine the reliability of the measure between the two visits.

Table 12 Test re-test reliability of the MFE-Shop and MFE-Restaurant surveys, difference between time point 1 (T1) and time point 2 (T2)

<i>Difference between T1 and T2</i>	<i>MFE-S</i>	<i>MFE-R</i>	<i>All surveys</i>
Mean difference – n (SD)	3.0 (5.4)	0.6 (4.6)	1.54 (5.0)
No difference – n (%)	0 (-)	1 (5)	1 (3)
+/- 1-5 points – n (%)	7 (58)	14 (78)	21 (70)
> +/-5 points – n (%)	5 (42)	3 (17)	8 (27)

Seventy-three percent of the surveys were scored within plus or minus five points indicating moderate test re-test reliability. The MFE-R survey performed more reliably than the MFE-S survey although the standard deviation (SD) was large for all surveys.

4.4.6 Individual measures of the visited food outlet environment

This section describes the calculation of three measures of the Visited Food Environment; VFE-Count, VFE-Ratio and individual MFE score. These measures assess the food outlet environment at an individual level and form the VFE predictor variables used in statistical analysis.

4.4.6.1 Visited Food Environment Count

The Visited Food Environment count (VFE-Count) is a measure of frequency of the food outlet use by individuals. It was calculated by identifying the total number of food outlet eating events recorded by a participant in their food diary. For this measure, the same food outlet can be counted multiple times.

4.4.6.2 Visited Food Environment Ratio

The Visited Food Environment Ratio (VFE-Ratio) is a measure of the variety of food outlet types an individual visits. The proportion of 'less healthy' to 'more healthy' food outlets was assessed, an approach adopted in a number of other studies (Spence *et al.*, 2009; Truong *et al.*, 2010). It was calculated using the formula below based on the food outlet classification categories making up the VFE-Count.

$$\text{VFE-Ratio} = \frac{\text{'Takeaway eatery' + 'Convenience' eating events}}{\text{VFE-Count (total number food outlet eating events)}}$$

A VFE-Ratio ≥ 0.5 was indicative of a greater proportion of 'takeaway eatery' and 'convenience' outlets to 'traditional eatery' and 'grocery' outlets and assumes a 'less healthy' visited food environment. A VFE-Ratio < 0.05 indicates a greater proportion of 'traditional eatery' and 'grocery' outlets to 'takeaway eatery' and 'convenience' outlets and therefore assumes a 'more healthy' visited food environment.

4.4.6.3 Individual Measuring Food Environment score

In order to assess the consumer food choice environment of individuals, an individual MFE score was calculated based on the results of the MFE surveys for VFE-Count food outlets (Figure 12).

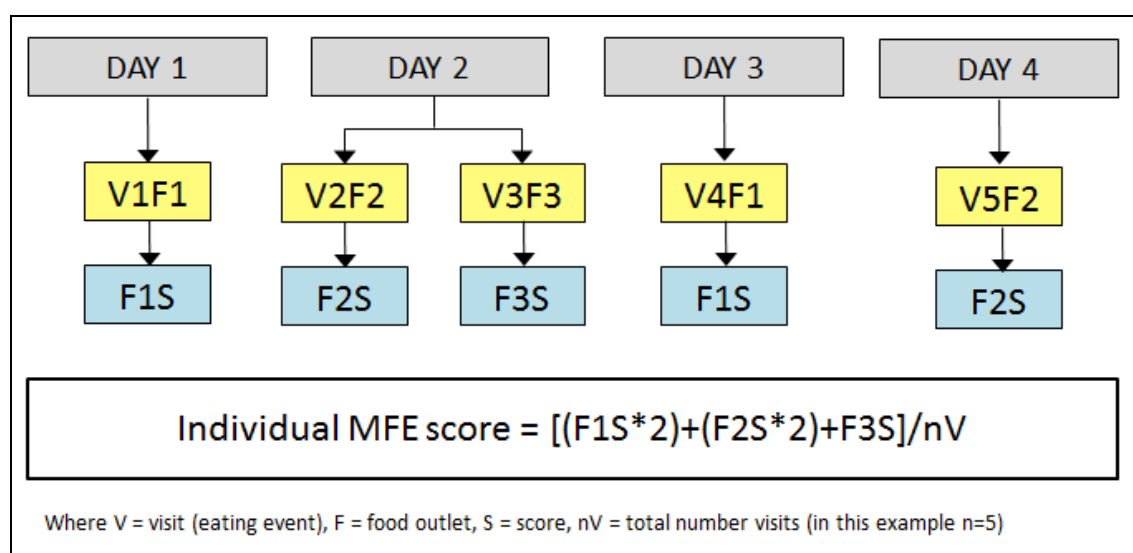


Figure 12 Calculation of Individual Measuring Food Environment Score

The Individual MFE score is a mean of the MFE survey scores for all the food outlet eating events forming the VFE-Count for a participant. This method takes into account use of the same outlet multiple times over the study period.

4.5 Exposure Food Environment

This study aimed to examine the relationship between the Exposure Food Environment and dietary intake at the individual level. The Exposure Food Environment (EFE) is defined as the opportunities an individual has to obtain food and is assessed according to the number and type of food outlets present within the geographic space an individual uses. Two sets of data were required in order to establish EFE at the individual level:

1. Global Positioning System (GPS) data identifying the geographic space used by individuals
2. Details of food outlets (opportunities to obtain food) located within the identified geographic space used by individuals

This section describes the steps taken to collect the necessary data and subsequent calculation of individual EFE measures.

4.5.1 Extraction and cleaning of the Global Positioning System data

GPS data were used to establish the geographic space used by individuals over the 4-day study period. Data in the form of waypoints were extracted from the QStarz GPS device carried for four days by study participants. A waypoint is defined as a reference point to a specific geographic space. Waypoint characteristics include: date, time, latitude and longitude co-ordinates, altitude and speed.

Waypoint data were cleaned using the method described in section 3.6.2.1. A review of the GPS data revealed that time gaps were present resulting in unknown routes between destinations, possibly due to failure of the devices to fix an adequate satellite reception. A decision was made to accept face errors in the GPS data and not to correct GPS points beyond those adjustments made automatically using the QTravel software. Efforts were made to ensure participants were aware of the study requirement to stay within Newcastle upon Tyne and the surrounding area for the duration of the 4-day study period. However, travel outside of the Newcastle area occurred on two occasions and these data were excluded from analysis.

Adjustments were made to the GPS data to account for speed of travel. GPS waypoints were excluded where the recorded speed exceeded five miles per hour (8.05 kilometres per hour). This decision was discussed in the methods development chapter (see section 3.6.2.3).

4.5.2 Identifying and classifying exposure food outlets

This section describes the process of identifying and classifying the food outlets making up the exposure food environment of individuals. A flow diagram of this process can be seen in Figure 13.

Using Geographic Information System software, ArcGIS version 10.1 (ESRI; Redlands, CA), GPS data were overlaid onto a base map of Newcastle upon Tyne and the surrounding area obtained from Ordnance Survey (Ordnance Survey, 2010). Street level routes were re-traced onto a hard copy Newcastle upon Tyne A-Z map (Geographers' A-Z Map Co Ltd, 2007). A researcher-completed walking survey was conducted where the routes taken by participants were re-traced in order to identify food outlets present. Areas with very low waypoint densities were excluded from the re-tracing exercise. By excluding waypoints with a speed above 5mph, these 'stray' waypoints were likely to represent times when participants were stationary for example when travelling in motorised transport stopped at traffic lights or a bus stop.

During the fieldwork exercise, opportunities to obtain food, or food outlets, present along the observed routes were recorded on a data collection sheet (Appendix R). The business name, business address (street name and building number if available) and details of food outlet type were noted on site for outlets present on both sides of the street being surveyed. A photograph of the food outlet exterior was taken using a mobile phone with integrated camera. Latitude and longitude figures (geo-tag) were recorded for all food outlets using a Garmin eTrex Vista HCx Handheld GPS device. Food outlets housed within buildings with multiple entrances, shopping centres, department stores and multi-stall static markets were geo-coded according to postcode centroid¹⁰.

Additional address details, including postcode, for each identified EFE food outlet were ascertained via an Internet search using websites such as Google, Google Maps and Royal Mail Postcode Finder. As with the VFE food outlets, EFE food outlets were classified and categorised using the 15-point outlet classification tool (Appendix L, Lake *et al.* (2010)) and amalgamated into the five food outlet type categories (see section 4.4.3). These details were entered into an Excel spread sheet, referred to from this point forward as '*food outlet database*'.

¹⁰ The term 'postcode centroid' refers to the geographic centre point of a collection of (usually) adjacent addresses, typically 15. A number of addresses sharing the same postcode would also share the same postcode centroid for example, a row of businesses would share the same geographic location.

A set of coding rules were applied to the food outlet classification system for outlets that could be classified within multiple categories (Appendix S). One example was the case of combination post office/newsagents; these were classified according to the dominant signage on the premise exterior.

A number of food outlets were excluded from the EFE analysis as they did not provide equal opportunity to obtain food for the whole population. This included outlets which required entry by membership (e.g. social clubs), educational establishments and workplaces, and seasonal markets. Specifically, outlets excluded were; schools, workplace canteens, working/ social clubs, churches, Christmas market, Monument Mall (demolished during data collection), and a football stadium.

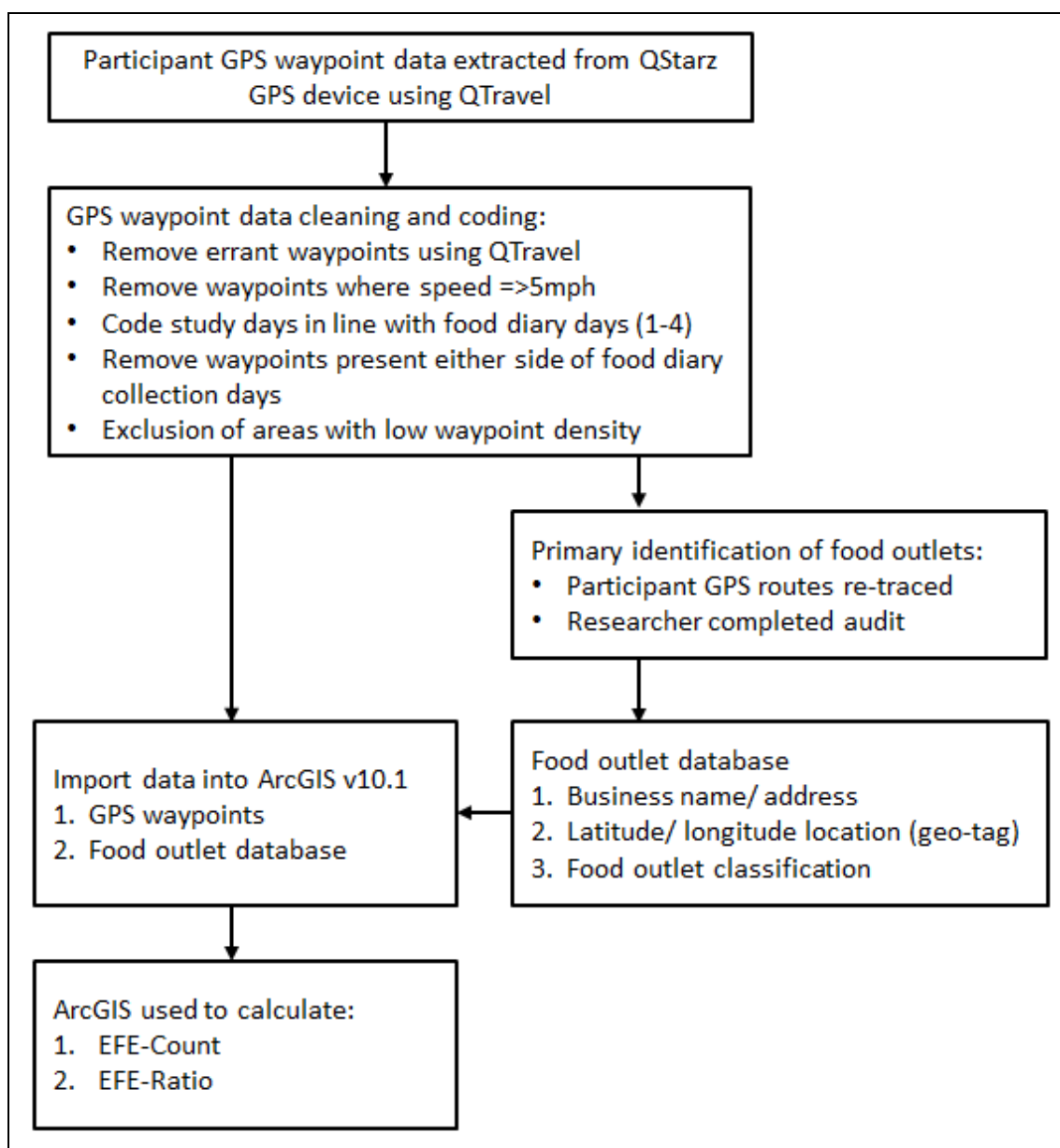


Figure 13 Flowchart to show the steps taken to link the Global Positioning System data with food outlet locations to establish the Exposure Food Environment of individuals

4.5.3 Calculating the Exposure Food Environment measures

Two measures of the Exposure Food Environment were calculated using participant GPS waypoints and the food outlet database:

- EFE-Count
- EFE-Ratio

4.5.3.1 Exposure Food Environment count

The Exposure Food Environment Count (EFE-Count) was defined as the total number of food outlets present within a 50 metre buffer of GPS waypoints recorded for by an individual participant. Figure 14 describes the process of calculating the EFE-Count for each participant using ArcGIS v10.1.

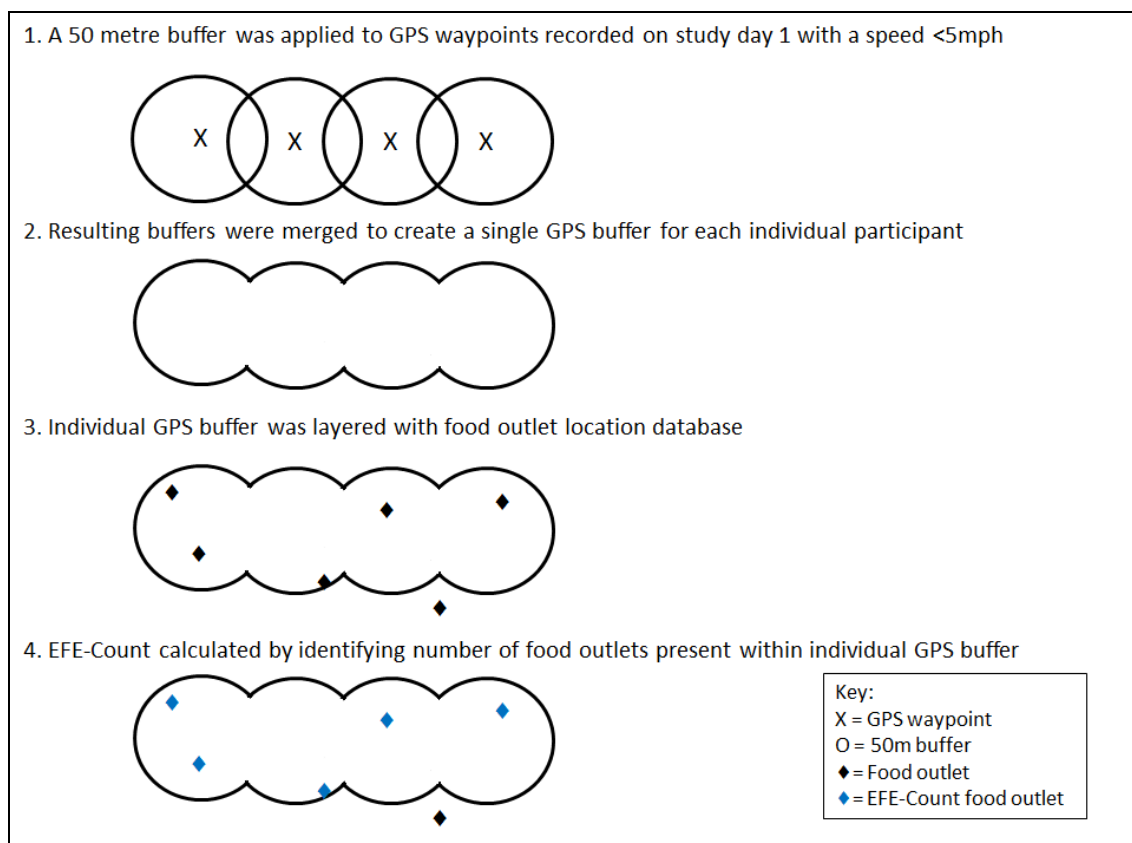


Figure 14 Process of calculating the EFE-Count from GPS waypoints and food outlet database using ArcGIS v10.1

Only the data for study day 1 was used to calculate the EFE measures as this was consistently available for all study participants regardless of GPS device battery life (as discussed in Chapter 3).

A list of the identified food outlets making up the EFE-Count was exported from ArcGIS as an Excel CSV file for each participant. The data included the food outlet classification information for each food outlet identified. The EFE-Count was used as continuous variable and dichotomised above and below the median value of 14.0; this gave two groups indicating 'low' (<14.0) and 'high' (>14.0) exposure to food outlets.

4.5.3.2 *Exposure food environment ratio*

The EFE-Ratio assessed the ratio of 'less healthy' food outlets to 'more healthy' food outlets. It was calculated based on the food outlets types identified via the EFE-Count using the following formula:

$$\text{EFE-Ratio} = \frac{\text{'Takeaway eatery' + 'Convenience' exposure food outlets}}{\text{EFE-Count (total number food outlet exposures)}}$$

An EFE-Ratio ≤ 0.5 indicated a 'more healthy' exposure food environment with exposure to a greater proportion of 'traditional eateries' and 'grocery outlets'. An EFE-Ratio > 0.5 indicated a 'less healthy' exposure food environment with exposure to a greater proportion of 'takeaway eateries' and 'convenience outlets'. The EFE-Ratio was used as a continuous variable and also dichotomised above and below the value of 0.50 indicating 'more healthy' and 'less healthy' exposure food environments.

4.6 Quantitative data analysis

This section outlines the outcome variables used in the study analysis. The statistical analysis methods adopted in the preparation of the results chapters are described.

4.6.1 Dietary analysis

A Microsoft Access 2010 database was developed for the study to manage the dietary data linked to the McCance and Widdowson's composition of foods database (Food Standards Agency, 2008). Intake of dietary variables were calculated as total intake over four days, total intake per day, mean daily intake and mean intake on week and weekend days.

Total intake of nutrients was calculated by eating event and assigned to food source and, where appropriate, food outlet classification category. Nutrient density was calculated for each eating event and these data were used to assess the nutrient density of food from each food source. The same process was used to calculate the energy density of eating events by food outlet classification categories.

Participants were dichotomised according to their mean dietary intake of energy, fat, saturated fat, and fruit and vegetable intake in relation to the dietary guidelines (Department of Health, 1991):

- Energy – above/below 11.51MJ for males and 8.83MJ for females
- % energy from fat – mean daily intake above/below 33% total energy
- % energy from saturated fat – mean daily intake above/below 11% total energy
- Fruit and vegetable intake – above/below two 80g portions

4.6.2 Statistical tests

All statistical analyses were conducted using SPSS Version 19 for Windows. Continuous variables were expressed as mean values and standard deviation (SD). The distribution of each variable was tested for normality using probability plots (histograms). Plots that did not follow the expected normality curve were considered to be non-parametric distributions and treated as such in statistical analysis. In addition, the Shapiro-Wilk statistic was used to confirm data normality, a value of $p > 0.05$ was indicative of a normal distribution. Bi-modal distributions when two bell curves were identified were treated as normal. Correlations were conducted using Pearson correlation co-efficient (r) and Spearman Rank (r_s) statistics for normally and non-normally distributed data as appropriate. Correlations were considered significant where $p < 0.05$.

Comparison between two groups (e.g. male/ female) was carried out using independent sample t-tests for normally distributed data and Mann-Whitney tests for non-parametric data. Where more than two groups were compared, ANOVA was used for normally distributed data and Kruskal-Wallis tests for non-parametric data. Bonferroni corrections were applied where the differences between more than three groups were tested.

Comparisons with set values, such as those between study participants and national figures (e.g. dietary intake compared to National Diet and Nutrition Survey (Department of Health, 2011b)) were carried out using one-sample t-tests. Paired sample t-tests were used to compare intakes between week and weekend days. Chi-Squared tests (χ^2) were used to investigate the distributions

of categorical data. All statistical tests were considered to be significant where the p -value was below the 0.05 threshold.

4.7 Individual qualitative interviews

Qualitative interviews were conducted in order to explore and unpack the environmental drivers of food choices and behaviours of participants in greater detail. Individual interviews rather than focus groups were chosen as the most appropriate qualitative method to use in this context. Interviews allowed participants to reflect on their food choice decisions and discuss their thoughts and opinions surrounding food without the direct influence of others (such as peers, parents, and teachers). Focus groups would not have elicited the same depth of detail (Denzin and Lincoln, 2000). This section describes the process of recruiting participants and conducting the interviews, before detailing the method of analysis used.

4.7.1 Recruitment, consent and incentives

Participants were informed of the individual interview phase of the study in the original recruitment session and information leaflet (see section 4.2). During the food diary collection interview, participants were asked if they had any objection to being contacted again should the researcher wish them to complete an interview. All participants gave their consent to be contacted for this purpose.

Following the food diary phase of data collection, participants were purposefully selected for interview using theoretical sampling (Hammersley, 1990). This process ensured a range of experiences relating to the individual food environment could be explored.

The interview sample was selected based on a variety of factors including:

- VFE-Count and type of food outlets recorded in 4-day food diary and EFE-Count estimated using pilot study method (section 3.6.2.4)
- School attended
- Age
- Gender
- Social-economic status

Selected participants were invited for interview via email and/ or text message. It was anticipated that 15-25 participants would be invited to complete an interview in order to achieve an adequate range of experiences and reach saturation of emergent themes (Strauss, 1987). Seventeen participants were invited to take part in the individual interviews. Six participants completed the interview phase giving a completion rate of 35%. Of the 11 non-respondents, two individuals declined participation, four did not attend an arranged interview appointment (only one gave notice) and five did not respond to the invitation. Although the interview sample was not sufficient to investigate differences between groups (for example, gender or adiposity), enough data was generated to give detailed insight into the factors and processes influencing adolescent food choice within different social contexts. The two-stage study design adopted to allow the qualitative data to build upon and compliment the quantitative data (Brannen, 2005).

All interviews were completed in privacy on a one-to-one basis with the researcher. They were conducted at a time and location convenient to the participants. Five of the interviews were conducted at the Human Nutrition Research Centre at Newcastle University and one was completed on school premises (arranged with participant and teacher). Participants received a £10 shopping voucher upon completion of the individual interview; this was in addition to the £10 voucher received on completion of the food diary.

Interviews were digitally audio recorded with participant consent and transcribed verbatim. It was anticipated that interviews would be approximately one hour in duration and recordings ranged from 29 and 53 minutes. All participant names (and those of people they talked about) cited in this thesis are pseudonyms and some place names have been removed or changed to respect anonymity and confidentiality.

4.7.2 Topic guide and supporting documents

A topic guide was developed in order to steer discussion during the interviews (Appendix O) using examples from other studies exploring the food behaviours of young people (Wills *et al.*, 2005; Wills *et al.*, 2008; Wills *et al.*, 2011) and data collected during the pilot study (section 3.7). Food diaries collected during the pilot study gave an indication of the food sources and eating locations used by

young people and context within which eating occurred, for example meals with friends or family. These were used as the basis for exploring food consumption outside of the home.

The topic guide followed a semi-structured interview format (Britten *et al.*, 1995) where participants were asked to talk through a typical weekday, explaining what they ate, where they got their food and with whom they ate. Interviewees were specifically asked to describe situations where they would obtain food outside of the home. As this was one of the focal points of this research, it was important to discuss this in detail with the interviewees. Participants were asked about occasions when they visited restaurants with friends or family, ate takeaway food at home or at friends' homes, and used shops to purchase food. Where these behaviours occurred, the young people were asked to consider *what* and *who* decides on where they go and what they eat.

After discussing the typical weekday, participants were asked to consider occasions where the 'normal routine' may be different. For example, were there any days where they made their own evening meal if a parent usually did this or occasions when they ate at a different time to fit around an extra-curricular activity. As weekend behaviours tend to differ from those on weekdays (Haines *et al.*, 2003; Wiehe *et al.*, 2008b), participants were asked to describe a typical weekend in the same manner as for a weekday.

Conducting the qualitative interviews as a follow-up phase of the study allowed for the use of data collected during the food diary collection period to support and steer discussion (Brannen, 2005). Visual maps, unique to the individual participant, were created using ArcGIS software depicting GPS data alongside location data of the food outlets recorded in the food diaries (VFE-Count). An estimate of food outlet exposure was calculated using a secondary food outlet database (Burgoine, 2010). Completed food diaries and any food photographs taken by the interviewee were used alongside the maps to encourage conversation during the interviews.

The semi-structured interview method provided a controlled approach to questioning with the researcher following the topic guide protocol, ensuring essential topics were discussed. However, the method also allowed the researcher to invite participants to elaborate on topics most relevant to them

and allow further questioning where the discussion was appropriate to the research questions (Denzin and Lincoln, 2000; DiCicco-Bloom and Crabtree, 2006).

4.7.3 Qualitative data analysis

The completion and analysis of interviews followed a grounded theory approach. Grounded theory is the process of building a theory derived from data, although the approach can be used more generically to develop theoretical constructs from qualitative data collection and analysis (Strauss, 1987).

In the first stage of analysis, the researcher repeatedly listened to audio recordings and read transcripts of the interviews in order to become familiar with the data. Transcripts were imported into the analysis software programme NVivo Version 9 which was used to organise the data and develop a coding frame.

The data were open-coded in order to identify the emerging concepts. Grounded theory suggests that at this stage, the concepts should be derived from the data itself, using words and terms used by the interview participants (Strauss, 1987). Transcripts were coded as soon as possible following data collection to allow for emergent findings to be further explored during subsequent interviews. Following interview two, additional prompt questions were added to the topic guide to explore the concepts of repeatedly ordering 'favourite' meals when visiting particular restaurants, and the location of takeaway food outlets used by family in relation to the home.

A selection of transcripts were read by another researcher (supervisor Wendy Wills) independently and the emergent coding frame was discussed in detail at various points in the analysis. This was to ensure the coding of transcripts and emergent themes were justified and appropriate to the research questions. This also ensured that the interpretation of data was not solely that of the primary researcher. Any disagreements regarding the interpretation of the data were discussed until consensus was reached.

Two key emergent themes were selected to investigate in greater detail:

1. Eating out
2. Takeaway food

These themes emerged from the data following open-coding and were selected for their close links to the overarching research aim to explore the out-of-home food environment of young people. The qualitative analysis was conducted prior to the statistical analysis of quantitative data and was therefore not influenced by these findings. Although the data are closely linked; the interview data added depth, meaning and context.

A number of themes emerged from the data that were not further explored in this research. These include, school food and the school fringe food environment, family eating patterns, and food preparation at home.

4.8 Summary

- The study adopted a multi-disciplinary approach drawing on methods used in nutritional science, geography and the social science.
- Four-day food diaries were used in conjunction with text messages, photography and receipt collection to estimate the dietary intake of young people.
- Three questionnaires (LSQ, HFEQ and AFHC) were completed to assess lifestyle behaviours, home food environment and usual food habits.
- Anthropometric measures (height, weight, waist and hip circumference) were recorded and BMI and WHR calculated.
- Socio-economic status was assigned using area-level IMD scores linked to individual home postcode.
- GPS devices were carried by participants for the 4-day study period in order to collect data on the activity space used by individuals.
- Eating events were identified within the food diaries and assigned to one of five food sources.
- Food outlets identified within the food diaries were visited by a researcher where the outlet was coded using the food outlet classification categories and a MFE survey was completed.

- An individual food environment score was calculated based on the results from the MFE surveys relating the food outlet consumer environment to the individual participant.
- Visited food environment measures, VFE-Count and VFE-Ratio, were calculated using food outlet eating event data recorded in the food diaries.
- GPS data were linked to researcher collected food outlet location data to form the exposure food environment measures, EFE-Count and EFE-Ratio.
- Qualitative interviews were conducted using a grounded theory approach with a sub-sample of the study participants to explore and unpack the drivers of food choice in young people.

The next seven chapters contain the results of the study as outlined below:

- Chapter 5: Participant characteristics including gender, age, socio-demographics, socio-economic status and the prevalence of overweight and obesity.
- Chapter 6: Results from the HFEQ and LSQ questionnaires.
- Chapter 7: Overview of dietary intake and by gender, adiposity, and SES. Dietary intake is compared to national figures. Results from AFHC.
- Chapter 8: Identification of food sources used by participants, contribution of food sources to dietary intake and nutrient density of eating events from different food sources.
- Chapter 9: Identifies and explores the visited food outlet environment including nutrient density of eating events sourced from different types of food outlets and relationship between visited food environment measures and dietary intake.
- Chapter 10: Identifies the exposure food environment of young people and explores the relationship between the exposure food environment measures and dietary intake, adiposity and SES.
- Chapter 11: Results from qualitative interviews exploring the factors and drivers influencing the food choice of young people.

Chapter 5 Results: Participant characteristics

Chapter overview:

- Introduction
- Ethnic origin, living arrangements and education/employment status
- Socio-economic status
- Anthropometric measurements
- Summary

The aims of this chapter are: to describe the demographic characteristics of the young people participating in the study in terms of their ethnic origin, living arrangements, education/employment status and socio-economic status; and to report the results of the anthropometric measurements.

5.1 Ethnic origin, living arrangements and education/employment status

Out of 52 young people who expressed an interest in the study, a total of 45 young people consented to take part (86%). All participants who provided consent completed the study. Participants had a mean age of 17.1 years (range 16.08–19.58) and all resided in the Newcastle upon Tyne area. Seventeen participants were male (36%) and 28 were female (64%).

The majority of the participants (77%) described themselves as White British. Eleven percent of participants identified themselves as Asian and 7% were from a mixed background. All participants lived with their parent(s)/ guardian(s) or grandparents. The majority of participants reported residing in one home only. A quarter of participants reported spending time in a second home, for example if their parents did not live together.

Ninety-three percent of participants were recruited through one of six schools (n=42). Two participants were recruited through word of mouth and one participant was recruited via a health centre. All participants were in full time education at the time of the study. In one of the schools, participants were recruited via AS/A Level classes in health and social care (n=7) and sports science (n=13). Thirty-eight percent (n=17) reported having a part-time job; working hours ranging from 2-17 per week.

5.2 Socio-economic status

The mean Index of Multiple Deprivation (IMD) score for the group was 34.2 (range 4.6–76.1), where a higher score indicates greater area level deprivation. There was no statistically significant difference between the mean IMD score of the study population and the mean IMD score for North East England (28.14, range 1.74-78.4). This indicates that the study sample is likely to be representative of the population of the North East.

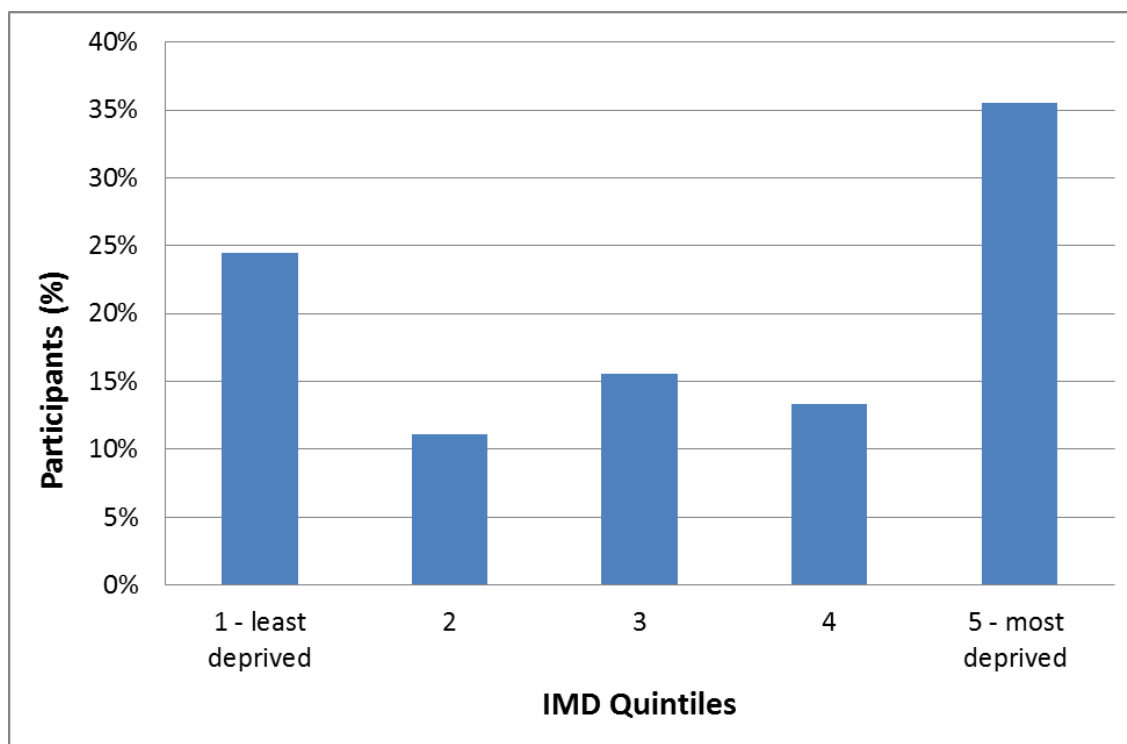


Figure 15 Distribution of participants within Index of Multiple Deprivation (IMD) quintiles for the North East of England

5.3 Anthropometric measurements

Anthropometric measurements of participants, including height, weight, Body Mass Index (BMI), waist circumference (WC), hip circumference and waist-hip ratio (WHR) are presented in Table 13.

Table 13 Anthropometric characteristics of participants

Characteristic	Total (n=45)	Male (n=17)	Female (n=28)
	Mean (range)	Mean (range)	Mean (range)
Height (m)	1.68 (1.53-1.83)	1.74 (1.61-1.83)	1.65 (1.53-1.74)
Weight (kg)	62.6 (44.4-96.2)	65.5 (47.5-96.2)	60.7 (44.4-82.2)
BMI (kg/m ²)	22.1 (17.4 – 30.7)	21.7 (17.4 – 30.7)	22.3 (18.0 – 30.2)
Waist Circumference (WC) (cm)	75.3 (63.0 – 96.3)	76.8 (68.4 – 96.3)	74.3 (63.0 – 88.0)
Hip Circumference (HC) (cm)	98.5 (84.4-113.6)	96.7 (84.4-113.6)	99.6 (87.8-110.3)
Waist to hip ratio (WHR)	0.76 (0.67 – 0.85)	0.79 (0.73 – 0.85)	0.75 (0.67 – 0.82)

On average, male participants were taller and heavier than female participants. Adiposity of participants was assessed using BMI (weight (kg)/height (m²)), waist circumference (WC), and waist to hip ratio (WHR). The mean BMI for all participants was 22.1, which falls within the healthy weight range (Cole *et al.*, 2000) (Cole *et al.*, 2007). Female participants had a higher BMI than male participants, however this difference was not statistically significant ($p=0.215$). There was no significant association between IMD score and BMI.

The participants were categorised into four BMI groups ('underweight', 'healthy', 'overweight' and 'obese') using the age and sex specific International Obesity Task Force (IOTF) cut-offs (Cole *et al.*, 2000; Cole *et al.*, 2007) (see Table 6, p99). Table 14 shows the prevalence of overweight and obesity in the study population was 20%.

Table 14 Prevalence of underweight, healthy weight, overweight and obesity assessed using BMI and International Obesity Task Force cut-offs (Cole *et al.*, 2000) (Cole *et al.*, 2007)

	BMI classification				
	n	n(%) Underweight	n(%) Healthy	n(%) Overweight	n(%) Obese
Males	17	2 (12)	11 (65)	3 (18)	1 (6)
Females	28	0 (0)	23 (82)	4 (24)	1 (4)
Total	45	2 (4)	34 (76)	7 (16)	2(4)

Due to small numbers in the underweight and obese categories, the BMI classification was amalgamated into two groups:

1. 'Healthy and underweight'
2. 'Overweight and obese'

The 'healthy and underweight' group had a mean BMI of 20.7 (range 17.4–24.3); the 'overweight and obese' group had a mean BMI of 27.6 (range 24.7–30.7). The difference between the mean values for the BMI groups was statistically significant ($p<0.001$).

Males had a higher mean WC measurement than female, although this was not statistically significant ($p=0.29$), and a significantly higher WHR than females ($p<0.001$). Thirteen percent of participants were above the WC cut-off for increased risk of cardiovascular disease (one male, five females). However, all participants fell in the 'healthy' WHR category. BMI was strongly correlated with both WC ($r=0.91$, $p<0.001$) and moderately correlated with WHR ($r=0.40$, $p<0.01$).

5.4 Summary

- Participants were all in full-time education, with just over one third also in part time employment.
- The participants were from a wide range of socio-economic backgrounds and the mean IMD score was comparable to the local average.
- Twenty percent of the study participants were classified as overweight or obese using the IOTF cut-offs.
- Males had a significantly higher WHR than females, however using the WHO cut-off for increased risk all participants' WHRs were classified as healthy.
- Gender differences in mean BMI and WC were not statistically significant.

Chapter 6 Results: Home Food Environment and Lifestyle Questionnaires

Chapter overview:

- Introduction
- Response rates
- Visits to fast food, restaurant and takeaway outlets
- Eating behaviours and food rules at home
- Home food availability
- Alcohol consumption habits
- Physical activity and sedentary behaviour
- Summary

This chapter reports the results of the Home Food Environment Questionnaire (HFEQ) and Lifestyle Questionnaire (LSQ) used to explore the lifestyle habits, home food environment and food habits of the study population. The results from these two questionnaires are presented descriptively and organised according to topic (outlined above in Chapter overview). Some figures in this chapter therefore contain responses from across these two questionnaires. These are identified within the figure notes.

6.1 Response rates

All participants (n=45) completed the HFEQ and 44 participants (16 male, 28 female) completed the LSQ.

6.2 Visits to fast food, restaurant and takeaway outlets

Within the HFEQ (section 4.3.6.2), over a third (38%) of participants reported eating takeaway or fast food more than once per week at home, and 36% reported eating takeaway or fast food away from the home more than once per week. No participants reported eating takeaway or fast foods every day.

Participants were asked in the LSQ (section 4.3.6.1) about the frequency with which they visited fast food and other restaurants (i.e. non-fast food) with their family and friends and about takeaway food consumed at home and out of the home (Figure 16).

The majority of participants reported visiting both fast food and other restaurants never or rarely, or less than once per week with their family. Only one participant reported visiting any kind of restaurant outlet every day.

Participants reported visiting fast food and other restaurant outlets more frequently with friends compared to family. Almost a third (30%) reported visiting fast food outlets 1-3 times per week with friends, compared to 11% with family. Overall, other restaurants were reported to be visited less frequently (16%) than fast food when with friends.

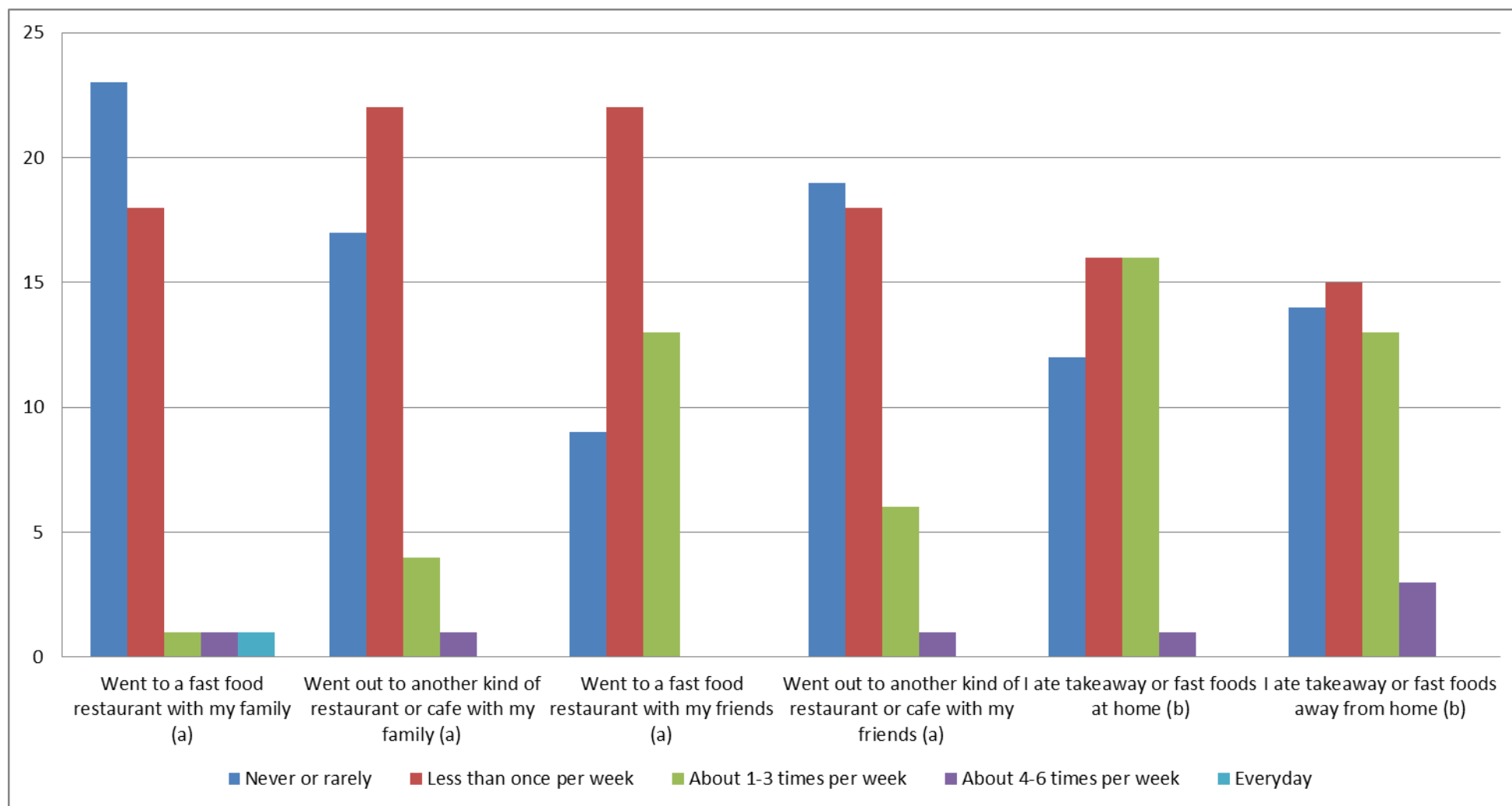


Figure 16 Frequency of visiting fast food, takeaway and other types of restaurant. Source (a) LSQ (n=44), (b) HFEQ (n=45)

6.3 Eating behaviours and food rules at home

The HFEQ contained questions regarding eating behaviours and food rules within the home (section 4.3.6.2). Results from these questions are presented in Figure 17 and Figure 18.

Over half of participants reported eating breakfast at home every day and 73% reported eating dinner at home more than 4 times per week (Figure 17).

Participants made or helped to make their own breakfast more frequently than lunch or dinner. Almost a third (29%) of those surveyed reported never deciding or helping to decide what the whole family eats for a meal. An overall majority of participants indicated that they helped clean up after a meal at home, at least once per week. Participants reported more frequent consumption (4-6 times per week or everyday) of snacks in front of the television than dinner (47% and 33%, respectively).

Food rules were defined as rules imposed by parents or guardians with regards to eating in the home (Figure 18). A minority of young people reported having any rules in place regarding portion sizes, eating meals or snacks in front of the television, or eating sweet or fried snacks (less than 11% in each case). More participants reported having a rule in place (yes or sometimes) to clean up after meals (78%) than helping with meal preparation (49%). The majority of participants indicated that they did have, or sometimes had, a rule dictating they must eat dinner with their family at home (71%). Over a third (38%) of participants indicated that 'limited fast food' was a rule set by their parent/guardian.

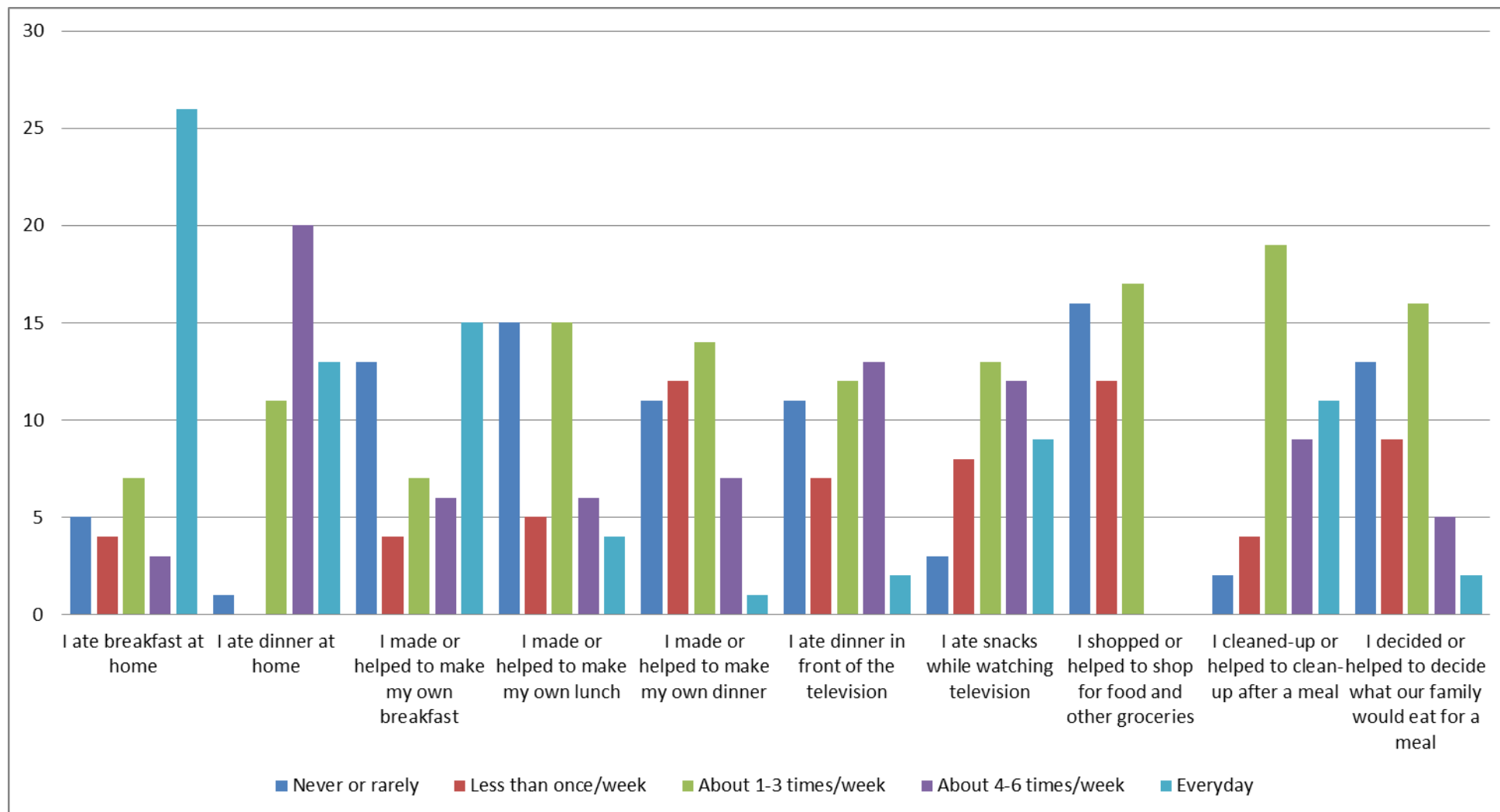


Figure 17 Eating habits and behaviours at home. Source: HFEQ (n=45)

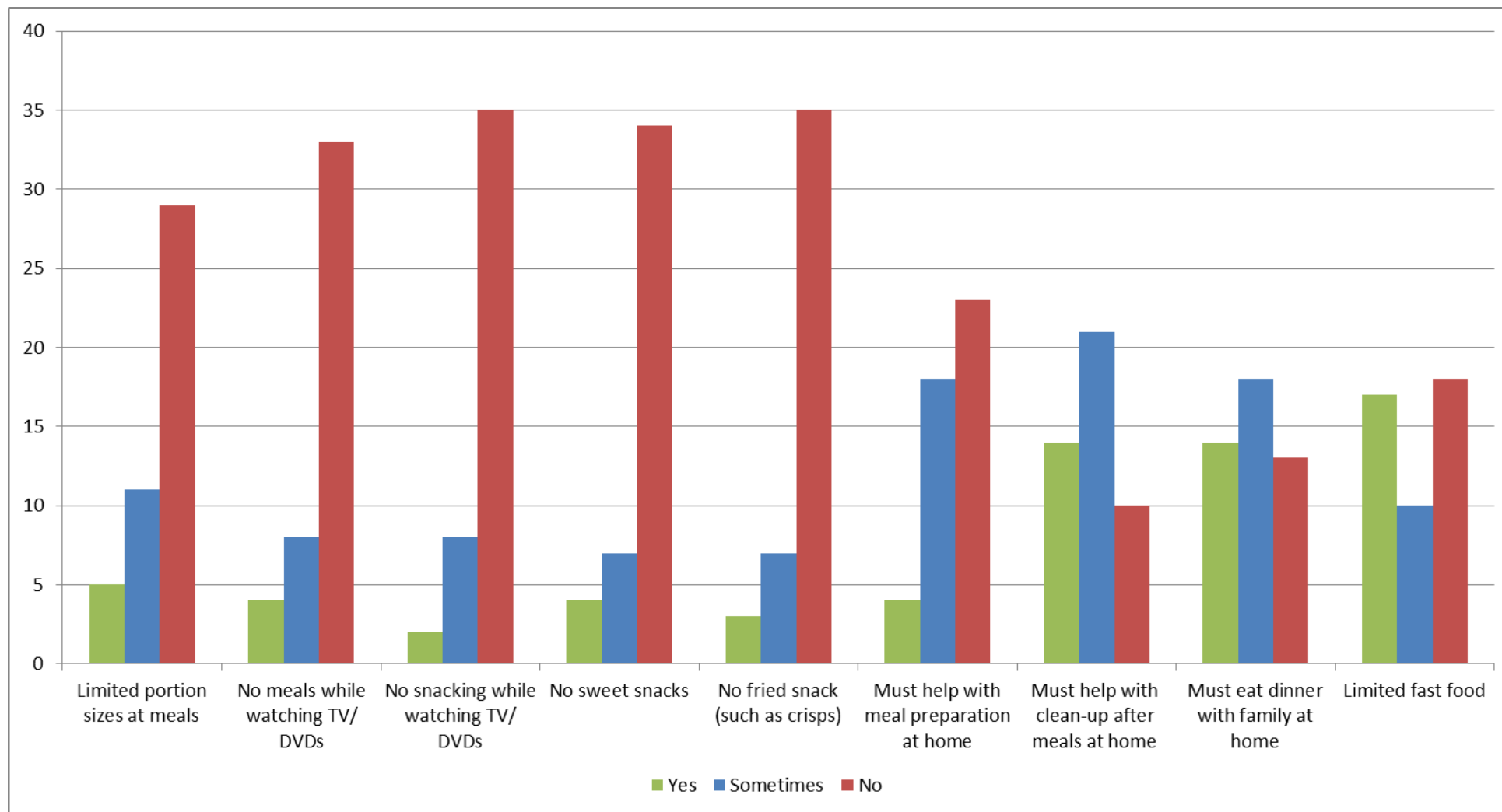


Figure 18 Parent/ guardian food rules at home. Source: HFEQ (n=45)

6.4 Home food availability

The HFEQ contained questions regarding the availability of a variety of food items in the home (section 4.3.6.2).

As shown in Figure 19, 93% of survey respondents reported usually or always having 'plenty to eat' in their home. The majority of participants reported a variety of fruits always being available in their home (69%) and over half (56%) reported 'always' having fruit juice available. Most participants (73%) reported vegetables 'always' or 'usually' being served at dinner in their home. No respondents reported fruits, vegetables or fruit juice never being available in their home. Very few participants reported never having junk food (n=3), chocolate/ sweets (n=3) or soft drinks (n=4) in their home.

Figure 20 shows the usual availability of specified fruits and vegetables within the home food environment. Bananas, peas and apples received the highest 'always' available response rate. Tomatoes, baked beans, salad vegetables and carrots were also reported to be always available by over 30% of respondents. Pears and canned fruit had the highest 'never' available response rates.

Almost half of participants reported fruit juice 'always' being available in their home, no participants reported fruit juice 'never' being available (Figure 21). Just under half of participants reported having chocolate and biscuits 'always' available at home. Other 'less healthy' food items had a greater spread of responses over the 'always' to 'never' scale. A higher number of participants reported 'never' having diet soft drinks available in their home compared with non-diet soft drinks.

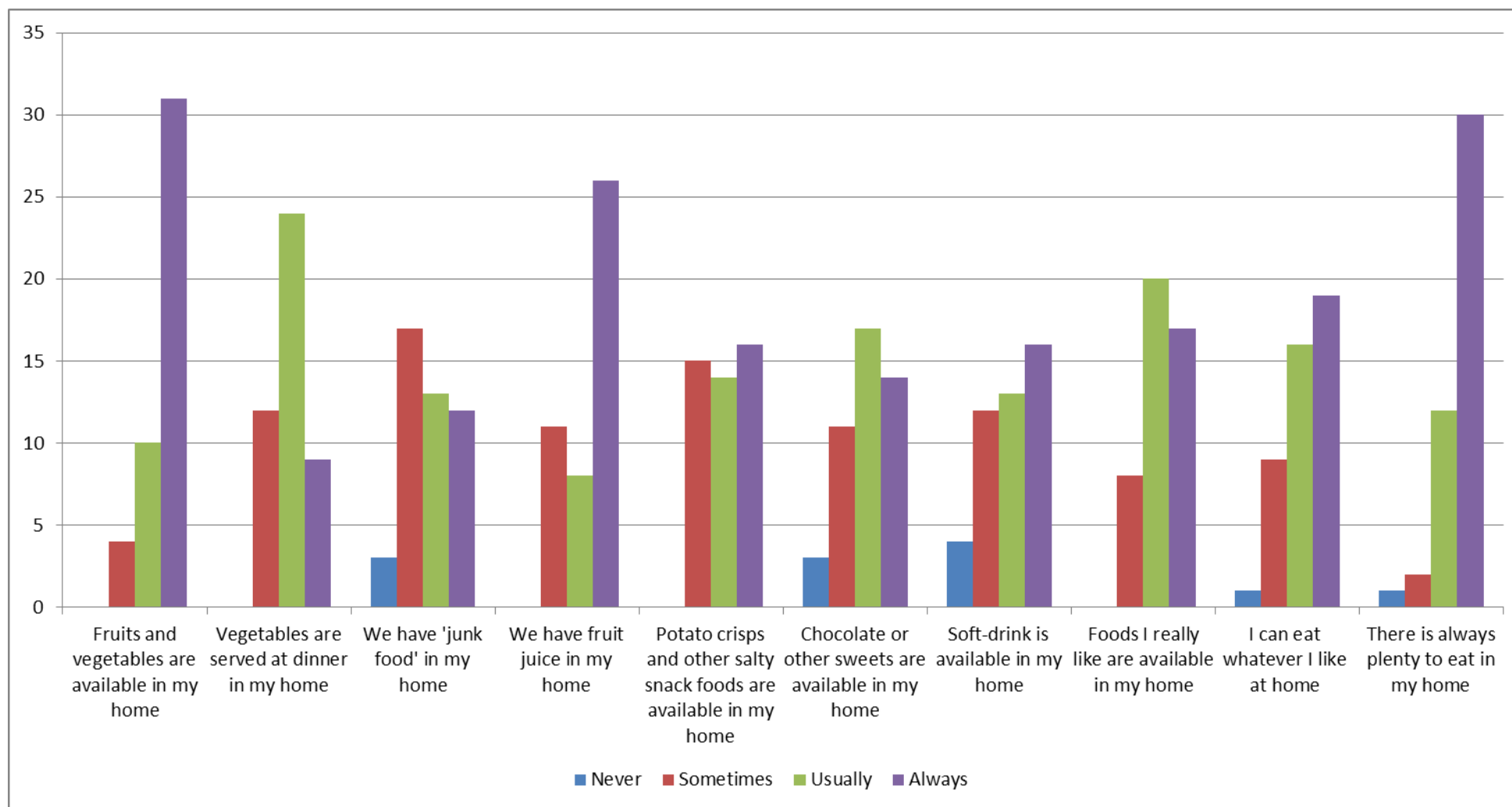


Figure 19 General availability of food in the home. Source: HFEQ (n=45)

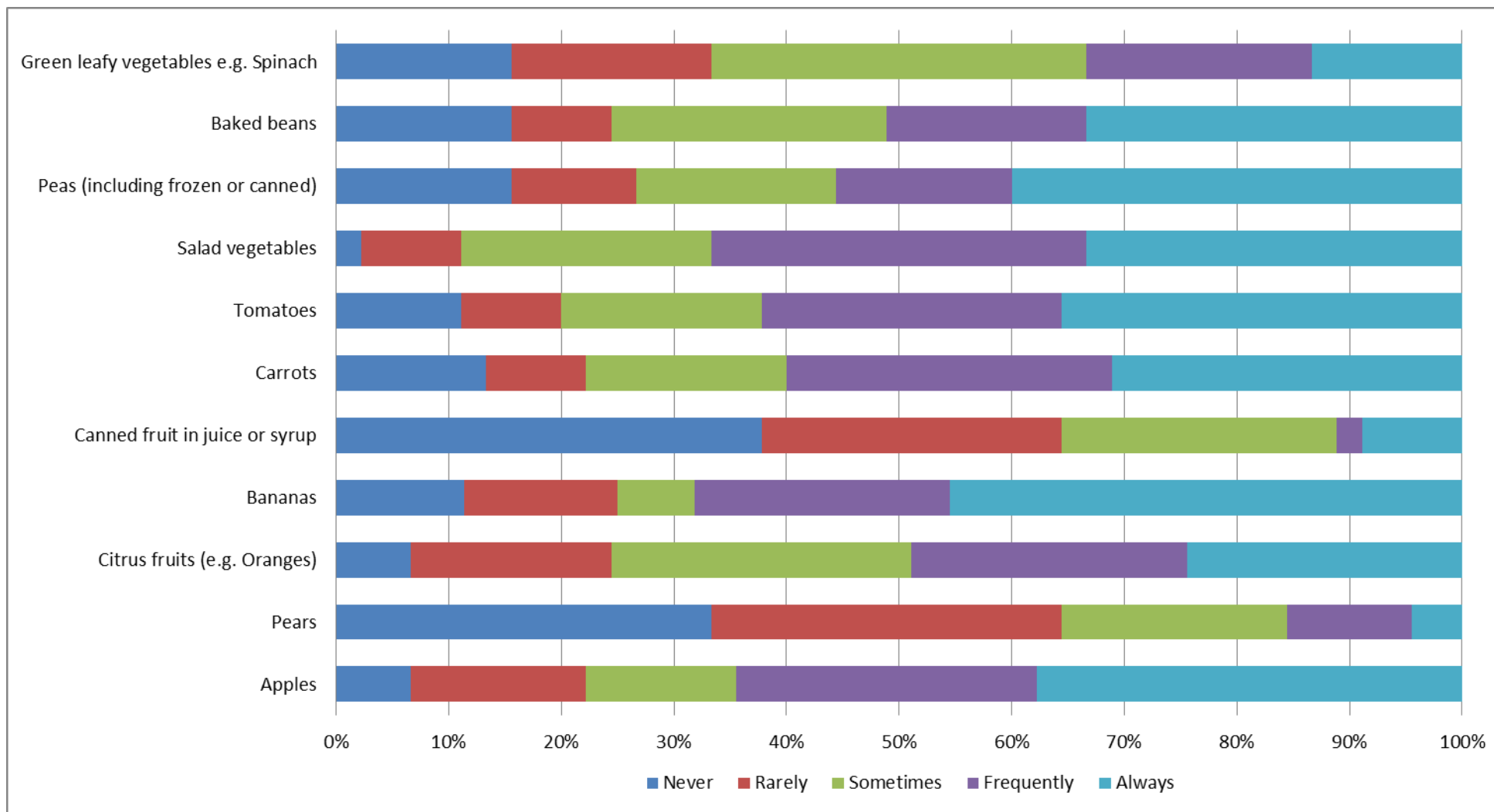


Figure 20 Availability of fruits and vegetables in the home. Source: HFEQ (n=45)

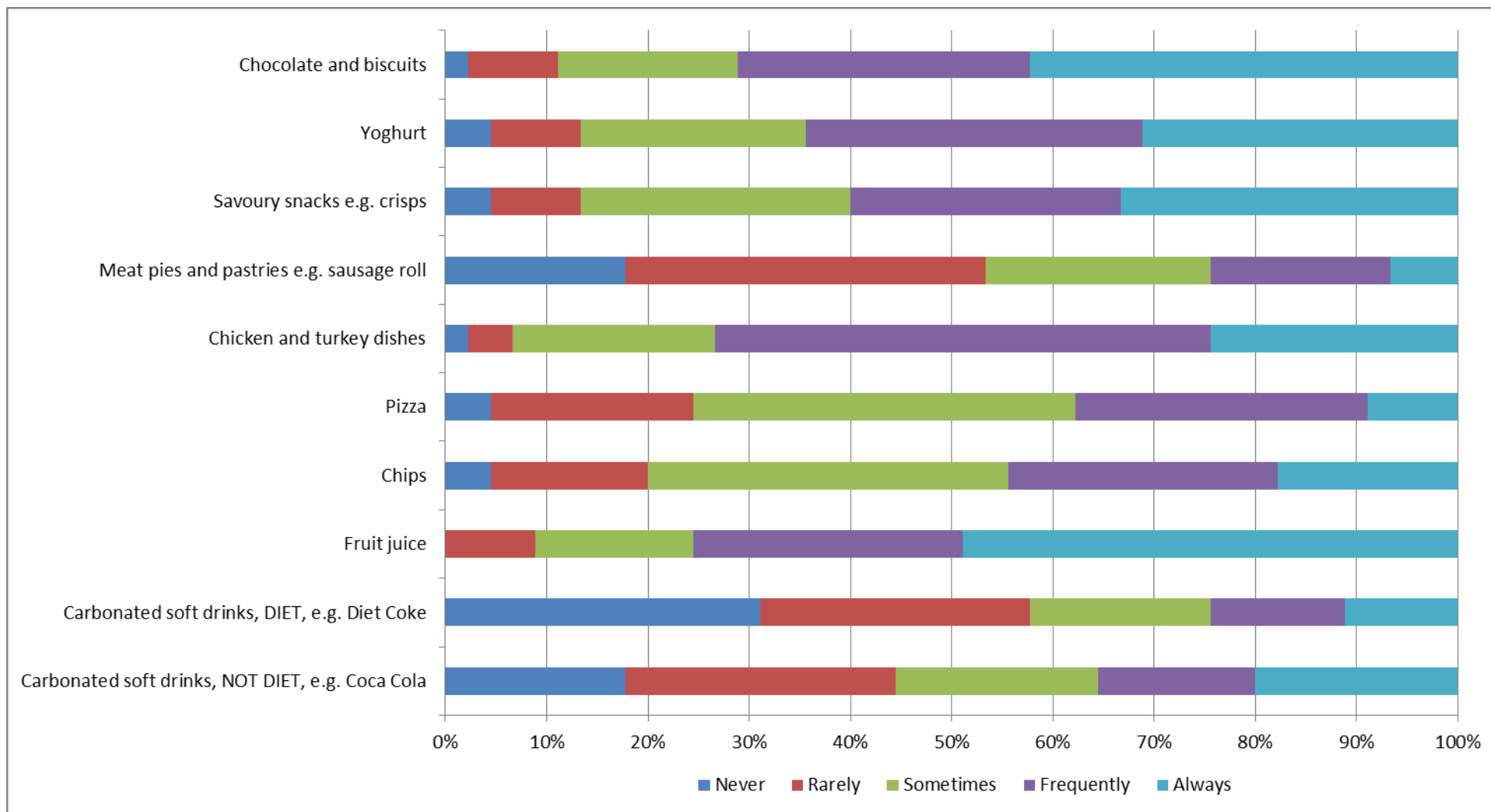


Figure 21 Availability of food items in the home. Source: HFEQ (n=45)

6.5 Alcohol consumption habits

Alcohol consumption habits were explored within the LSQ (section 4.3.6.1). The majority of participants reported infrequent consumption (never or rarely) of all types of alcoholic beverage (Figure 22). No participants reported consuming any type of alcoholic beverage ‘everyday’. Over half of the participants reported ‘never’ drinking wine. The most commonly reported alcoholic beverages consumed were spirits/ liquor and beer with 39% and 30% of participants reporting drinking these ‘every month’ or ‘every week’.

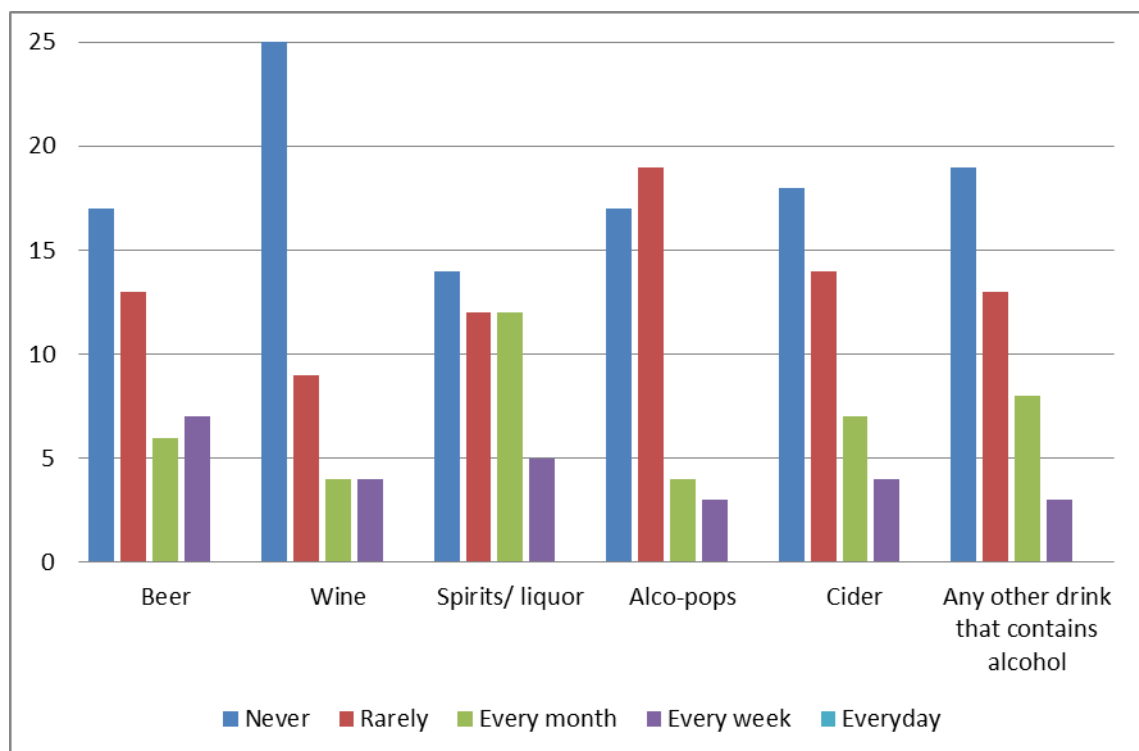


Figure 22 Frequency of alcohol consumption by beverage type. Source: LSQ (n=44)

6.6 Physical activity and sedentary behaviour

Two questions within the LSQ were used to estimate the time participants spent in physical activity and sedentary behaviour. With one exception, all participants reported spending some time in in sedentary screen based activities (such as watching TV, using PC/laptop/games consoles), most reporting ‘2 hours or less’ or ‘3-4 hours’ on both week and weekend days (Figure 23). Few participants reported five hours or more of sedentary screen based behaviour per day.

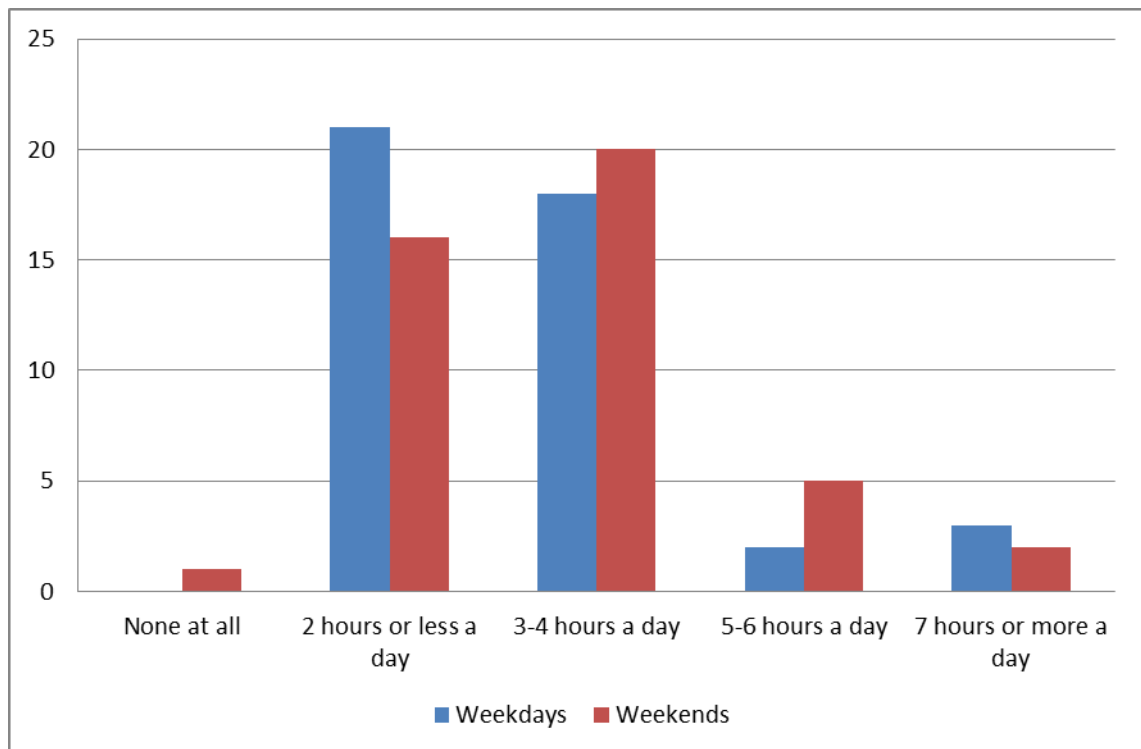


Figure 23 Self-reported number of hours per day spent in screen based sedentary behaviour on weekdays and weekend days. Source: LSQ (n=44)

Participants were asked to estimate the amount of time they were physically active over the previous week. Participants were categorised according to their self-reported physical activity level. Data were dichotomised to give high physical activity (>60 mins \geq 5 days/week) and low physical activity (>60 mins <5 days/week) levels.

Figure 24 shows the reported time spent in physical activity overall, by gender and BMI groups. A third of the young people (33%) reported meeting the recommended guidelines for physical activity, having at least 60 minutes of physical activity on 5 or more days a week (Department of Health, 2004). A greater proportion of males reported physical activity on 5 or more days per week than females. Those participants who were in the 'Healthy and underweight' BMI category reported being physically active on more days than those in the 'overweight and obese' category. However, Chi Squared tests for physical activity level and gender, SES and BMI groups revealed no statistically significant differences.

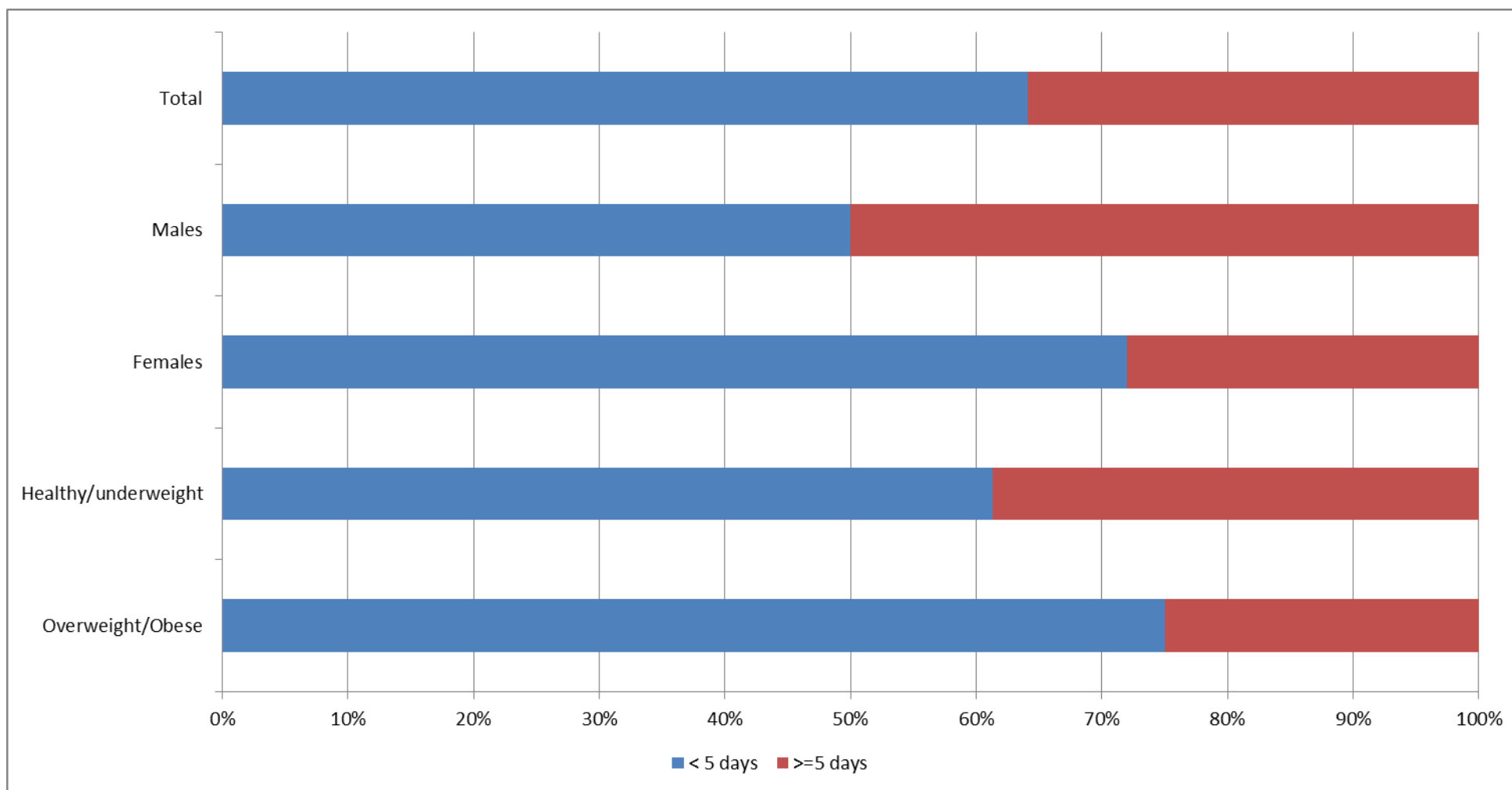


Figure 24 Physical activity: Over the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day? Source: LSQ (n=44)

6.7 Summary

- Participants reported a greater frequency of fast food and restaurants visits with friends compared to family; 16% compared to 7% for fast food and 30% compared to 11% for restaurants for participants reporting visits more than once per week.
- Thirty-eight percent of participants reported eating takeaway or fast food at home more than once per week.
- Almost three quarters of participants reported eating their evening meal at home more than 4 times per week.
- Almost half of participants reported regularly consuming snacks in front of the television; a third reported regularly consuming dinner in front of the television.
- The majority of participants reported no parental rules restricting their consumption of snacks or meals whilst watching television.
- Over half of participants reported having a variety of fruits and vegetables 'usually' or 'always' available in their home.
- 'Never' or 'rarely' were the most common answers for frequency of consumption of all types of alcoholic beverages.
- Most participants reported spending less than 5 hours in sedentary activities on either week or weekend days.
- A third of participants reported reaching the recommended guidelines for physical activity. More males and 'healthy and underweight' participants reported reaching the target than females or those 'overweight and obese' although these differences were not statistically significant.

Chapter 7 Results: Dietary intake and habits

Chapter overview:

- Introduction
- Normality testing
- Dietary intake compared to current recommendations and national averages
- Dietary intake on week and weekend days
- Relationship between dietary intake and adiposity
- Relationship between dietary intake and socio-economic status
- Adolescent Food Habits Checklist results
- Summary

This chapter presents the dietary intake of the study participants as measured by a 4-day food diary (section 4.3.2). The aims of the chapter are: to assess the distribution of dietary intake data; to present the dietary intake data overall and by gender and compare these figures to the current recommended intakes and to appropriate national data; to investigate any differences between week and weekend days; to assess the relationship between dietary intake and BMI and SES; and finally to report the results of the Adolescent Food Habits Checklist (AFHC) and its associations with dietary intake.

7.1 Normality testing

Dietary intake data were tested for normality using histograms with normality curves and the Shapiro-Wilk statistic ($p > 0.05$ was indicative of a normal distribution). Pearson correlation co-efficient and independent sample t-tests were used where data were normally distributed. Spearman rank correlation and Mann-Whitney non-parametric tests were used where the data were non-parametrically distributed. Alcohol and fruit intake had bimodal distributions for non-consumers and consumers and were treated as normal. In addition to total population analysis, these variables were analysed within 'consumers only'.

7.2 Dietary intake compared to current recommendations and national averages

Participants' mean daily dietary intake is reported in this section alongside an analysis of differences in dietary intake by gender. Data from the National Diet and Nutrition Survey (NDNS) (Department of Health, 2011b; Department of Health, 2012) has been included to indicate the national averages for dietary intake by gender. The results of this comparison should be interpreted with caution as the study population (aged 16-19 years) is at the higher end of the NDNS age range (11-18 years). The recommended intakes for nutrients, reported as Dietary Reference Values (DRVs) and Reference Nutrient Intakes (RNIs) are also included.

Male participants had significantly higher energy ($p=0.020$) and food weight ($p=0.002$) intakes than females; however there was no significant difference in energy density (KJ/100g food) between males and females (Table 15). Female participants had significantly higher %E from sugars than males ($p=0.017$). Total %E from fat and alcohol was higher in males than females but the difference was not significant (%E fat 34.2% versus 33.4% and %E alcohol 6.4% versus 4.4%, in males and females respectively).

Table 15 Mean daily dietary intake of all participants and by gender compared to National Diet and Nutrition Survey (NDNS) Rolling Programme figures for 2008/09 – 2010/11 for 11-18 year olds (Department of Health, 2012) (Iron and Vitamin C 2009/10 figures (Department of Health, 2011b)) and UK recommended intakes for young people aged 15-18 years (Department of Health, 1991)

Dietary intake/ day (unit)	Total (n=45)	All NDNS ⁶	Male (n=17)	Male NDNS	Female (n=28)	Female NDNS	Dietary Reference Values/ Reference Nutrient Intakes	
	Mean (SD)	Mean	Mean (SD)	Mean	Mean (SD)	Mean	Male	Female
Food weight (g) ¹	2183 (636)	-	2452 (715)	-	2020 (532)	-	-	
Total energy (MJ) ¹	7.8 (2.9)	7.54	9.5 (3.4)	8.28	6.8 (2.0)	6.76	11.51	8.83
Energy density (KJ/100g) ²	385.7 (105.0)	-	420.1 (97.6)	-	364.8 (107.1)	-	-	
Protein (%E) ¹	13.9 (4.1)	14.9	14.9 (5.9)	15.1	13.2 (2.3)	14.6	Average intake 15% total energy	
Total fat (%E) ²	33.1 (5.7)	33.9	34.2 (4.1)	33.8	32.4 (6.5)	34.1	33% total energy	
Saturated fat (%E) ²	10.6 (3.2)	12.5	10.5 (3.2)	12.6	10.7 (3.2)	12.4	11% total energy	
Carbohydrate (%E) ²	49.6 (7.8)	50.3	47.0 (7.3)	50.2	51.1 (7.8)	50.4	47% total energy	
Total sugars (%E) ²	22.5 (5.3)	21.5	20.2 (4.9)	21.5	24.0 (5.1)	21.5	No recommendation	
Fibre - NSP (g) ¹	8.7 (3.0)	11.8	9.6 (3.3)	12.8	8.2 (2.8)	10.8	18g/ day	
Iron (mg) ¹	8.3 (3.5)	9.9	10.0 (4.4)	10.8	7.2 (2.4)	8.9	11.3mg/ day	14.8mg/ day
Vitamin C (mg) ¹	71.9 (53.2)	84.5	51.9 (32.9)	89.7	84.1 (59.8)	79.0	40mg/ day	
Alcohol (%E) ²	5.1 (7.1)	0.9	6.4 (8.0)	0.9	4.4 (6.5)	0.9	-	
- consumers only ^{2,3}	11.0 (6.6)	6.0	12.2 (7.2)	6.2	10.2 (6.4)	5.8	Average intake 5% total energy	
Alcohol (g) ²	14.2 (20.9)	2.7	19.0 (22.5)	3.0	11.3 (19.6)	2.3	-	
- consumers only ^{2,3}	30.4 (21.0)	18.0	35.8 (18.4)	20.6	26.4 (22.7)	15.3	-	
Fruit (g) ^{2,4}	89.8 (83.4)	157	76.4 (85.3)	165	97.9 (82.6)	150	-	
- consumers only ^{2,5}	115.4 (77.1)	-	108.2 (82.7)	-	119.1 (75.7)	-	-	
Vegetables (g) ¹	71.5 (44.2)	115	59.1 (31.7)	121	79.0 (49.3)	109	-	
Fruit and vegetables (g) ^{2,4}	161.2 (99.6)	177	135.5 (97.4)	182	176.9 (99.3)	172	400g fruits and vegetables	
Fruit & veg portions (n) ²	2.0 (1.2)	2.9	1.7 (1.2)	3.0	2.2 (1.2)	2.8	5x 80g portions/ day	

¹Not normally distributed; means compared using Mann-Whitney test ²Normally distributed; mean compared using independent sample t-test

³Alcohol consumers only; n=21, 9 male, 12 female

⁴NDNS fruit intake calculated using fruit intake plus fruit juice intake, NDNS fruit and vegetable intake does not include fruit juice

⁵Fruit consumers only; n=35, 12 male, 23 female

⁶One sample t-test used to compare mean total sample intake to NDNS

Highlight indicates significant difference between mean total diet and NDNS or between male and female participants ($p < 0.05$)

Total energy intake patterns for study participants were comparable with those reported in the NDNS but lower than the DRV recommended by the Department of Health. As expected, the total food weight and total energy intake were significantly higher for males than females. Participant intake of protein, total fat, carbohydrate, sugars and vitamin C were comparable to the NDNS figures.

Overall, intake of protein was slightly lower than the DRV of 15% energy from protein. Total fat intake of participants met the recommended intake of not more than 33% total energy. Carbohydrate intake was slightly higher than the DRV. Total sugars intake of study participants was comparable to the NDNS figures. However, the intake of sugars was significantly higher for females than for males (24% and 20%, respectively). Overall, vitamin C intake was almost twice the RNI, male intake was lower than that of females although this difference was not significant ($p=0.062$).

Participant intake of saturated fat, fibre, iron, fruit, vegetables and fruit and vegetable portions were significantly lower than those reported in the NDNS ($p<0.05$). In line with NDNS figures, study participants did not meet the recommended intakes of fibre, iron and fruits and vegetables. Although females have a higher RNI for iron than males, females reported a lower mean intake and this approached significance ($p=0.052$).

A higher mean alcohol intake was seen in study participants compared with the NDNS, likely reflecting the older mean age of the current study participants compared to the NDNS sample. For the alcohol consumers group, the mean intake of alcohol (%E) was almost twice the amount recommended by the Department of Health. The alcohol intakes reported in this study were closer to the adult intakes reported in the NDNS than those for young people. The mean daily % energy from alcohol reported in the NDNS for the total population of 19-64 year olds was 5.1 and 8.7% for alcohol consumers only (Department of Health, 2012).

7.3 Dietary intake on week and weekend days

The difference in dietary intake on week and weekend days was explored. The mean for each day type was calculated on an individual basis as individuals reported a range of 2-3 week days and 1-2 weekend days. One individual

recorded intake on four week days only and was excluded from this analysis. Table 16 shows the mean dietary intake on week and weekend days. Paired sample t-tests indicated no significant difference between week and weekend dietary intake.

Table 16 Mean (SD) dietary intake by week and weekend day (n=44)

Dietary intake variable (unit)	Weekday Mean (SD)	Weekend Mean (SD)
Food weight (g)¹	2239 (767)	2135 (749)
Total energy (MJ)¹	8.1 (3.4)	7.8 (3.1)
Energy density (KJ/100g)²	376.6 (160.1)	397.3 (139.8)
Protein (%E)¹	14.1 (4.8)	13.9 (4.2)
Total fat (%E)²	33.3 (7.3)	33.8 (7.1)
Saturated fat (%E)²	11.1 (3.8)	10.4 (3.6)
Carbohydrate (%E)²	49.4 (8.7)	51.8 (15.3)
Total sugars (%E)²	23.2 (7.2)	22.4 (7.7)
Fibre - NSP (g)¹	8.6 (3.9)	8.7 (3.5)
Iron (mg)¹	8.4 (3.6)	8.4 (4.6)
Vitamin C (mg)¹	72.2 (62.0)	71.0 (78.1)
Alcohol (%E)²	4.4 (7.5)	4.7 (11.7)
Alcohol (g)²	17.0 (34.1)	14.1 (31.7)
Fruit (g)²	85.4 (90.6)	84.7 (97.4)
Vegetables (g)¹	71.2 (57.8)	66.7 (53.9)
Fruit & veg portions (n)²	2.0 (1.3)	1.9 (1.5)

7.4 Dietary intake and adiposity

In this section, the relationships between dietary intake and BMI are presented. Correlations between dietary intake variables and BMI as a continuous variable are shown in Table 17.

Table 17 Correlations between mean daily dietary intake and Body Mass Index (BMI)

Dietary intake variable (unit)	BMI	
	<i>r</i> value	<i>p</i> value
Food weight (g) ¹	0.13	0.40
Total energy (MJ) ¹	- 0.26	0.09
Energy density (KJ/100g) ²	- 0.47	<0.01
Protein (%E) ¹	- 0.11	0.49
Total fat (%E) ²	- 0.25	0.10
Saturated fat (%E) ²	- 0.39	0.01
Carbohydrate (%E) ²	0.00	0.99
Total sugars (%E) ²	- 0.11	0.46
Fibre - NSP (g) ¹	- 0.24	0.11
Iron (mg) ¹	- 0.27	0.08
Vitamin C (mg) ¹	0.03	0.84
Alcohol (%E) ²	0.39	0.01
- consumers only ^{2,3}	0.09	0.70
Alcohol (g) ²	0.21	0.17
- consumers only ^{2,3}	- 0.23	0.32
Fruit (g) ²	- 0.15	0.34
- consumers only ^{2,4}	- 0.09	0.61
Vegetables (g) ¹	- 0.12	0.44
Fruit & veg portions (n) ²	- 0.19	0.20

¹Not normally distributed, analysed using Spearman Rank correlation (*r_s*)

²Normally distributed, analysed using Pearson correlation co-efficient (*r*)

³Alcohol consumers only; n=21, 9 male, 12 female

⁴Fruit consumers only; n=35, 12 male, 23 female

Highlight indicates significant correlation (*p*<0.05)

Energy density and saturated fat (%E) were negatively correlated with BMI (Figure 25 and Figure 26), suggesting that those with higher BMI had lower intakes of saturated fat and lower energy density intake. Alcohol (%E) was positively associated with BMI, indicating that those with a greater BMI had a higher alcohol intake (Figure 27). However, no significant association was found within alcohol consumers only.

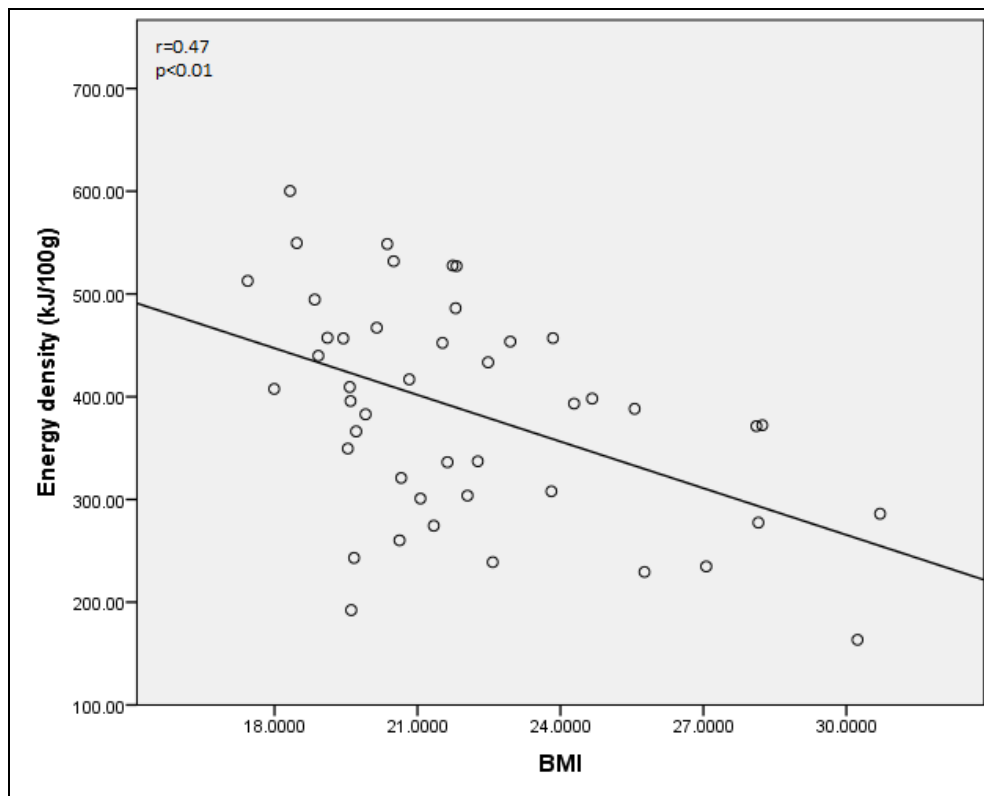


Figure 25 Scatterplot to show the correlation between mean daily energy density (KJ/100g) and BMI (n=45)

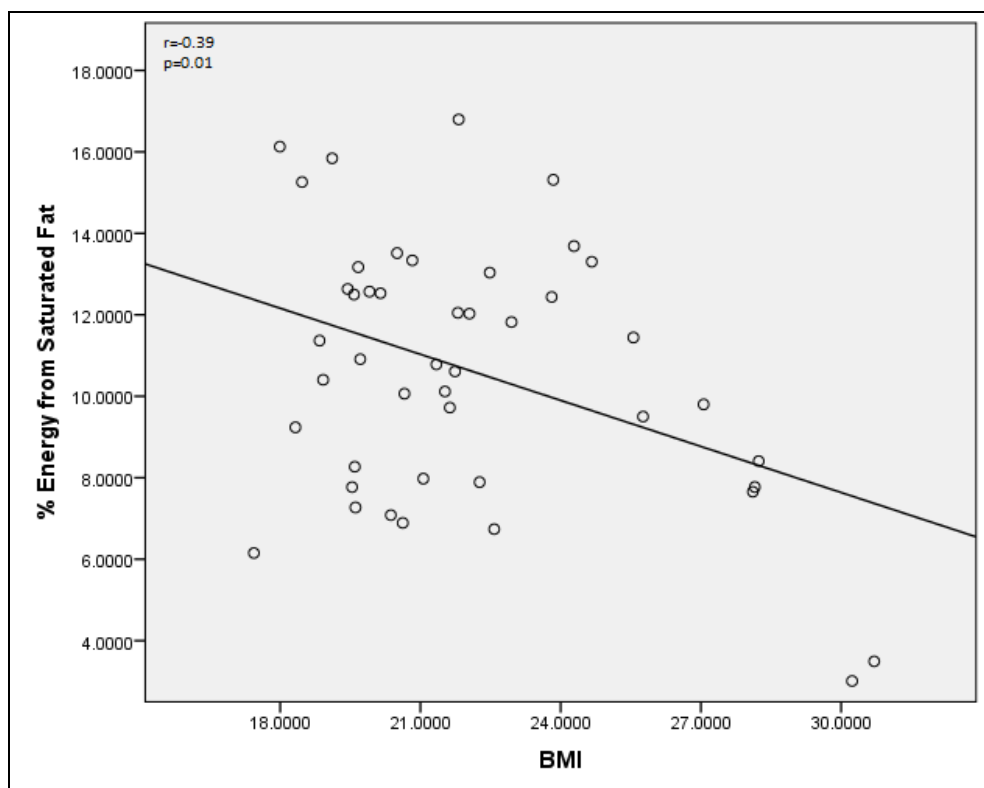


Figure 26 Scatterplot to show the correlation between mean daily of saturated fat (% energy) and BMI (n=45)

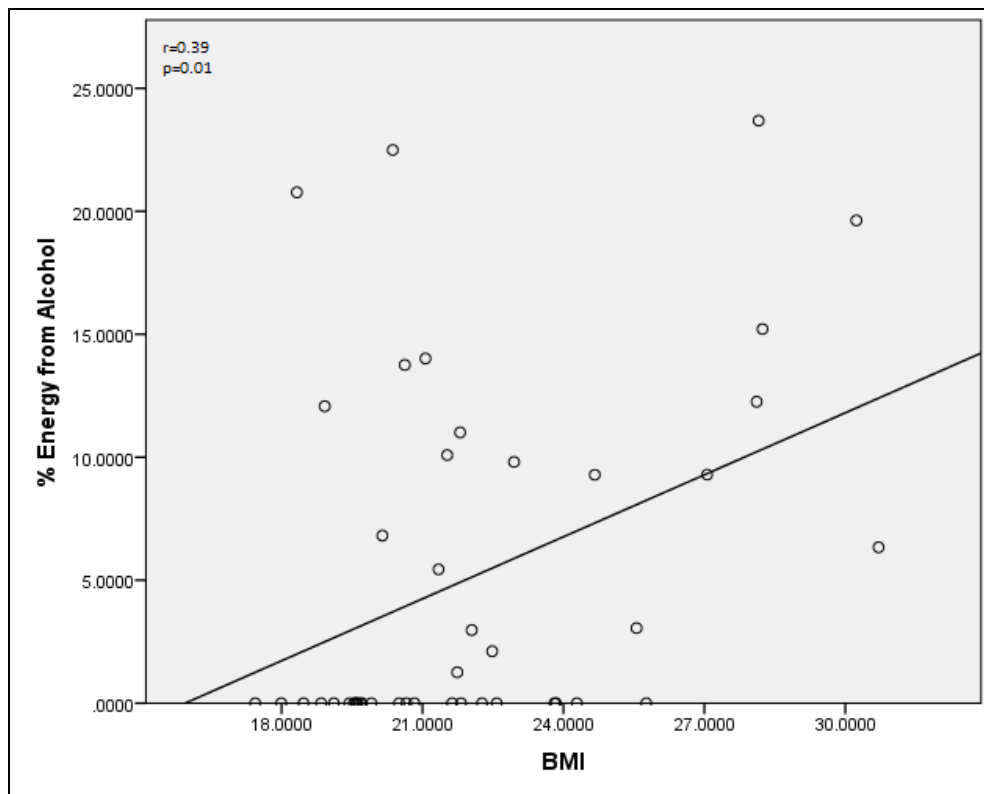


Figure 27 Scatterplot to show the correlation between mean daily of alcohol (% energy) and BMI (n=45)

7.5 Dietary intake and socio-economic status

The relationships between dietary intake variables and socio-economic status (SES) as measured by area level IMD score are shown in Table 18.

Table 18 Correlations between mean daily dietary intake and socio-economic status (IMD score) (n=45)

Dietary intake variable (unit)	Socio-economic status	
	<i>r</i> value	<i>p</i> value
Food weight (g) ¹	- 0.20	0.19
Total energy (MJ) ¹	0.02	0.88
Energy density (KJ/100g) ²	0.36	0.02
Protein (%E) ¹	- 0.26	0.09
Total fat (%E) ²	0.28	0.06
Saturated fat (%E) ²	0.33	0.03
Carbohydrate (%E) ²	- 0.05	0.75
Total sugars (%E) ²	0.05	0.73
Fibre - NSP (g) ¹	0.07	0.64
Iron (mg) ¹	- 0.23	0.13
Vitamin C (mg) ¹	- 0.22	0.15
Alcohol (%E) ²	- 0.05	0.73
- consumers only ^{2,3}	0.19	0.41
Alcohol (g) ²	0.06	0.71
- consumers only ^{2,3}	0.39	0.08
Fruit (g) ²	- 0.36	0.01
- consumers only ^{2,4}	- 0.38	0.03
Vegetables (g) ¹	- 0.10	0.51
Fruit & veg portions (n) ²	- 0.36	0.02

¹Not normally distributed, analysed using Spearman rank correlation (*r_s*)

²Normally distributed, analysed using Pearson correlation co-efficient (*r*)

³Alcohol consumers only; n=21, 9 male, 12 female

⁴Fruit consumers only; n=35, 12 male, 23 female

Highlight indicates significant correlation (*p*<0.05)

Energy density and saturated fat (%E) were positively correlated with IMD score (Figure 28 and Figure 29). This suggests that energy density and %E saturated fat intakes were higher for those living in more socio-economically deprived areas. IMD score was negatively correlated with fruit intake (Figure 30) and fruit and vegetable portions, indicating those living in more deprived areas had both lower fruit intake (g) and consumed a lower number of fruit and vegetable portions per day. The association between fruit intake and IMD score remained when analysed for fruit 'consumers only' group.

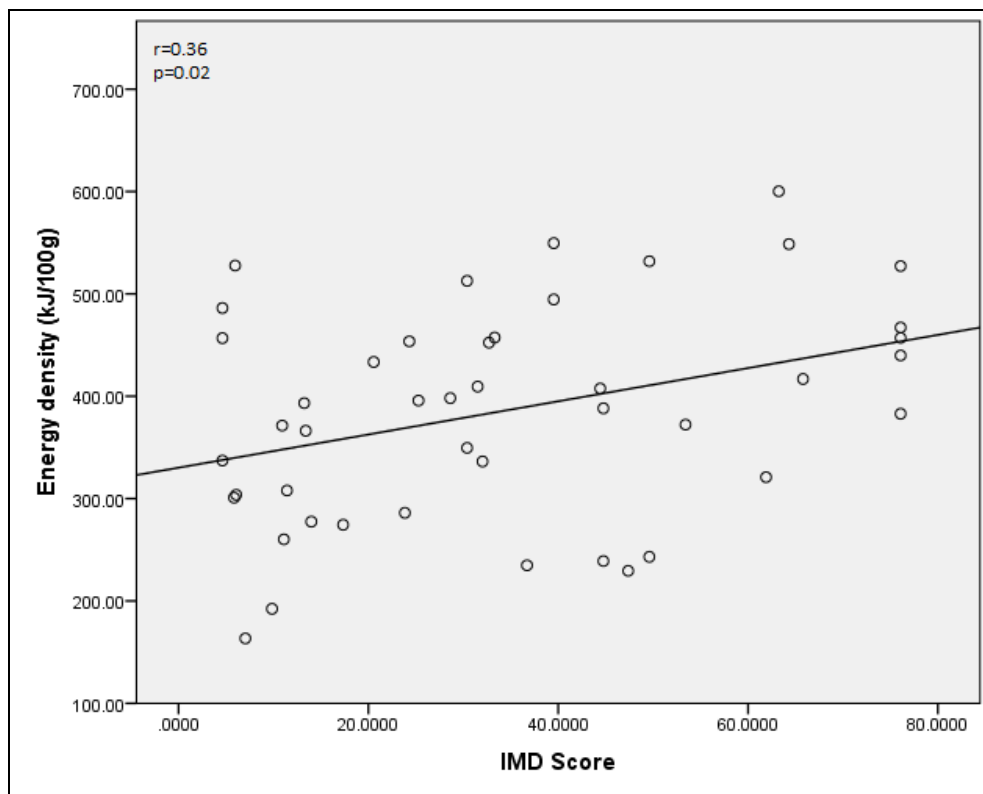


Figure 28 Scatterplot to show the correlation between mean daily energy density (KJ/100g) and socio-economic status (IMD score) (n=45)

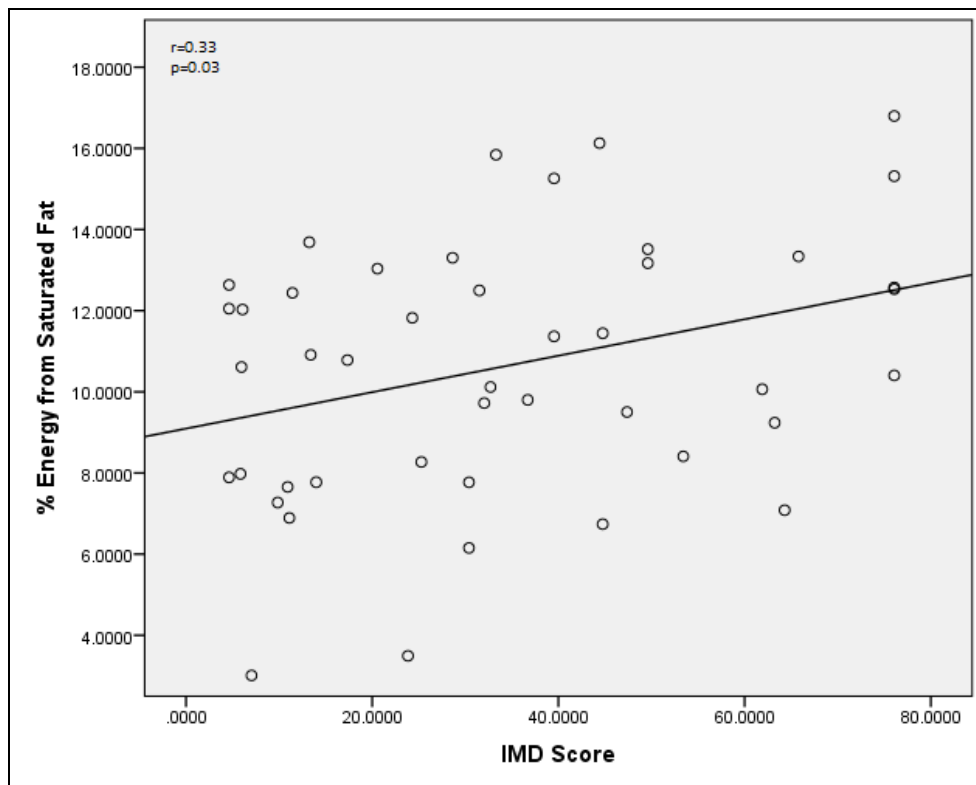


Figure 29 Scatterplot to show the correlation between mean daily intake of saturated fat (% energy) and socio-economic status (IMD score) (n=45)

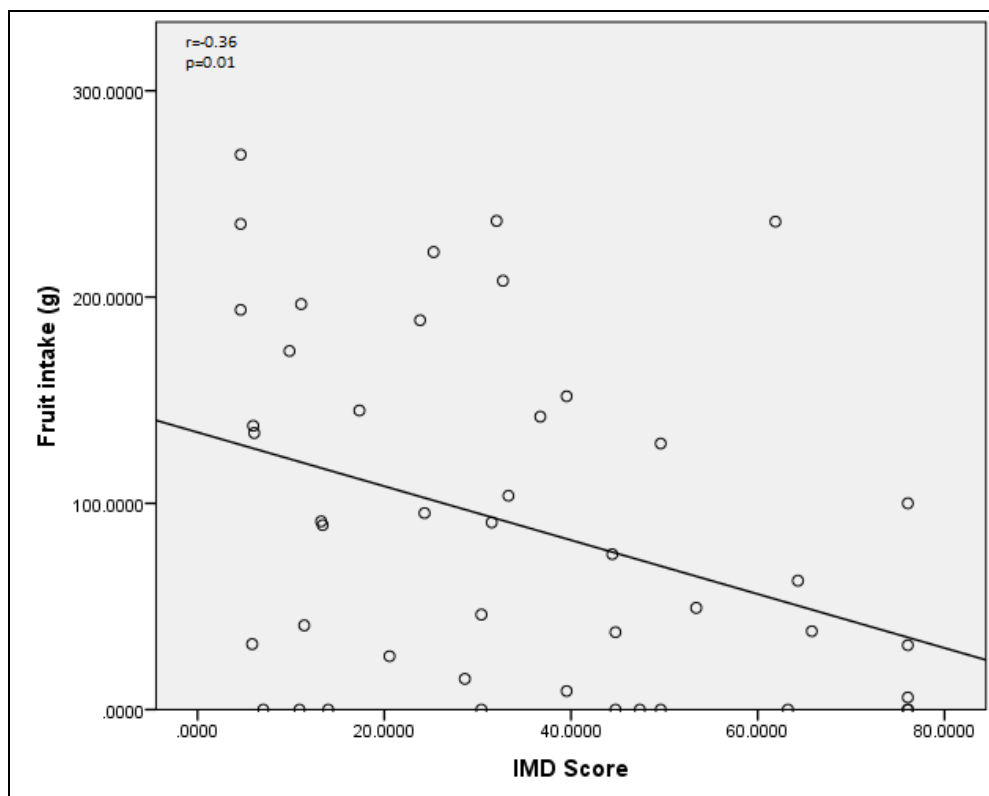


Figure 30 Scatterplot to show the correlation between mean daily intake of fruit (g) and socio-economic status (IMD score) (n=45)

7.6 Adolescent Food Habits Checklist results

The AFHC (see section 4.3.6.3) was used to assess the ‘usual’ food habits of young people. A score was calculated for each individual, a higher score indicates more healthful food habits. Mean AFHC scores overall and for gender, BMI and SES groups are presented in Table 19. No significant differences were found, however the difference between the SES groups was approaching significance, potentially suggesting more healthful food habits in those living in the least deprived areas.

Table 19 Adolescent Food Habit Checklist (AFHC) score overall and by gender, BMI and SES (n=45)

	Mean (SD)	p-value
All	10.9 (5.0)	
Gender		
Male	10.6 (5.2)	
Female	11.1 (5.0)	0.75
BMI		
Healthy and underweight	10.7 (5.0)	
Overweight and obese	11.7 (5.2)	0.61
Socio-economic status		
Low SES ¹	9.5 (4.6)	
High SES ²	12.3 (5.0)	0.05

¹Low SES = participants living in most deprived areas

²High SES = participants living in least deprived areas

When assessed as a continuous variable there was a significant correlation between the AFHC score and mean daily energy intake ($r=-0.36$, $p=0.02$) indicating that more healthful food habits are associated with a lower energy intake (Table 19). The AFHC score was also found to be significantly negatively correlated with SES (IMD score) suggesting that higher area level deprivation is associated with poorer food habits ($r=-0.39$, $p<0.01$).

The AFHC score was examined for relationships with dietary intake (Table 20). AFHC score was negatively associated with energy density and energy, total fat and saturated fat intake, and positively associated with fruit intake and fruit and vegetable portions. These results suggest that the more healthful food habits, as reported using the AFHC, is indicative of a more healthful dietary intake. Although not significant, fibre intake was negatively correlated with AFHC score suggesting that a more healthful food habits are associated with lower fibre intake, opposite to the hypothesised result.

Table 20 Correlations between Adolescent Food Habits Checklist score and mean dietary intake (n=45)

Dietary intake variable (unit)	AFHC score	
	<i>r</i> value	<i>p</i> value
Food weight (g) ¹	0.11	0.46
Total energy (MJ) ¹	-0.31	0.04
Energy density (KJ/100g) ²	-0.53	<0.001
Protein (%E) ¹	0.11	0.48
Total fat (%E) ²	-0.42	<0.01
Saturated fat (%E) ²	-0.33	0.03
Carbohydrate (%E) ²	0.13	0.38
Total sugars (%E) ²	0.27	0.07
Fibre - NSP (g) ¹	-0.28	0.07
Iron (mg) ¹	-0.07	0.66
Vitamin C (mg) ¹	0.18	0.25
Alcohol (%E) ²	0.04	0.80
- consumers only ^{2,3}	0.10	0.67
Alcohol (g) ²	-0.12	0.44
- consumers only ^{2,3}	-0.09	0.69
Fruit (g) ²	0.39	0.01
- consumers only ^{2,4}	0.41	0.02
Vegetables (g) ¹	0.07	0.66
Fruit & veg portions (n) ²	0.39	0.01

¹Not normally distributed, analysed using Spearman rank correlation (*r_s*)²Normally distributed, analysed using Pearson correlation co-efficient (*r*)³Alcohol consumers only; n=21, 9 male, 12 female⁴Fruit consumers only; n=35, 12 male, 23 female**Highlight** indicates significant correlation (*p*<0.05)

7.7 Summary

- As expected, males had significantly higher food weight and energy intakes than females.
- Females had significantly higher intake of total sugars than males.
- Mean daily energy intake of participants was comparable to NDNS values and below the DRV.
- Overall, total fat and saturated fat intake was lower than the national average and met the DRVs (less than 33% energy from fat, 11% from saturated fat).
- In line with NDNS figures, study participants did not meet the recommended intakes of fibre (NSP), iron and fruits and vegetables.

- The mean intake of alcohol (%E) for the alcohol consumer group was almost double the amount recommended by the Department of Health.
- Alcohol intake figures reported in this study were closer to those reported for the adult NDNS population of 19-64 year olds than those for 11-18 year olds.
- BMI was negatively correlated with energy density and saturated fat intake.
- BMI was significantly positively associated with %E from alcohol, although this relationship was not significant when non-consumers of alcohol were excluded.
- Lower SES was significantly associated with higher energy density, higher saturated fat intake and lower intakes of fruit (g) and portions of fruit and vegetables.
- The AFHC score was significantly associated with SES indicating that those living in less deprived areas tended to have more healthful food habits.
- AFHC score was significantly negatively correlated with energy density, total energy, total fat and saturated fat intake and positively correlated with fruit intake and fruit and vegetables portions indicating that the intake of nutrients associated with health was associated with more healthful dietary habits.

Chapter 8 Results: Identifying and characterising the source of food

Chapter overview:

- Introduction
- Identifying and describing the food sources used by young people
- Describing the source of food in relation to the eating location
- Exploring the relationship between food source and dietary intake
- Energy and nutrient density by food source
- Summary

This chapter aims to identify the food sources used by young people and give an indication of how often these sources are used, by whom in terms of gender, BMI status and SES, and whether different food sources are visited on week and weekend days. The chapter goes on to describe the relationship between food source and eating location. In terms of dietary intake, the contribution of each food source to the mean daily dietary intake is explored and then finally the nutrient density of food from each of identified sources is explored.

8.1 Identifying and describing of the food sources used by young people

A total of 1053 eating events were reported by the participants over 4 days, representing a mean of 23 eating events per person (range 11–42), and 5.9 eating events/ person/ day (range 2.75–10.5) (Table 21). Number of eating events was weakly but significantly positively correlated with BMI ($r=0.30$, $p<0.05$) but was not associated with SES. There were no significant differences in the mean number of eating events reported by gender, BMI groups, or SES groups.

Eating events were placed into five food source categories based on information recorded in food diaries (Table 21). Food source data were missing for seven eating events; these were excluded from further analysis, leaving 1046 (99%) eating events over the 4-day study period. All participants used 'home' as a source of food at least once. The majority of participants (96%) used a 'food outlet' as a source of food at least once over the 4-day study period. The least used food source was 'work' with only 11% of participants

reporting accessing food from/at work in their food diary; this represented a third of those reporting having part time jobs.

Table 21 Total and mean number of Eating Events (EE) by food source over 4 days and per day for total study population and users only

	Total eating events n (%)	Mean EE/ day (all) (SD)	Users n (%)	Mean EE/ day (user) (SD)
All food sources	1053	5.9 (1.7)	-	-
Home	648 (62)	3.6 (1.5)	45 (100)	3.6 (1.5)
Food Outlet¹	210 (20)	1.2 (0.8)	43 (96)	1.2 (0.8)
School	91 (9)	0.5 (0.5)	34 (76)	0.7 (0.5)
Friend/ relative's home	79 (8)	0.4 (0.6)	24 (53)	0.8 (1.6)
Work	18 (2)	0.1 (0.3)	5 (11)	0.9 (0.5)

¹Food outlets include all retail outlets including shops and restaurants that participants visited themselves for food purchases. It does not include food purchased by parents/ guardians for home preparation.

For 62% of eating events, food was sourced from the home. The second most common food source was 'food outlets', accounting for 20% of eating events.

Figure 31 shows the contribution of the five identified food sources to the total eating events reported by all study participants, by gender, BMI groups and SES groups.

The mean proportion of eating events from 'home' was significantly greater for females than males ($p=0.05$) and males obtained a significantly greater proportion of eating events from 'work' than females ($p=0.03$). The mean proportion of eating events from 'school' was significantly greater for the low SES group than for the high SES group ($p=0.02$). No statistically significant differences between BMI groups were found.

The differences in contribution of food source eating events for week and weekend days was also explored (Figure 32). As expected, the main difference between the eating event profiles was the use of school as a food source on week days. There was no apparent shift in the proportion of any one food source to replace school food at a weekend.

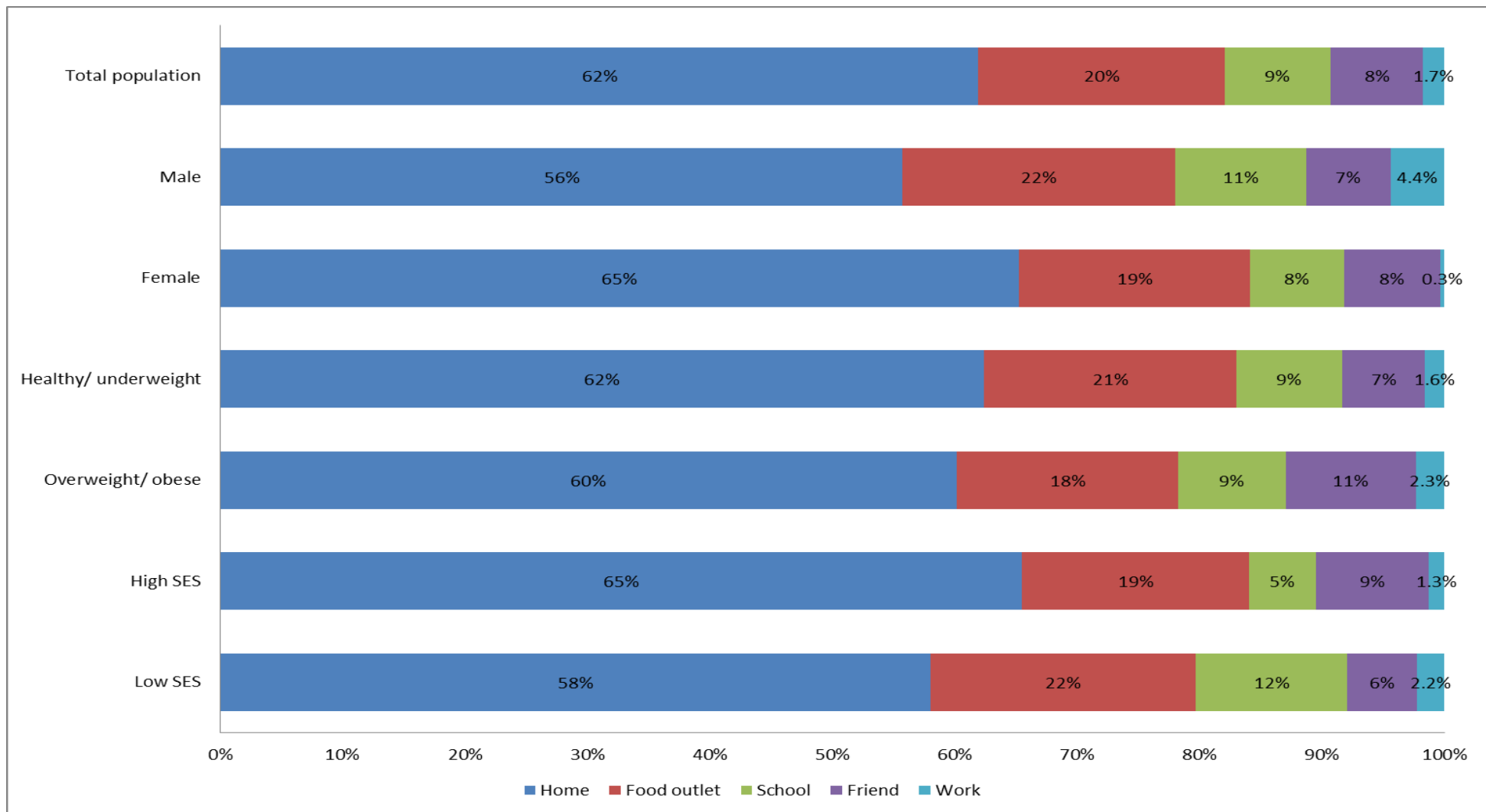


Figure 31 Contribution of food source to total eating events, overall and by gender, BMI and SES groups (n=45)

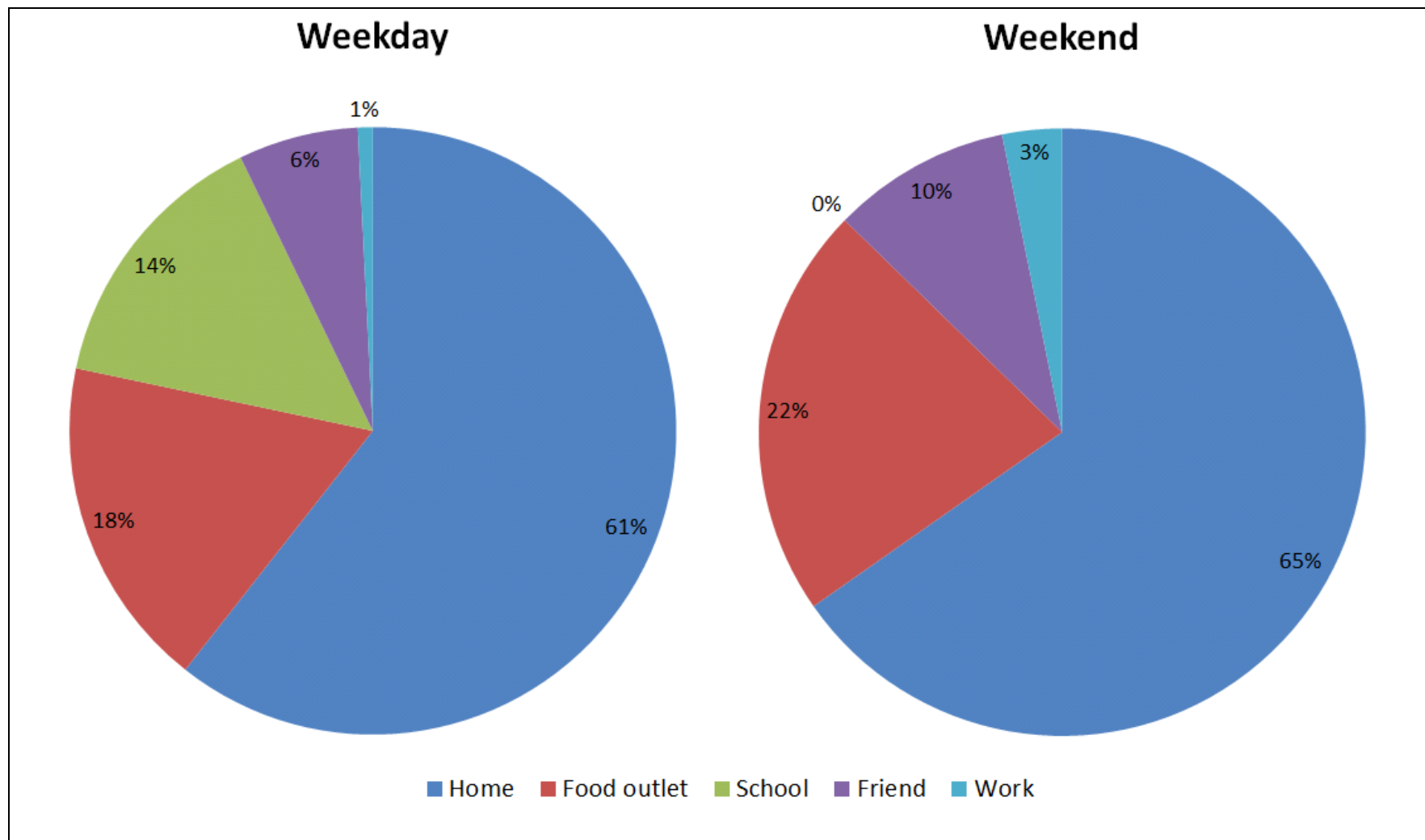


Figure 32 Contribution of food source to total eating events for week and weekend days (n=45)

8.2 Describing the source of food in relation to the eating location

This section explores the links between the five food source and seven eating location categories. Figure 33 shows the complex relationship between where food is sourced and subsequently consumed (eating location).

For the 'home', 'friend', 'school', and 'work' food sources, the main eating location matched the source of food. For example, for 86% of eating events where food was sourced from 'home', the food was also consumed at 'home'; similarly, 97% of eating events from school were also eaten at school.

Food sourced from 'food outlets' showed the greatest variation in terms of eating location. Only a quarter of the eating events sourced from 'food outlets' were also consumed within 'food outlets'. Twenty-three percent of the eating events sourced from 'food outlets' were consumed in the home. An additional 17% of 'food outlet' eating events were consumed in 'other' locations, for example eating takeaway fish and chips at the seaside.

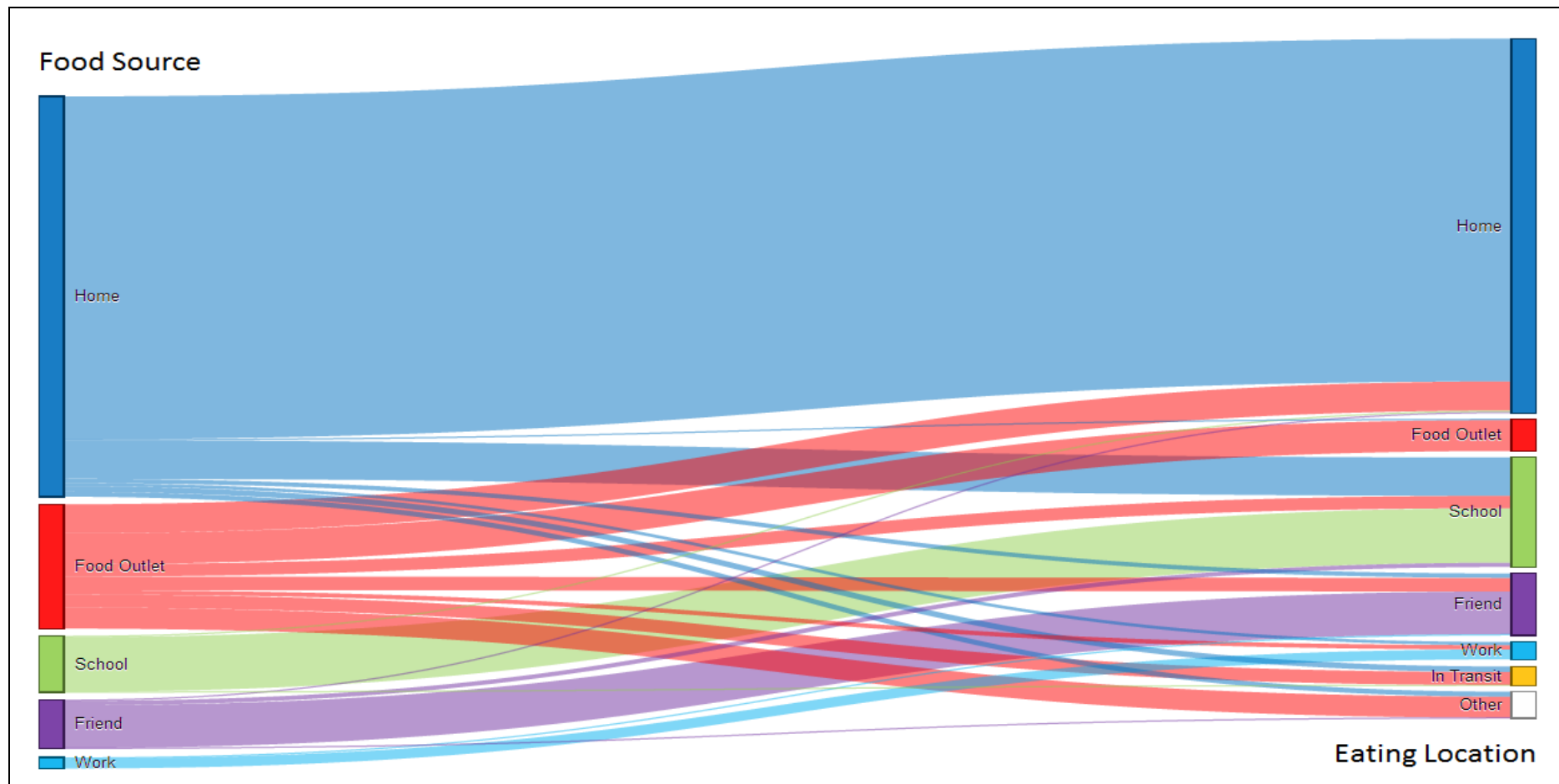


Figure 33 Sankey diagram showing the flow of eating events from food source to eating location¹¹

¹¹ Acknowledgement for Sankey diagram JavaScript and d3.js to Mike Bostok (<http://bost.ocks.org/mike/>), accessed via <http://ramblings.mcpher.com/Home/excelquirks/d3/sankey>, and Dave Smith for generating the diagram from these PhD study data.

8.3 Exploring the relationship between food source and dietary intake

This section outlines the contribution of each food source to the overall dietary intake of participants. The mean contribution of each of the five food sources to the total dietary intake for the whole population is seen in Figure 34, with additional analyses for fruit and alcohol amongst 'consumers only' (n=35 and n=21 respectively).

The majority of food by weight was sourced from 'home' and in line with this the majority of nutrients were also sourced from 'home'. Alcohol was the exception to the rule, 'food outlets' and 'friends' were identified as the most prominent sources.

For the majority of nutrients, the percentage contribution of food source to the dietary intake (Figure 34) is in line with the figures seen for eating events (see Figure 31). Food outlets provide almost a third of the intake of total fat and saturated fat. The majority of alcohol intake was sourced from either food outlets or friends' (and relatives') homes. In contrast, less than half of the total alcohol intake was sourced from home. The home was the main source for both fruit and vegetables. Food outlets provided a greater proportion of vegetables (16%) than fruits (4%); this is likely to be explained by the tendency for vegetables to be included as ingredients in meals or side dishes whereas fruit is often consumed as a snack.

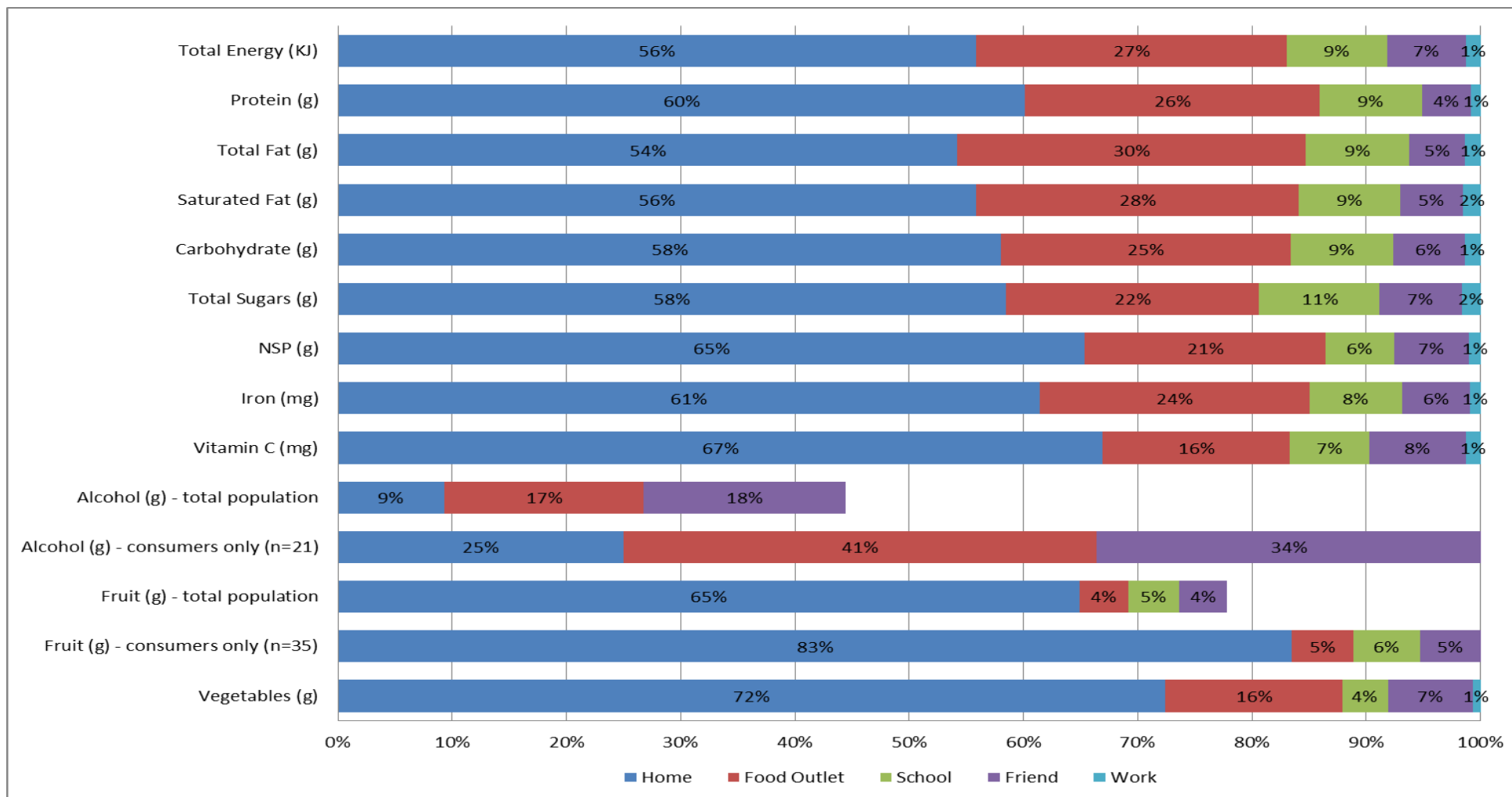


Figure 34 Mean contribution of food source to total dietary intake (n=45)

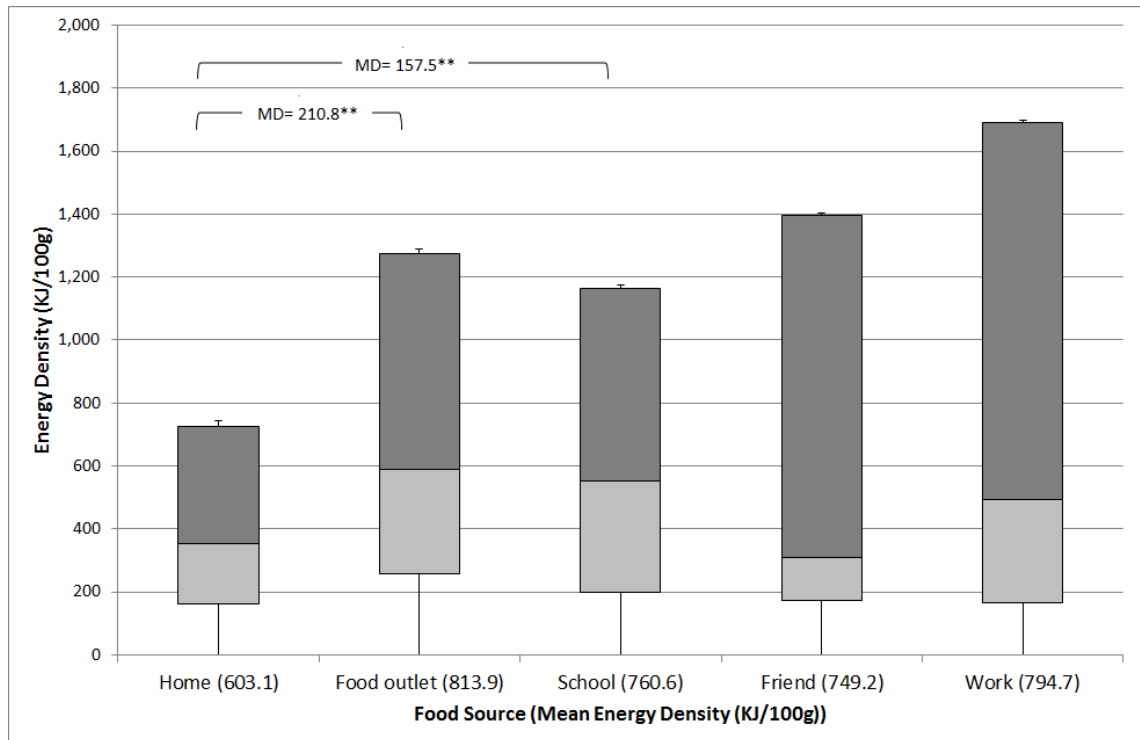
8.4 Energy and nutrient density by food source

This section presents a comparison of the energy and nutrient density of food obtained from the five identified food sources. Energy density was calculated as KJ/100g of food for each identified eating event. The nutrient density is presented per MJ of energy provided by each food source. Kruskal-Wallis non-parametric ANOVA tests were used to investigate differences between the mean energy and nutrient density for each food source. The median, 25th and 75th centiles and the data range are depicted in box plots (Figures 34-41), shown only for those nutrients where a significant result was found ($p < 0.05$). The mean figures for each food source are presented within the food source labels.

Nutrient densities for energy, protein, carbohydrate, fibre (NSP), iron, and vitamin C were found to be highly significantly different between the food source groups ($p < 0.005$). The nutrient density for total fat and sugars was also statistically significantly different between the food source groups ($p < 0.05$). Significant differences between the mean values for the food source groups are highlighted in figures 34-41.

'Food outlets' had the highest energy density of the five food sources with a mean of 8.1 KJ/100g food. The least energy dense food was that sourced from 'home' with a mean of 6.0 KJ/100g. Food sourced from 'food outlets' and 'school' were found to be significantly higher in energy density than food sourced from 'home' (Figure 35)

Figure 35 Energy density (KJ/100g food) by food source



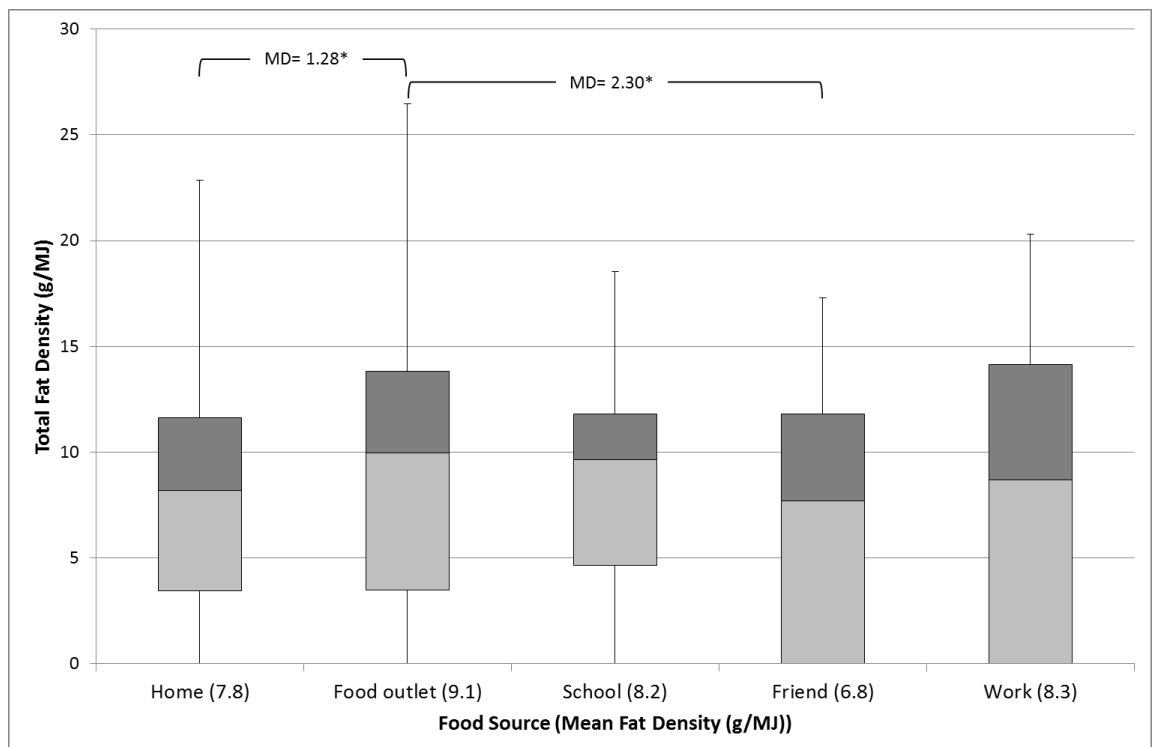
Boxplot shows median, 25th and 75th centiles and data range.

MD= difference between means

*statistically significant difference between means where $p < 0.05$

**statistically significant difference between means where $p < 0.01$

Figure 36 Nutrient density: Total fat density per MJ energy by food source



Boxplot shows median, 25th and 75th centiles and data range.

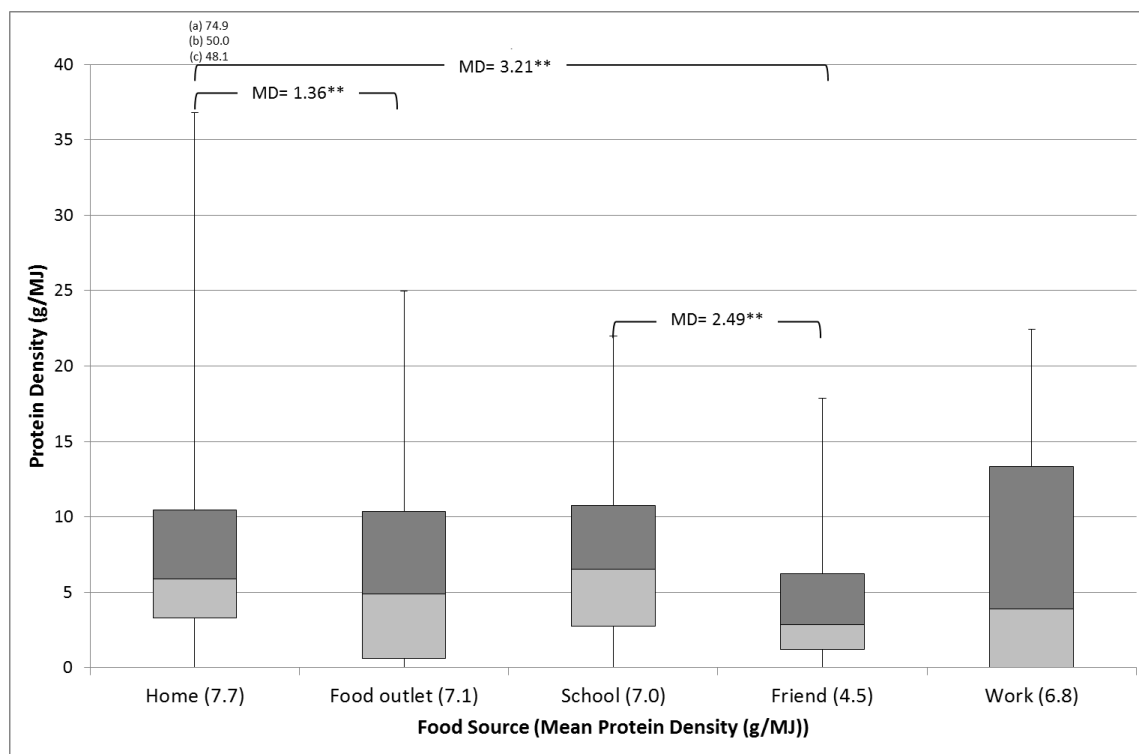
MD= difference between means

*statistically significant difference between means where $p < 0.05$

**statistically significant difference between means where $p < 0.01$

'Food outlets' had the highest mean density of fat (9.1g/MJ); this was significantly higher than mean fat density from 'home' and 'friend' (7.8 and 6.8 respectively, Figure 36).

Figure 37 Nutrient density: Protein density per MJ energy by food source



Boxplot shows median, 25th and 75th centiles and data range.

MD= difference between means

*statistically significant difference between means where $p < 0.05$

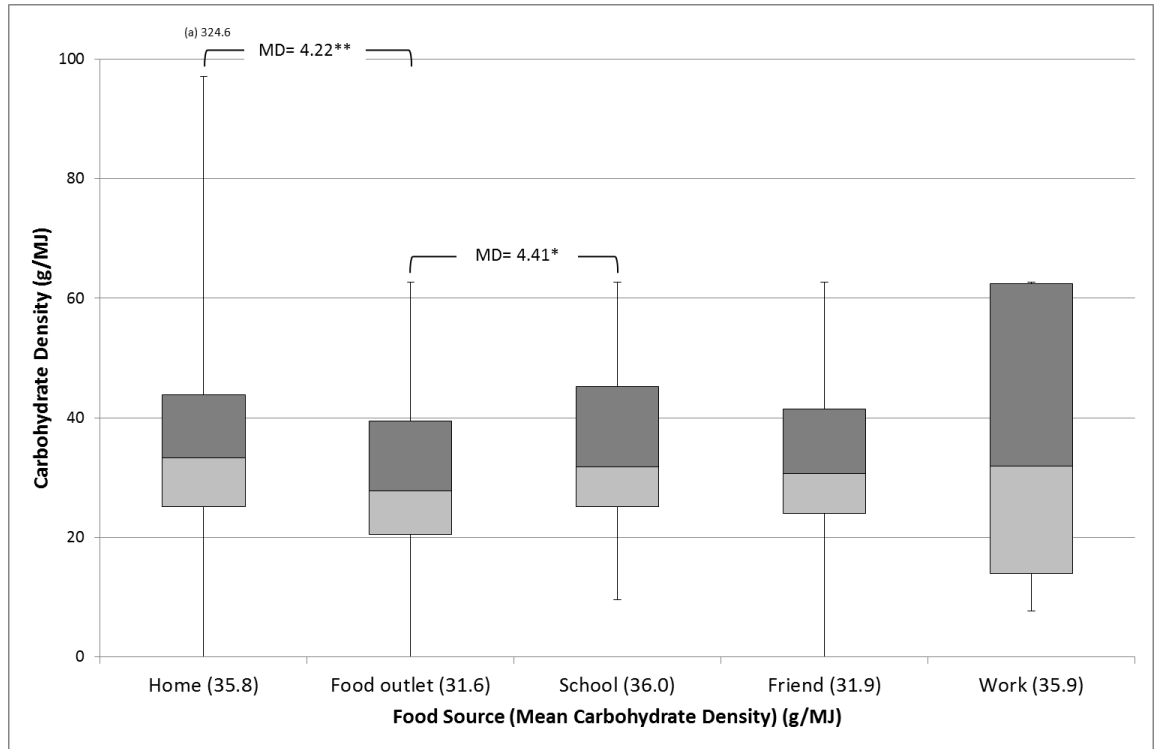
**statistically significant difference between means where $p < 0.01$

(a) Recovery drink (b) black tea (c) chicken slices

The food source with the lowest protein density was 'friend'. This was found to be significantly lower than 'home' and 'school' (Figure 37).

Food sourced from 'home' and 'school' had significantly higher carbohydrate densities than food sourced from 'food outlets' (Figure 38).

Figure 38 Nutrient density: Total carbohydrate density per MJ energy by food source



Boxplot shows median, 25th and 75th centiles and data range.

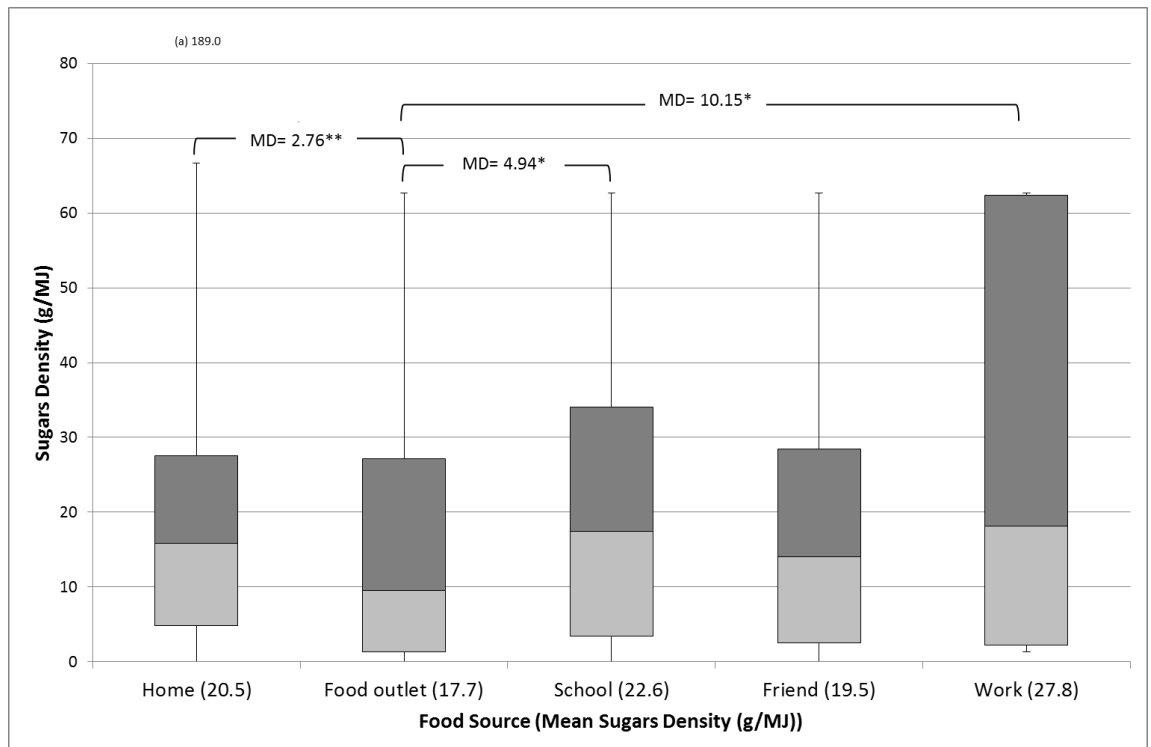
MD= difference between means

*statistically significant difference between means where $p < 0.05$

**statistically significant difference between means where $p < 0.01$

(a) Recovery drink

Figure 39 Nutrient density: Total sugars density per MJ energy by food source



Boxplot shows median, 25th and 75th centiles and data range.

MD= difference between means

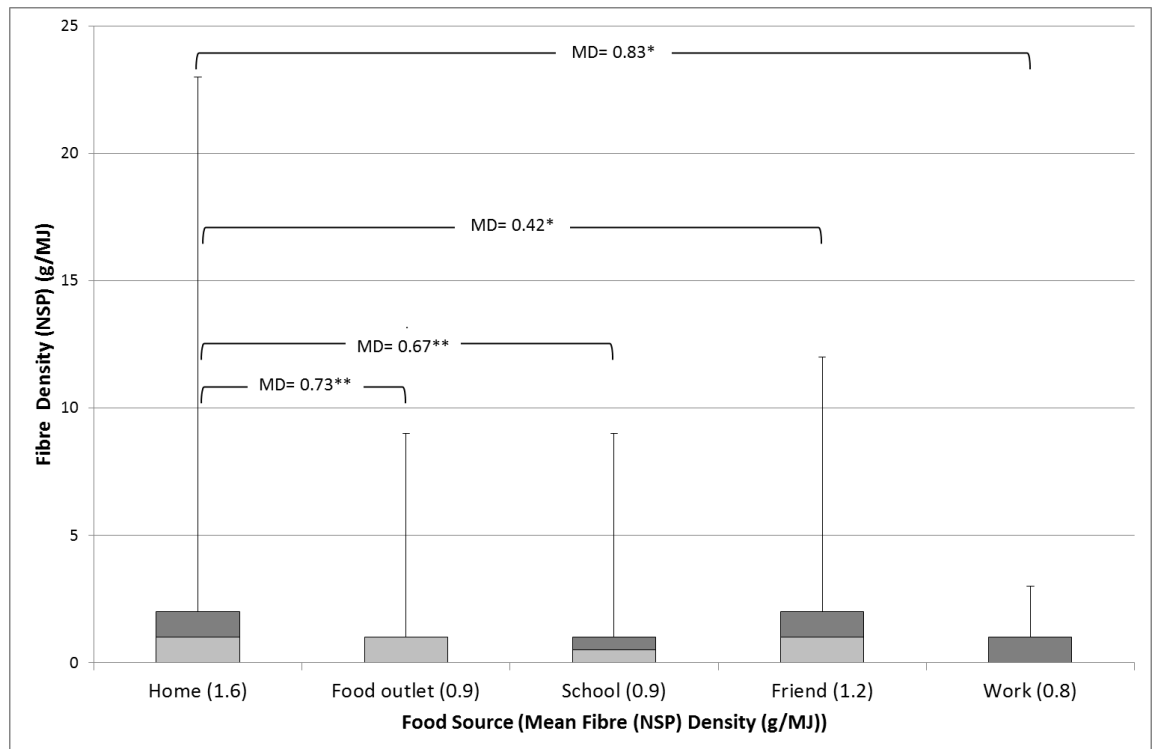
*statistically significant difference between means where $p < 0.05$

**statistically significant difference between means where $p < 0.01$

(a) Recovery drink

Food sourced from 'food outlets' had the lowest sugars density; significantly lower than 'home', 'school' and work'. The mean sugars density for work food was the highest of the food sources. Food sourced from 'home' had the highest density of fibre. This was significantly higher than the mean nutrient density of fibre obtained from all other food sources.

Figure 40 Nutrient density: Fibre (NSP) density per MJ energy by food source

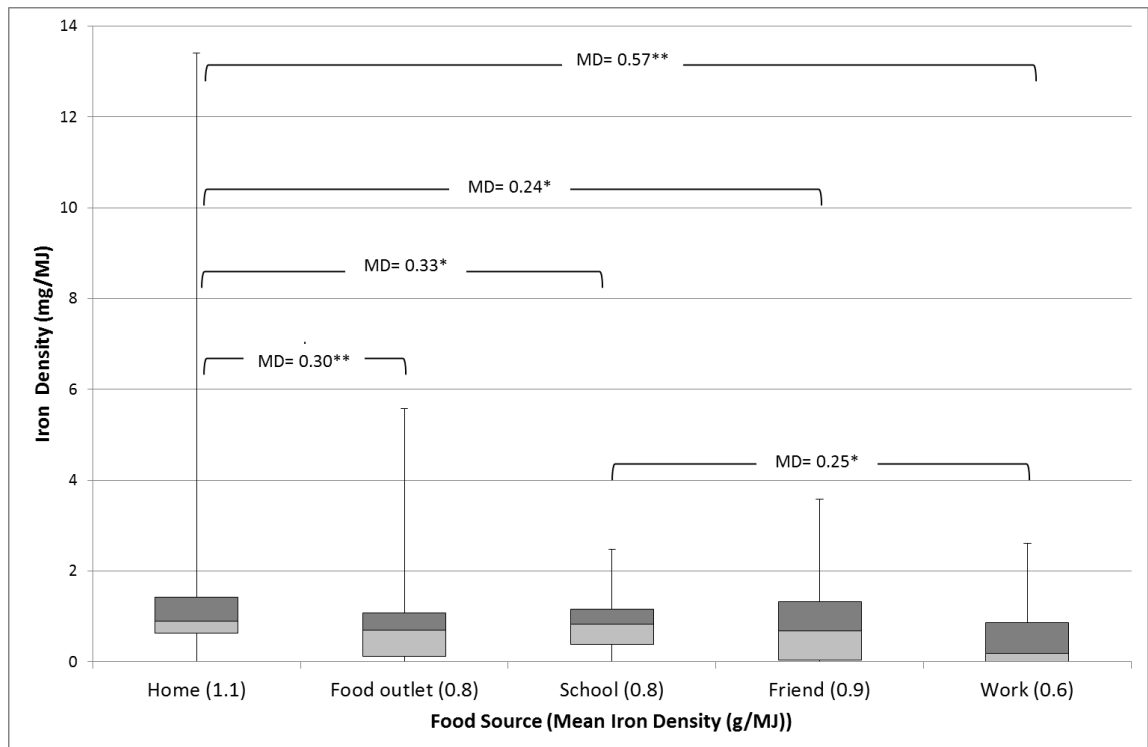


Boxplot shows median, 25th and 75th centiles and data range.

MD= difference between means

*statistically significant difference between means where $p < 0.05$

**statistically significant difference between means where $p < 0.01$

Figure 41 Nutrient density: Iron density per MJ energy by food source

Boxplot shows median, 25th and 75th centiles and data range.

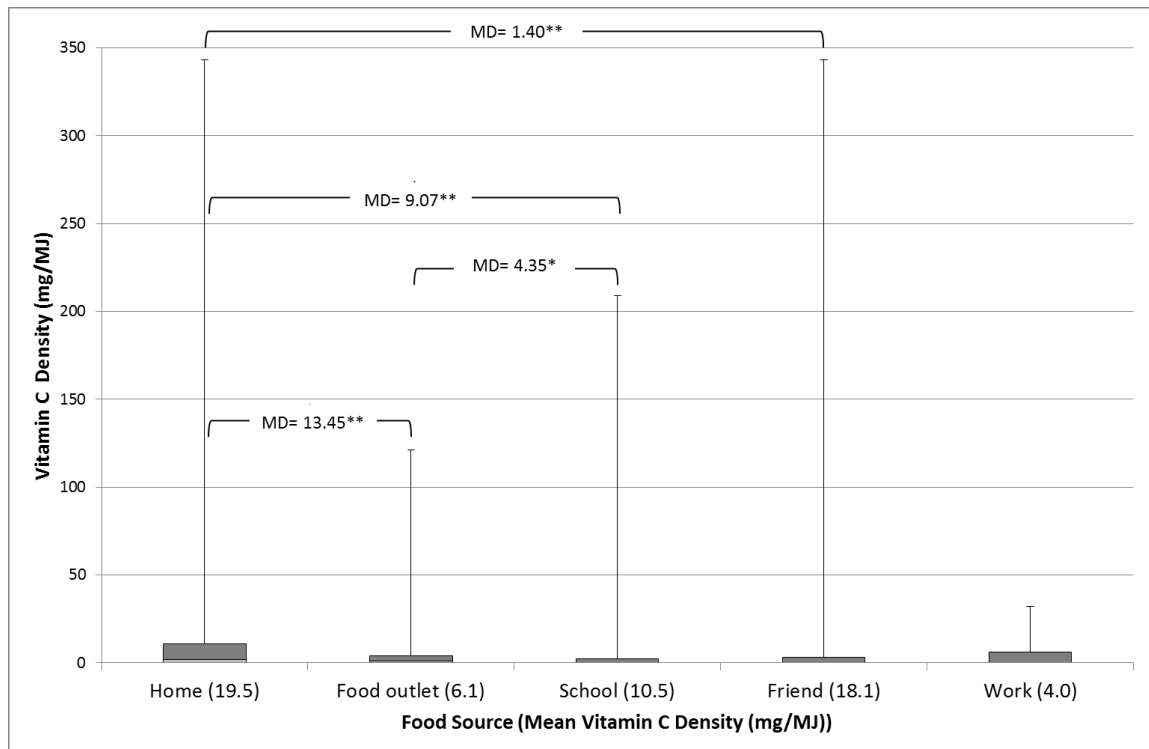
MD= difference between means

*statistically significant difference between means where $p < 0.05$

**statistically significant difference between means where $p < 0.01$

The nutrient density of iron was highest in food sourced from 'home'; significantly higher than that seen in all other food sources. In addition, nutrient density of iron for 'school' food was significantly higher than for food sourced from 'work' (Figure 41).

Similarly, vitamin C density was greatest for food sourced from 'home', significantly higher than 'food outlet', 'school' and 'friend'. Food sourced from 'school' was significantly higher in vitamin C density than food from 'food outlets' (Figure 42).

Figure 42 Nutrient density: Vitamin C density per MJ energy by food source

Boxplot shows median, 25th and 75th centiles and data range.

MD= difference between means

*statistically significant difference between means where $p < 0.05$

**statistically significant difference between means where $p < 0.01$

8.5 Summary

- 20% of eating events are sourced from food outlets, second in popularity to home (62%).
- School was the only food source to be used on weekdays only. The remaining four food sources remained proportionally equal over the 4 days.
- Only a quarter of food sourced from food outlets is consumed within food outlets, 23% was consumed at home as takeaway meals and snacks.
- The main sources of alcohol were food outlets and friends' and relatives' homes.
- Home was the main source of fruit and vegetables; a greater proportion of vegetables than fruit were sourced from food outlets.
- Food sourced from 'food outlets' was high in fat but low in protein, carbohydrate and sugars.
- Results from the nutrient density analysis suggest that eating events sourced from 'home' were the 'most healthful' with food from home

containing the highest levels of iron, vitamin C and protein when compared to the other food sources.

- Food outlet eating events were highest in energy density and total fat and low in fibre, iron and vitamin C.

Chapter 9 Results: Relationship between the Visited Food Environment and dietary intake

Chapter overview:

- Introduction
- Describing the visited food outlet environment using food outlet classification categories
- Nutrient density and the food outlet environment
- Visited food outlet environment and dietary intake
- Summary

Over a third of food was sourced from outside of the home (38%). Of this, half was obtained from 'food outlets'. This chapter presents a detailed description of the food outlet environment visited by young people over the 4-day study period. It goes on to explore the relationship between the visited food environment (VFE) and dietary intake. Finally, results from the Measuring Food Environment surveys exploring the 'healthiness' of the food outlet environments are presented.

9.1 Describing the visited food environment using food outlet classification categories

The food outlets used as a source of food for participants were classified into 15 food outlet categories (section 4.4.3). Two participants did not visit any food outlets over the 4-day study period and were subsequently excluded from the food outlet analysis. All analyses in this section were therefore based on data for 43 participants. The proportion of eating events recorded in participant food diaries according to food outlet classification are presented in Table 22.

Table 22 Food outlet classification category use: total number of users (n), total count (n) and percentage contribution (%) of eating events in each food outlet category; mean, standard deviation (SD), range of food outlet eating events per user of the food outlet category

Food outlet classification category	Users	Eating events				
	n	n	%	Mean*	SD*	Range*
Traditional eateries						
Traditional/pub/hotel restaurant	15	26	12.4	1.73	0.80	1–3
Sit-in café/coffee/sandwich shop	8	10	4.8	1.25	0.46	1–2
Health and Leisure	4	9	4.3	2.25	1.26	1–4
Takeaway eateries						
Takeaway café/coffee/sandwich shop	6	8	3.8	1.33	0.52	1–2
Retail Baker	7	9	4.3	1.29	0.49	1–2
Takeaway and fast food outlet	28	54	25.8	1.93	1.02	1–4
Mobile food and market	0	0	-	-	-	-
Grocery outlets						
Supermarket	18	30	14.4	1.67	0.91	1–4
Specialist supplier (e.g. butcher)	3	4	1.9	1.33	0.58	1–2
Convenience & incidental outlets						
Convenience store	20	38	18.2	1.90	1.92	1–9
Vending machine	1	1	0.5	1.00	-	-
Non-food store (e.g. post office)	6	9	4.3	1.50	0.84	1–3
Entertainment (e.g. cinema, library)	4	6	2.9	1.50	0.58	1–2
Closed/private/age restricted outlets						
Pub (no food)	2	2	1.0	1.00	0.00	1–1
Closed/private outlet (e.g. social club)	2	3	1.4	1.50	0.71	1–2
Total	43	210	100	4.9	3.05	1-13

*Note that the mean, standard deviation and range are presented for users only, not total population.

Three food outlet categories made up over half of the eating events; ‘takeaway and fast food’ (25.8), ‘convenience store’ (18.2%) and ‘supermarket’ (14.4%). ‘Takeaway and fast food outlet’ was recorded as the source of food on twice as many occasions as ‘traditional/pub/hotel restaurants’.

The 15 food outlet categories were amalgamated into five overarching food outlet types: Traditional eateries; Takeaway eateries; Grocery outlets; Convenience and incidental outlets; and Closed/private/age restricted outlets. Figure 43 shows the mean contribution of each food outlet type to the total food outlet eating events recorded by participants, by gender, BMI and SES groups.

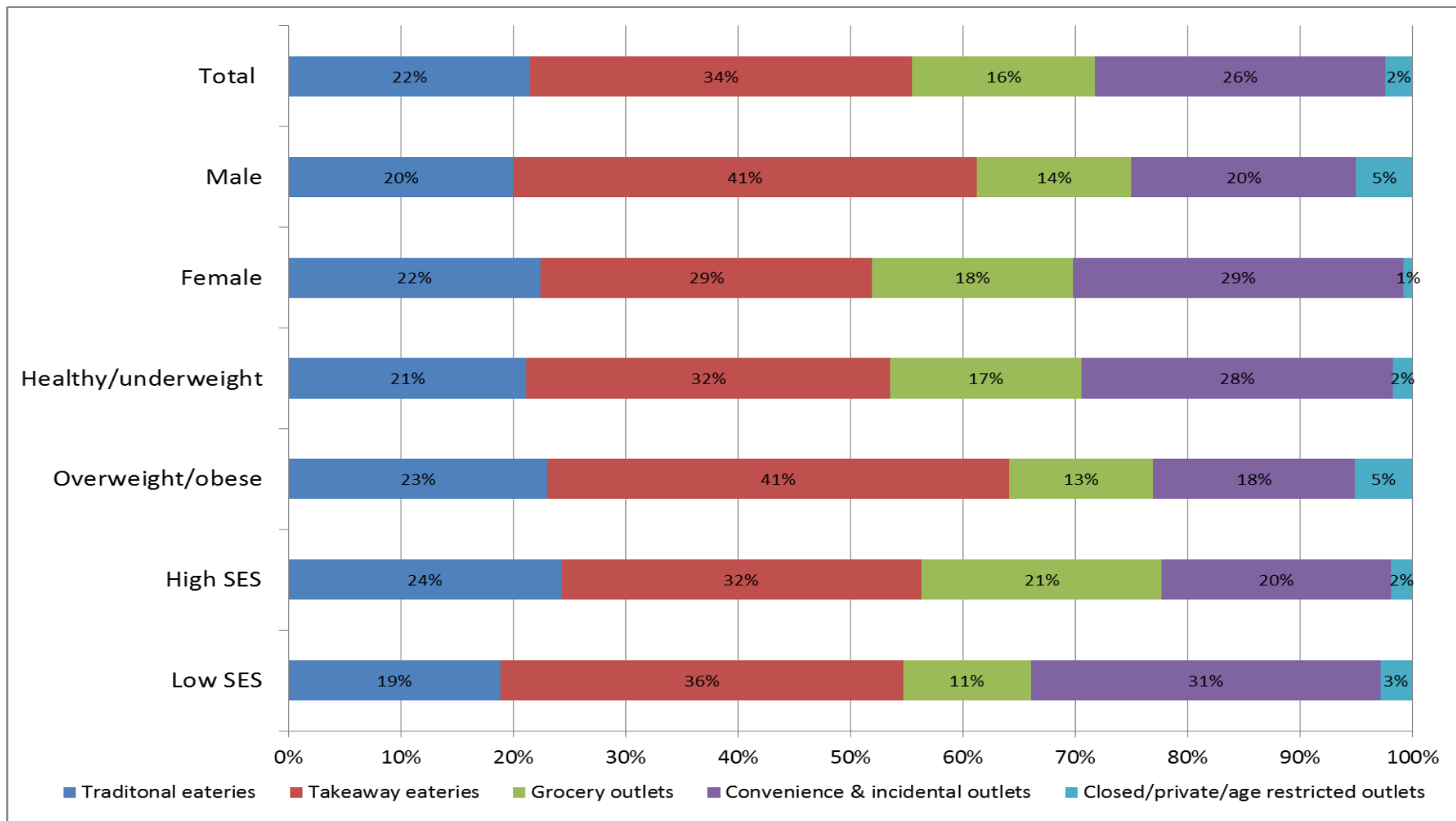


Figure 43 Mean proportional contribution of food outlet types to food outlet eating events overall, by gender, BMI and SES groups

Although the data in Figure 43 suggests differences in the mean proportions of food outlet eating events by food outlet category, no significant differences between the gender, BMI or SES group means were found.

As only a small number of food outlet eating events (2%) were obtained from closed/private/age restricted outlets, the following analysis was conducted excluding this category. Examples of the types of meals obtained from the four food outlet categories are presented in Figures 43-45 as photographs taken by the study participants.



Figure 44 Food photographs taken by participant of food sourced from traditional eateries



Figure 45 Photographs taken by participants of food sourced from takeaway eateries



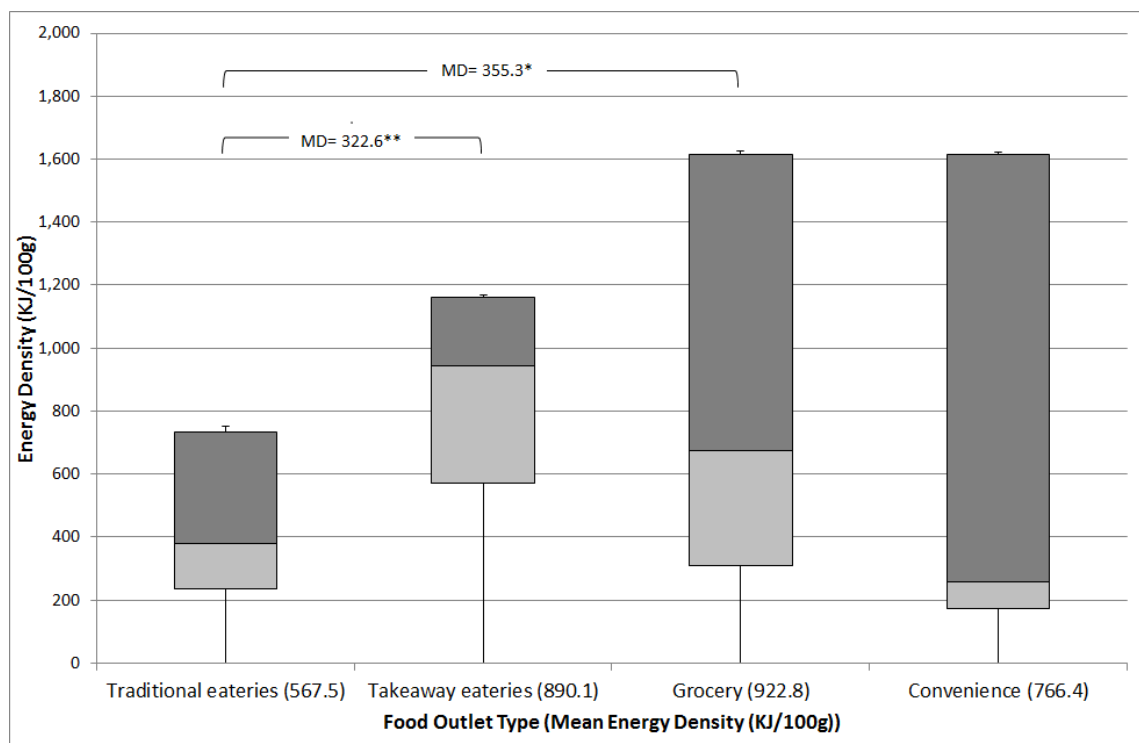
Figure 46 Photographs taken by participants of food sourced from grocery outlets and convenience outlets

9.2 Nutrient density and food outlet environment

The analysis presented in this section shows the energy and nutrient density of food obtained from different types of food outlet calculated by eating event. Energy density was calculated for each eating event as the KJ present per gram of food. The density of nutrients per MJ of energy was also calculated. The mean values from the four identified food outlet groups (traditional eateries, takeaway eateries, grocery, and convenience). The median, 25th and 75th centiles and the data range are depicted in box plots (Figures 46-53), shown only for those nutrients where a significant result was found. Statistical differences between the mean values for the food outlet types are highlighted within the figures.

The mean nutrient density for total fat, saturated fat, protein, carbohydrate, sugars, and iron was found to be highly significantly different between the food outlet types ($p < 0.01$). Mean energy density and nutrient density of fibre were also significantly different between the food outlet types ($p < 0.05$).

Figure 47 Energy density (kJ/100g) by food outlet type



Boxplot shows median, 25th and 75th centiles and data range.

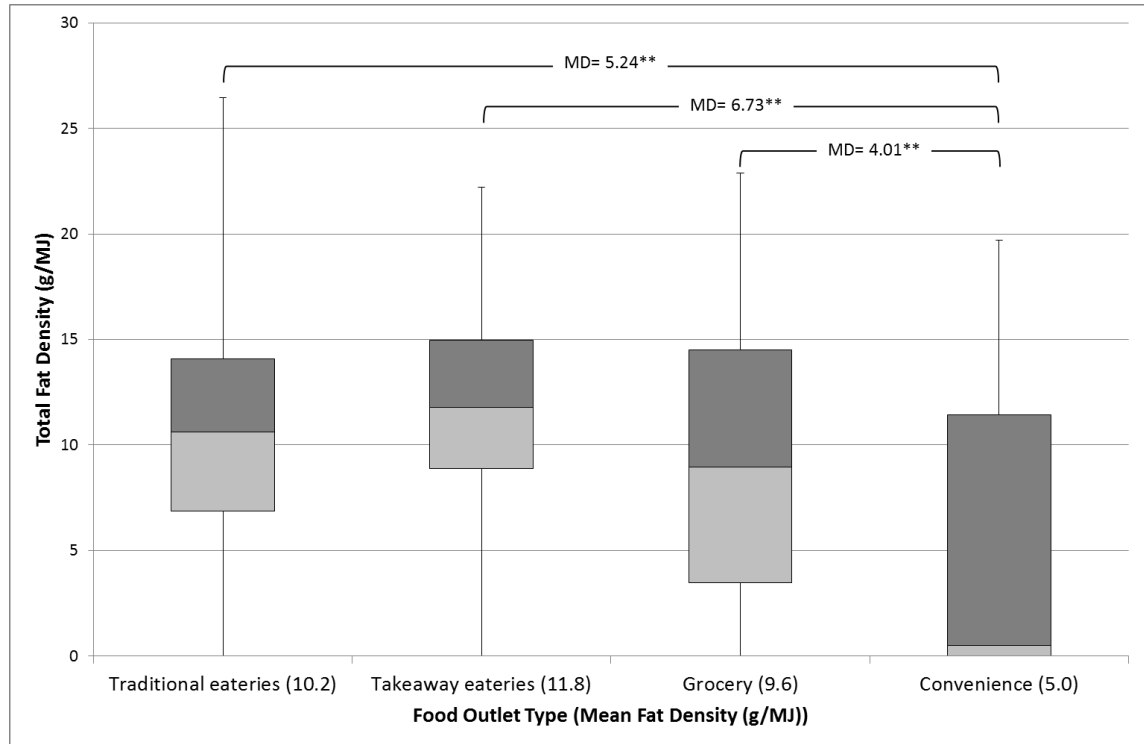
MD= difference between means

*statistically significant difference between means where $p < 0.05$

**statistically significant difference between means where $p < 0.01$

The energy density of food sourced from 'traditional eateries' was significantly lower than food obtained from 'takeaway eateries' and 'grocery' (Figure 47). Food from 'convenience' outlets had the lowest total fat density, significantly lower than 'traditional eateries', 'takeaway eateries' and 'grocery' (Figure 48). The same pattern was seen for saturated fat (Figure 49).

Figure 48 Nutrient density: Total fat density per MJ energy by food outlet type

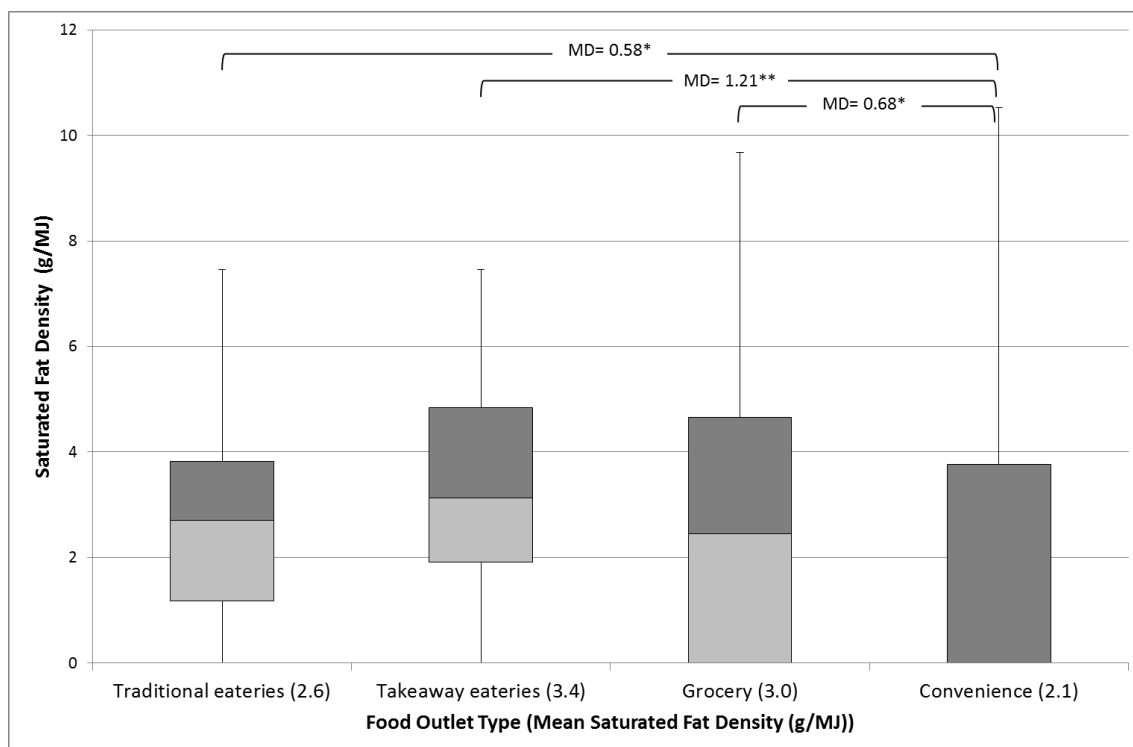


Boxplot shows median, 25th and 75th centiles and data range.

MD= difference between means

*statistically significant difference between means where $p < 0.05$

**statistically significant difference between means where $p < 0.01$

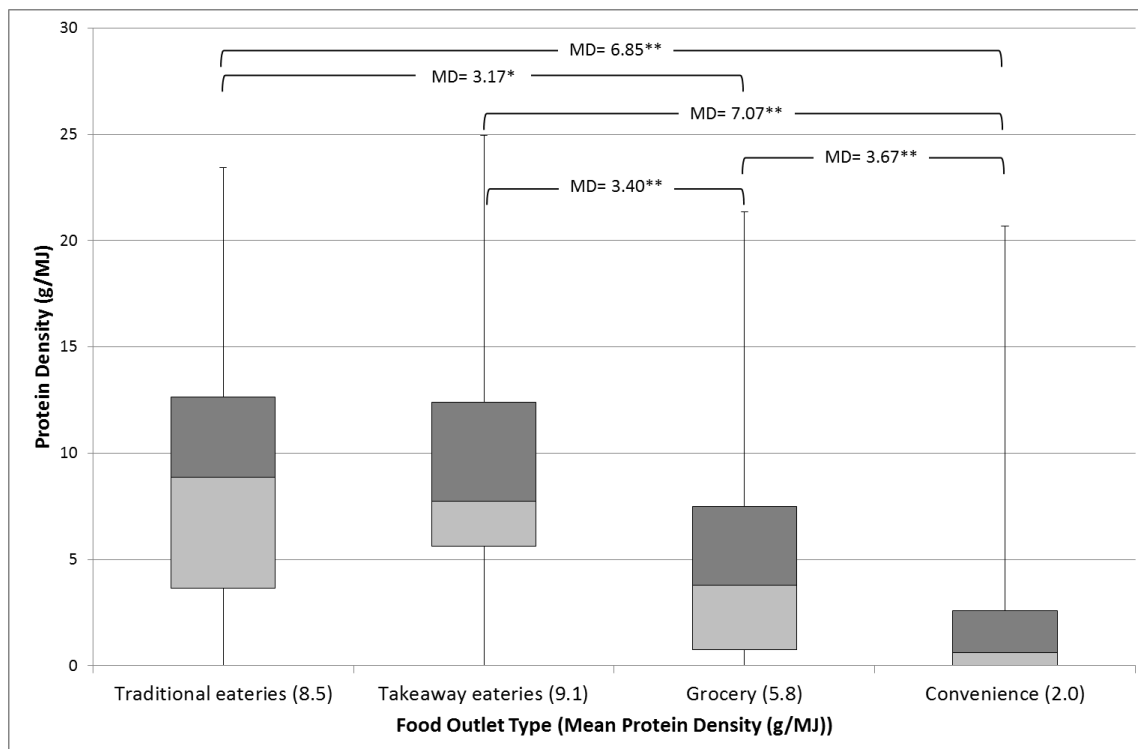
Figure 49 Nutrient density: Saturated fat density per MJ energy by food outlet type

Boxplot shows median, 25th and 75th centiles and data range.

MD= difference between means

*statistically significant difference between means where $p < 0.05$

**statistically significant difference between means where $p < 0.01$

Figure 50 Nutrient density: Protein density per MJ energy by food outlet type

Boxplot shows median, 25th and 75th centiles and data range.

MD= difference between means

*statistically significant difference between means where $p < 0.05$

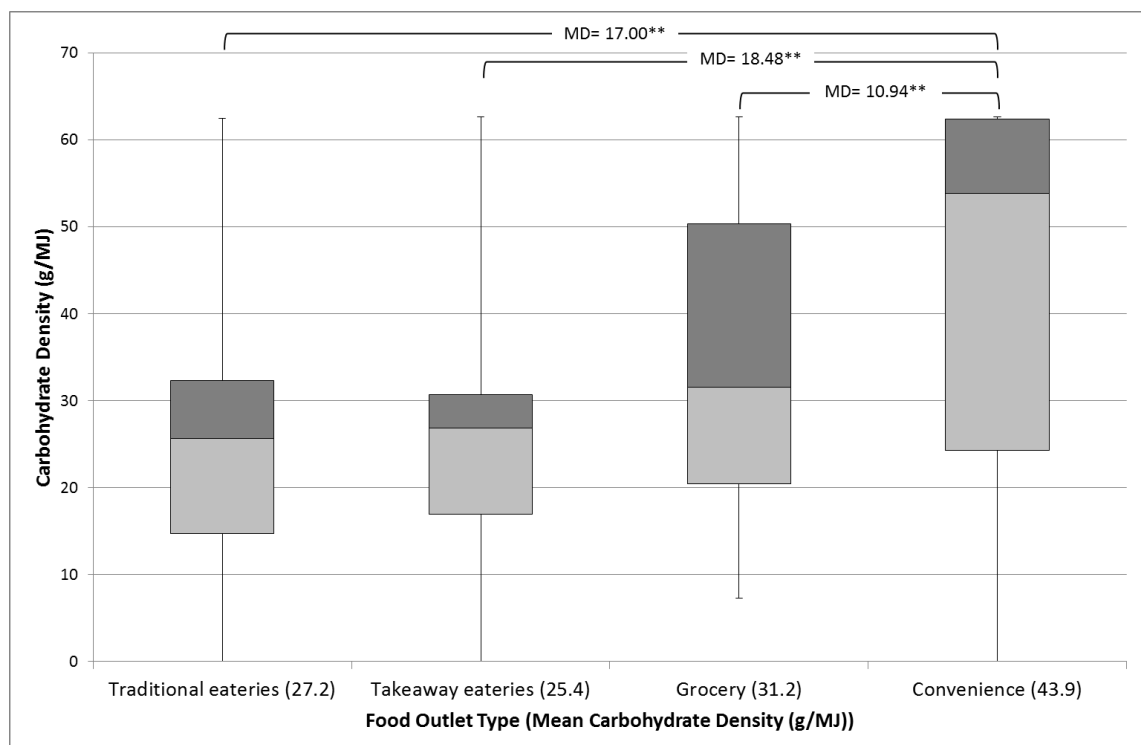
**statistically significant difference between means where $p < 0.01$

Food from 'convenience' outlets had the lowest protein density, significantly lower than food obtained from all other food outlet types. Food obtained from 'takeaway eateries' and 'traditional eateries' both had significantly higher protein densities than food sourced from 'grocery' (Figure 50).

The food outlet type with the highest carbohydrate density was 'convenience'. The mean carbohydrate density of food obtained from 'convenience' outlets was significantly higher than that of 'traditional eateries' 'takeaway eateries' and 'grocery' (Figure 51).

Mean sugars density was also highest from 'convenience' outlets, again significantly higher than the other food outlet types. The mean sugar density of food from 'takeaway eateries' was significantly lower than that from 'traditional eateries' and 'grocery' (Figure 52).

Figure 51 Nutrient density: Carbohydrate density per MJ energy by food outlet type

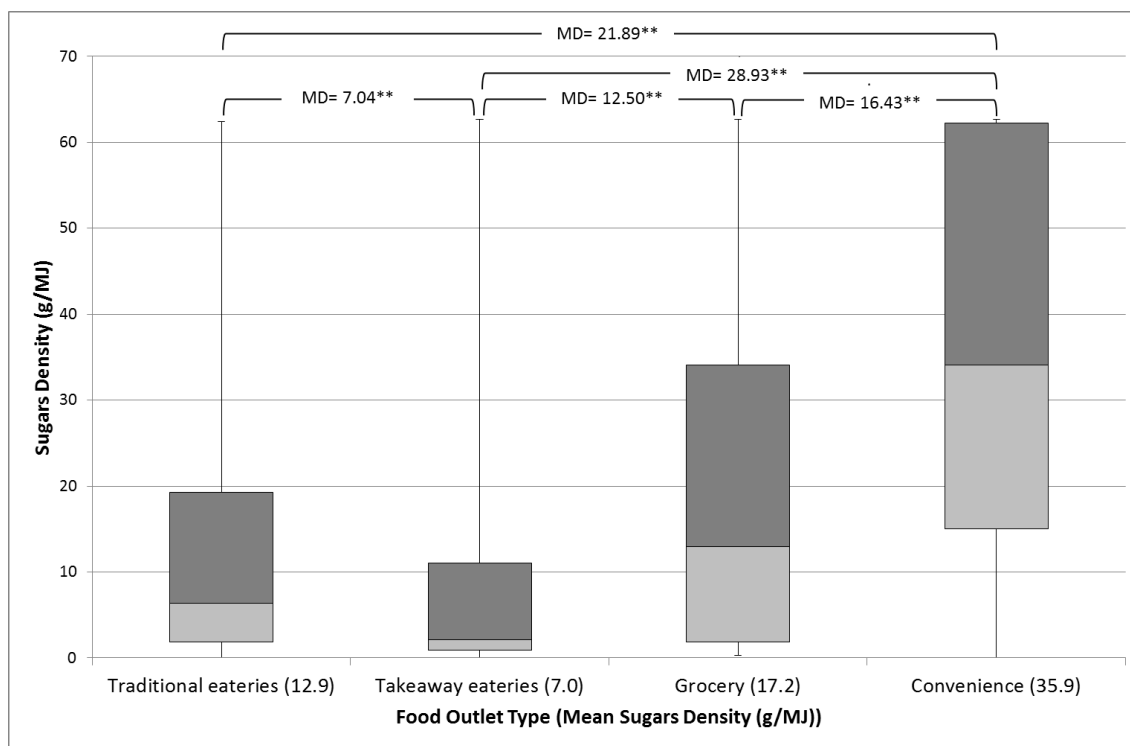


Boxplot shows median, 25th and 75th centiles and data range.

MD= difference between means

*statistically significant difference between means where $p < 0.05$

**statistically significant difference between means where $p < 0.01$

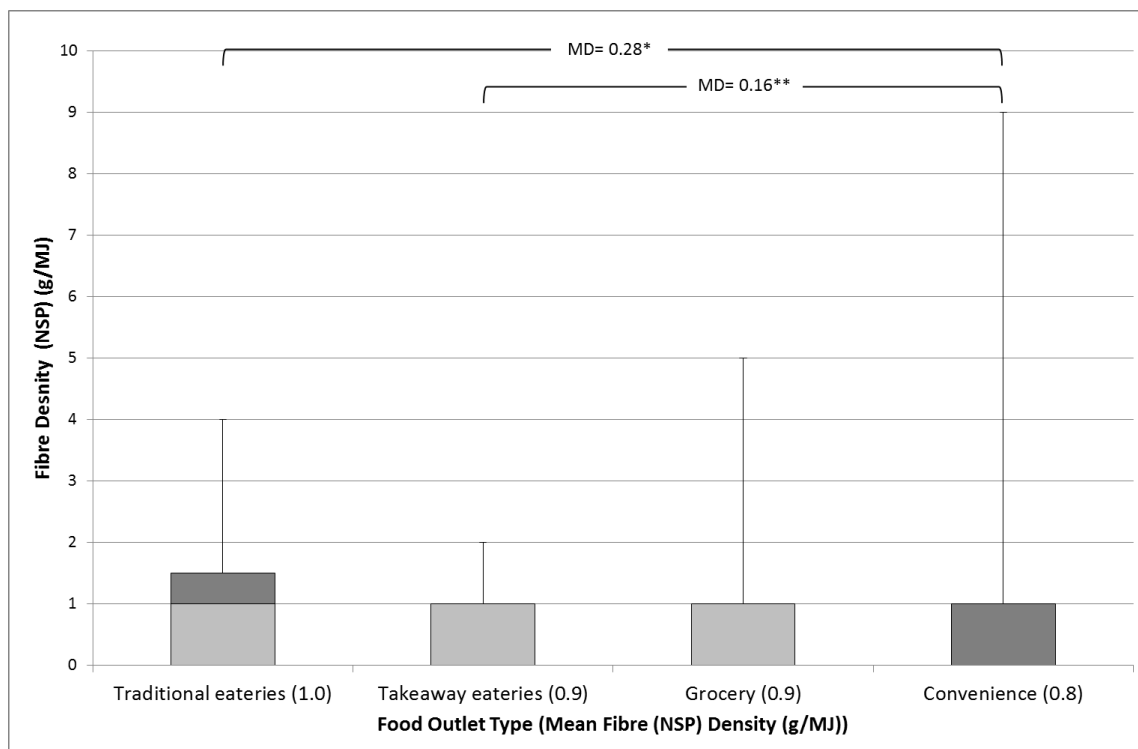
Figure 52 Nutrient density: Total sugars density per MJ energy by food outlet type

Boxplot shows median, 25th and 75th centiles and data range.

MD= difference between means

*statistically significant difference between means where $p < 0.05$

**statistically significant difference between means where $p < 0.01$

Figure 53 Nutrient density: Fibre (NSP) density per MJ energy by food outlet type

Boxplot shows median, 25th and 75th centiles and data range.

MD= difference between means

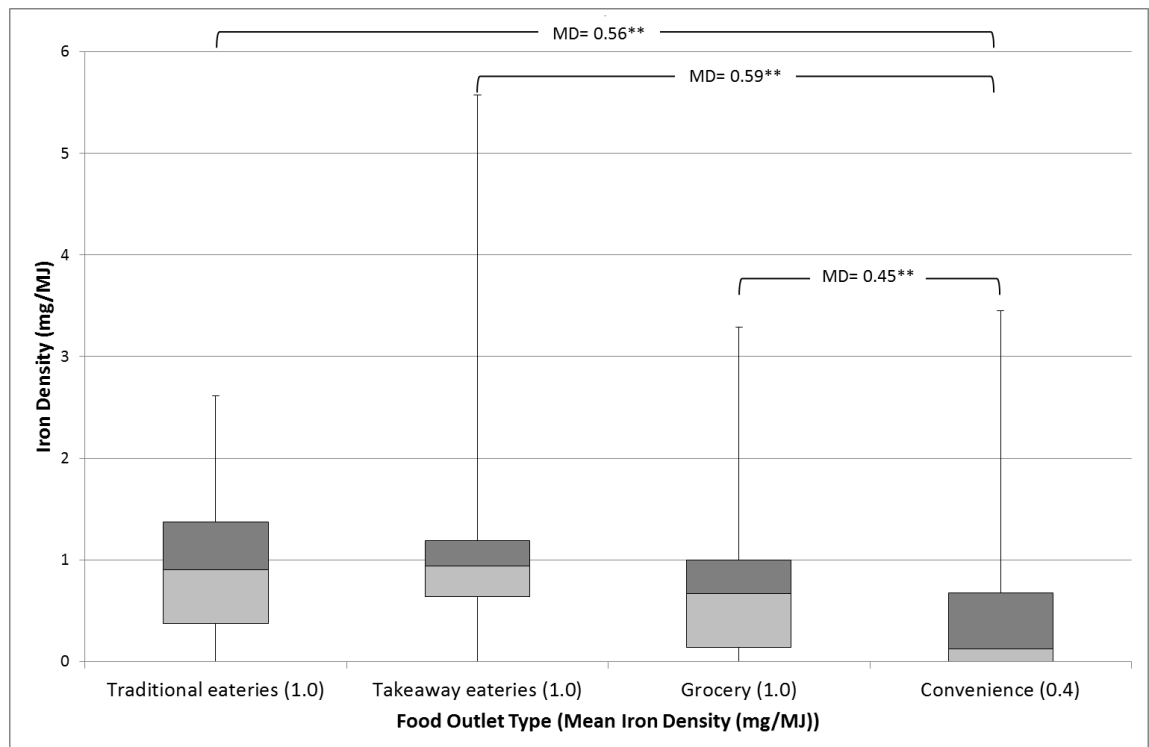
*statistically significant difference between means where $p < 0.05$

**statistically significant difference between means where $p < 0.01$

The fibre density of food from 'convenience' outlets was significantly lower than food obtained from 'traditional eateries' and 'takeaway eateries' (Figure 53).

The nutrient density of iron was significantly lower for food obtained from 'convenience' outlets than from all other food outlet types (Figure 54).

Figure 54 Nutrient density: Iron density per MJ energy by food outlet type



Boxplot shows median, 25th and 75th centiles and data range.

MD= difference between means

*statistically significant difference between means where $p < 0.05$

**statistically significant difference between means where $p < 0.01$

'Takeaway eateries' had the highest density of total fat and saturated fat although not the highest energy density as perhaps would be expected. The Highest mean energy density was 'grocery' outlets although this was not significantly different to 'takeaways'. 'Convenience' outlets had the highest carbohydrate density of which a high proportion was sugars, 'takeaway' eateries had the lowest mean sugars density. Food from 'convenience' outlets had a significantly lower protein density than the other food outlet types. 'Traditional' eateries were the 'healthiest' food outlet type with the lowest energy density, high protein density and the highest density of fibre and iron.

9.3 Visited food outlet environment and dietary intake

The visited food environment consists of the food outlets individuals recorded using as a food source over the 4-day study period. The aims of this section

are: to investigate the relationship between the number of food outlet eating events (VFE-Count) and dietary intake; to explore the 'healthiness' of the visited food outlet environment using Measuring Food Environment (MFE) surveys; to relate MFE food outlet scores to participants by generating individual MFE scores; and to investigate the relationship between the proportion of less healthy to more healthy food outlet visits (VFE-Ratio) and dietary intake.

9.3.1 VFE-Count and dietary intake

VFE-Count is defined as the number of food outlet eating events recorded in the food diary. All but two of the participants used a food outlet to source food at least once over the 4-day study period. The mean VFE-Count was 4.7 eating events/ person (range of 0-13). Figure 55 shows the VFE-Count distribution across the study population.

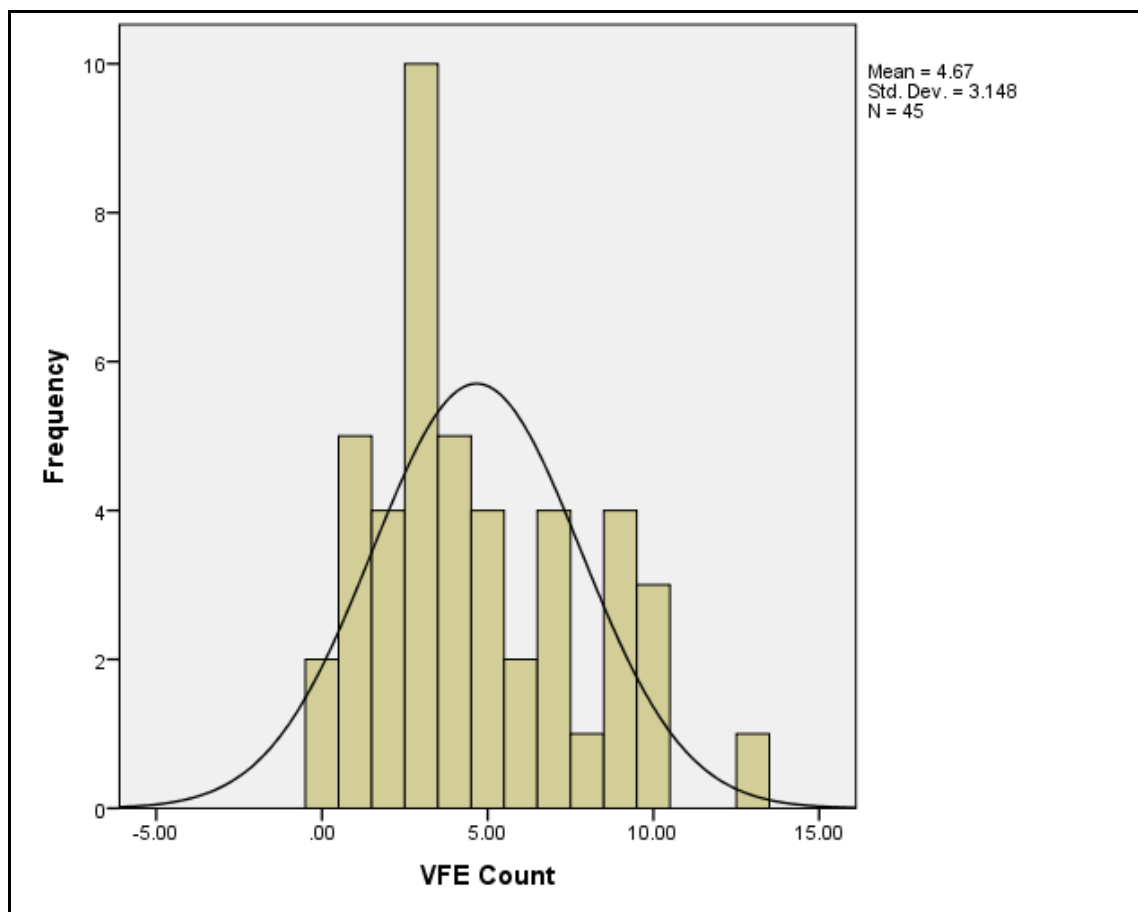


Figure 55 Histogram to show the variation in VFE-Count across the study population (n=45)

This analysis aimed to establish the relationship between mean daily intake of food and nutrients and the frequency of food outlet use. Significant correlations

between VFE-Count and dietary intake were further investigated for relationships by gender, BMI and SES.

The number of food outlet eating events was positively associated with greater energy density (KJ/100g) and a higher total population mean daily intake of alcohol (g) (see Table 23). No other significant correlations between VFE-Count and individual dietary intake were found.

Table 23 Relationship between participants (n=45) mean daily intake of food and nutrients and total number food outlet eating events (VFE-Count)

Dietary intake/ day (unit)	VFE-Count	
	<i>r</i> score	<i>p</i> value
Total energy (MJ) ¹	0.27	0.07
Energy density (KJ/100g) ²	0.34	0.02
Protein (%E) ¹	-0.25	0.10
Total fat (%E) ²	0.10	0.53
Saturated fat (%E) ²	0.05	0.74
Carbohydrate (%E) ²	-0.10	0.51
Total sugars (%E) ²	-0.05	0.75
Fibre - NSP (g) ¹	0.24	0.12
Iron (mg) ¹	0.19	0.21
Vitamin C (mg) ¹	0.10	0.51
Alcohol (%E) ²	0.20	0.19
- consumers only ^{2,3}	0.03	0.90
Alcohol (g) ²	0.34	0.02
- consumers only ^{2,3}	0.35	0.12
Fruit (g) ²	-0.16	0.29
- consumers only ^{2,4}	-0.15	0.38
Vegetables (g) ¹	-0.19	0.22
Fruit & veg portions (n) ²	-0.25	0.10

¹Not normally distributed, analysed using Spearman Rank correlation (*r_s*)

²Normally distributed, analysed using Pearson correlation co-efficient (*r*)

³Alcohol consumers only; n=21, 9 male, 12 female

⁴Fruit consumers only; n=35, 12 male, 23 female

Highlight indicates significant correlation (*p*<0.05)

9.3.1.1 VFE-Count and energy density

Mean energy density was positively correlated with VFE-Count for females (*r*=0.47, *p*=0.01) but not males, suggesting females who had a higher VFE-Count had a more energy dense diet. Energy density was also significantly correlated with VFE-Count for the 'healthy and underweight' group (*r*=0.36, *p*=0.03) indicating healthy weight individuals who had a higher VFE-Count had

a more energy dense diet. However, this relationship was not seen for 'overweight and obese' individuals. No significant correlations were found between VFE-Count and energy density for SES groups.

9.3.1.2 VFE-Count and alcohol intake

A relationship between alcohol intake (g) and VFE-Count was seen for females ($r=0.46$, $p=0.02$) but not males, and 'healthy and underweight' ($r=0.42$, $p=0.01$) but not 'overweight and obese'. No significant relationship was found between alcohol intake and VFE-Count when the analysis was conducted for the alcohol 'consumers only' group. No significant correlations were found between VFE-Count and alcohol intake (g) for SES groups.

9.3.2 Measuring Food Environment survey results

This section presents data from the Measuring Food Environments (MFE) surveys (section 4.4.4) completed by researchers in food outlets visited by study participants. Differences between MFE scores for food outlet classification categories were investigated.

9.3.2.1 MFE survey completion rate

MFE surveys scores were available for 84% of the 210 food outlet eating events recorded in the food diaries (Figure 56). One hundred and thirty five unique food outlets were identified in the overall dataset, 109 of which had complete MFE survey data.

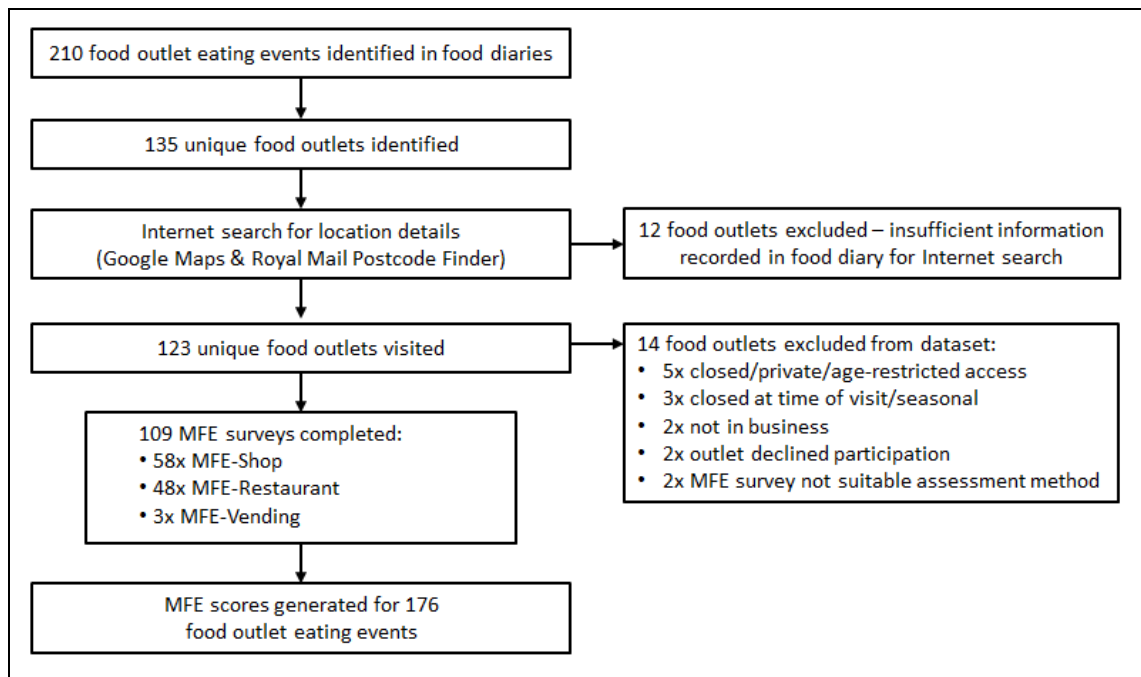


Figure 56 Flow chart of the Measuring Food Environment Survey completion process

9.3.2.2 MFE score and food outlet classification categories

This section investigates the MFE survey results overall and in relation to food outlet classification categories. The MFE score is a percentage score, with a higher score indicative of a 'more healthful' food outlet environment. The mean MFE score for unique food outlets (n=109) was 40.9% (range 22-65); the mean MFE score for food outlet eating events (n=176) was 39.7%.

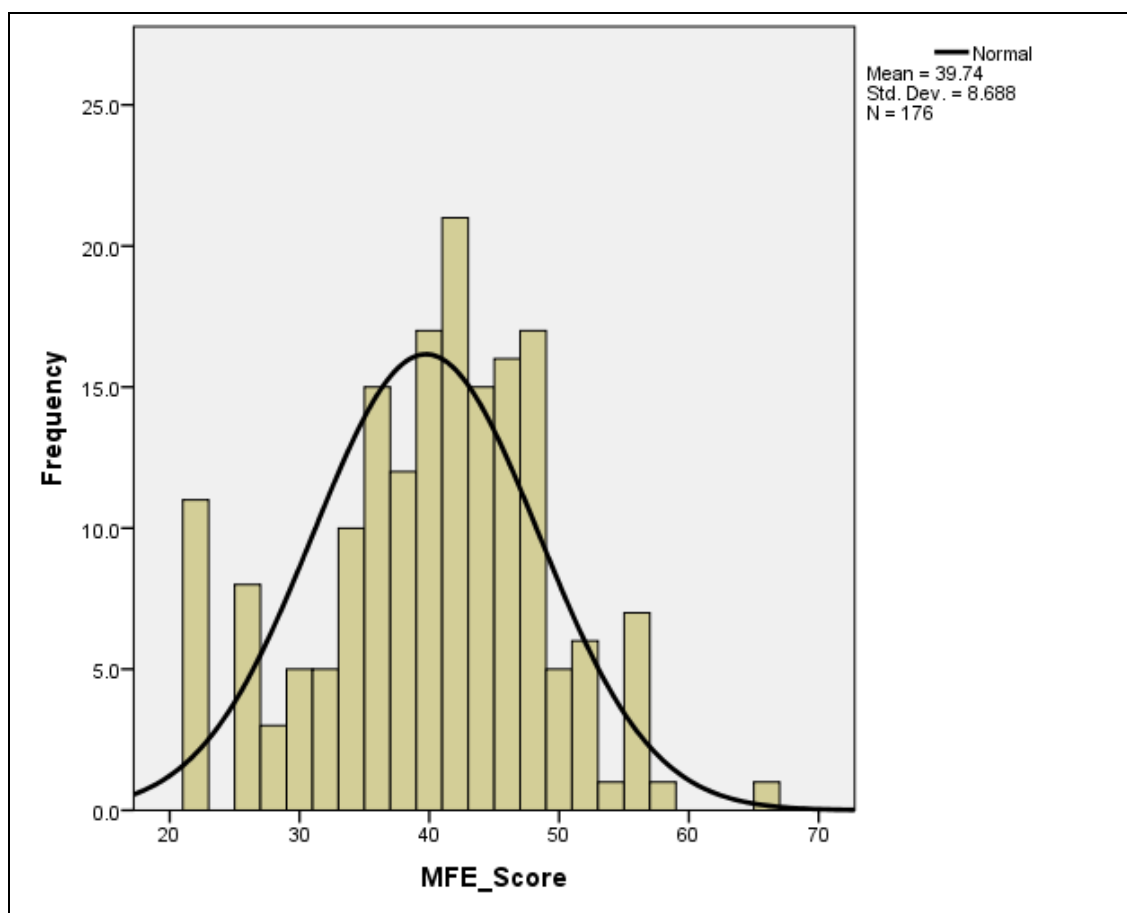


Figure 57 Histogram to show the distribution of food outlet MFE scores

Table 24 contains the MFE scores by food outlet classification category. The 'health and leisure' category had the 'most healthful' food outlet environment with a mean MFE score of 50.0. The 'least healthful' food outlet category was 'convenience store' with a mean score of 29.9.

Table 24 Measuring Food Environments Survey score by food outlet classification category

Food outlet classification category	Number users	Food outlet eating event count	Unique Food outlet count	MFE score*
	N	n	n	Mean (SD)
Total	41	176	109	40.94 (8.3)
Traditional eateries				
Traditional/pub/hotel restaurant	14	25	15	45.20 (7.4)
Sit-in café/coffee/sandwich shop	8	10	9	47.67 (6.3)
Health and Leisure	3	6	3	50.00 (4.4)
Takeaway eateries				
Takeaway café/coffee/sandwich shop	6	8	8	41.63 (9.1)
Retail Baker	7	9	7	42.14 (2.2)
Takeaway and fast food outlet	27	48	31	40.29 (6.4)
Grocery outlets				
Supermarket	16	27	12	42.92 (7.0)
Specialist supplier (e.g. butcher)	2	2	2	38.50 (2.1)
Convenience & incidental outlets				
Convenience store	14	31	13	29.85 (4.5)
Vending machine	1	1	1	41.00 (-)
Non-food store (e.g. post office)	6	8	7	39.43 (12.3)
Entertainment (e.g. cinema, library)	1	1	1	31.00 (-)

* Mean MFE score based on unique food outlet count and scores

An ANOVA test revealed there was a statistically significant different mean MFE score for food outlet category types ($p < 0.001$, Table 25). The 'traditional eateries' category had a significantly higher MFE score than the 'takeaway eateries' category ($p = 0.01$) indicating that 'traditional eateries' were 'more healthful' environments than 'takeaway eateries'. 'Convenience' was the 'least healthful' food outlet category type with a significantly lower mean MFE score than 'traditional eateries', 'takeaway eateries' and 'grocery' ($p < 0.05$ in each case). There were no significant differences between the scores generated from the different MFE survey types for assessing restaurants (MFE-R), shops (MFE-S, and vending machines (MFE-V)(Table 25).

Table 25 MFE score by food outlet type and Measuring Food Environment survey type*

Food outlet type		All Surveys	MFE-R	MFE-S	MFE-V
<i>Traditional eateries</i>	n	27	17	8	2
	Mean (SD)	46.6 (6.8)	45.6 (7.3)	48.4 (6.3)	47.5 (0.7)
<i>Takeaway eateries</i>	n	46	31	15	-
	Mean (SD)	40.8 (6.4)	40.3 (6.4)	41.9 (6.6)	-
<i>Grocery outlets</i>	n	14	-	14	-
	Mean (SD)	42.3 (6.7)	-	42.3 (6.7)	-
<i>Convenience & incidental outlets</i>	n	22	-	21	1
	Mean (SD)	33.5 (8.8)	-	33.1 (8.9)	41.0 (-)

*MFE-Restaurant (MFE-R); MFE-Shop (MFE-S); MFE-Vending (MFE-V)

9.3.3 Individual Measuring Food Environments scores

This section aims to assess the healthiness of the food outlets used by participants. An individual MFE score was calculated for each participant, this individual score was assessed for relationships with dietary intake, BMI and number of food outlets visited. Four participants were excluded from the analysis; two participants did not use a food outlet over the 4-day study period; and two participants for whom food outlet eating event MFE surveys were not completed. Therefore, 41 subjects are included in this analysis.

A significant positive correlation between individual MFE score and protein intake indicated that individuals exposed to a healthier consumer food outlet environment had a higher mean daily protein intake. Alcohol intake (g) was significantly negatively associated with individual MFE score for alcohol consumers only (Table 26).

Table 26 Correlations between Individual Measuring Food Environments (MFE) score and mean daily dietary intake (n=41)

Dietary intake/ day (unit)	Individual MFE score	
	<i>r</i> score	<i>p</i> value
Total energy (MJ) ¹	0.04	0.79
Energy density (KJ/100g) ²	-0.23	0.15
Protein (%E) ¹	0.38	0.01
Total fat (%E) ²	0.06	0.72
Saturated fat (%E) ²	-0.14	0.38
Carbohydrate (%E) ²	-0.05	0.77
Total sugars (%E) ²	-0.08	0.60
Fibre - NSP (g) ¹	-0.12	0.44
Iron (mg) ¹	0.20	0.20
Vitamin C (mg) ¹	0.02	0.92
Alcohol (%E) ²	-0.13	0.42
- consumers only ^{2,3}	-0.18	0.43
Alcohol (g) ²	-0.25	0.12
- consumers only ^{2,3}	-0.43	0.05
Fruit (g) ²	0.21	0.18
- consumers only ^{2,4}	0.28	0.12
Vegetables (g) ¹	0.12	0.46
Fruit & veg portions (n) ²	0.23	0.15

¹Not normally distributed, analysed using Spearman Rank correlation (*r_s*)²Normally distributed, analysed using Pearson correlation co-efficient (*r*)³Alcohol consumers only; n=21⁴Fruit consumers only; n=32**Highlight** indicates significant correlation (*p*<0.05)

Individual MFE score was investigated for associations with SES, BMI and gender. A negative relationship was found between SES (IMD score) and individual MFE score ($r=-0.34$, $p=0.03$) suggesting that individuals living in more deprived areas had less healthful dietary habits. When assessed at the group level, the high SES group had a significantly higher (more healthful) individual MFE score than the low SES group (mean=42.0 and 38.8 respectively, $p<0.05$). There was no significant relationship between individual MFE score and BMI or gender.

9.3.4 VFE-Ratio and dietary intake

This section aims to establish the relationship between mean daily intake of food and nutrients and the ratio of 'less healthy' to 'more healthy' food outlet eating events (VFE-Ratio). A ratio figure above 0.5 indicates a greater proportion of these 'less healthy' food outlets to 'more healthy' outlets calculated at the individual level. Figure 58 shows the distribution of the VFE-Ratio data across the study population; the distribution was shifted to the right of the normality curve indicating that a greater number of participants had a 'less healthy' VFE-Ratio.

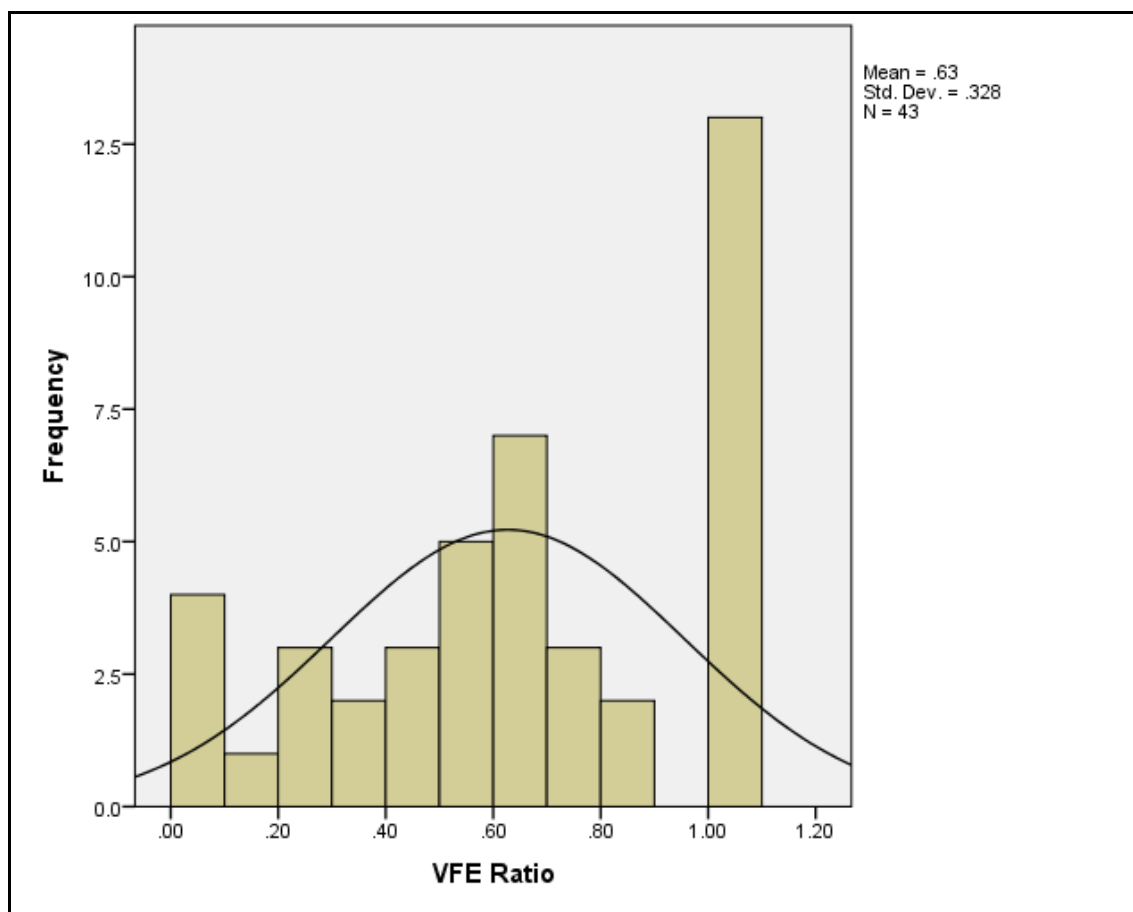


Figure 58 Histogram to show the variation in VFE-Ratio across the study population

Correlation analysis was conducted to investigate the relationship between VFE-Ratio and dietary intake variables (Table 27). Significant correlations between VFE-Ratio and dietary intakes were further investigated for relationships by gender, BMI and SES.

Table 27 Relationship between participants (n=43) mean daily intake of food and nutrients and ratio of takeaway/convenience outlet eating events to total food outlet eating events (VFE-Ratio)

Dietary intake/ day (unit)	VFE-Ratio	
	<i>r</i> score	<i>p</i> value
Total energy (MJ) ¹	0.03	0.84
Energy density (KJ/100g) ²	0.39	0.01
Protein (%E) ¹	-0.11	0.47
Total fat (%E) ²	0.12	0.43
Saturated fat (%E) ²	0.18	0.24
Carbohydrate (%E) ²	0.07	0.65
Total sugars (%E) ²	-0.02	0.91
Fibre - NSP (g) ¹	-0.04	0.82
Iron (mg) ¹	-0.22	0.16
Vitamin C (mg) ¹	-0.42	<0.01
Alcohol (%E) ²	0.01	0.99
- consumers only ^{2,3}	0.24	0.30
Alcohol (g) ²	0.06	0.73
- consumers only ^{2,3}	0.32	0.16
Fruit (g) ²	-0.49	<0.01
- consumers only ^{2,4}	-0.54	<0.01
Vegetables (g) ¹	-0.20	0.20
Fruit & veg portions (n) ²	-0.47	<0.01

¹Not normally distributed, analysed using Spearman Rank correlation (*r_s*)²Normally distributed, analysed using Pearson correlation co-efficient (*r*)³Alcohol consumers only; n=21⁴Fruit consumers only; n=33**Highlight** indicates significant correlation (*p*<0.05)

A greater proportion of 'less healthy' food outlet eating events (higher VFE-Ratio) was significantly associated with greater energy density (KJ/100g). A higher VFE-Ratio was significantly associated with lower mean daily intake of vitamin C (mg), fruit (g), and fruit and vegetable portions.

9.3.4.1 VFE-Ratio and energy density

The relationship between VFE-Ratio and energy density was significant for females (*r*=0.44, *p*=0.02) but not males. The VFE-Ratio was strongly correlated with energy density for the 'overweight and obese' group (*r*=0.72, *p*=0.03, Figure 59). However, due to the small population within this group, this result should be interpreted with caution. No relationship was seen in the 'healthy and underweight' group.

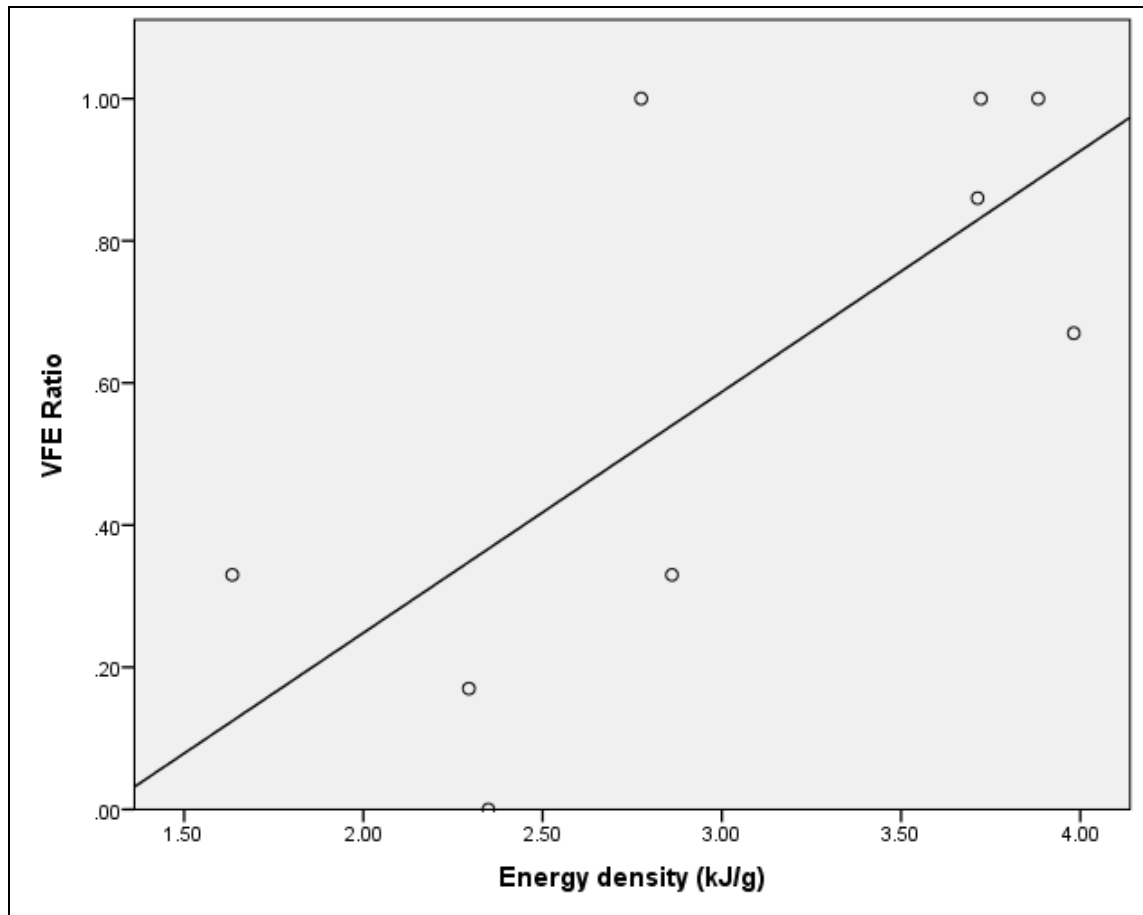


Figure 59 Correlation between VFE-Ratio and mean daily energy density for 'overweight and obese' BMI group (n=9)

For the low SES group, VFE-Ratio was positively associated with energy density ($r=0.51$, $p=0.02$). No significant correlation was present for the high SES group.

9.3.4.2 VFE-Ratio and Vitamin C

VFE-Ratio was significantly negatively correlated with mean daily vitamin C intake (Table 27). This indicates that visiting a higher proportion of less healthy food outlets is associated with lower vitamin C intakes. The relationship between vitamin C and VFE-Ratio was significant for males ($r_s=-0.56$, $p=0.02^{12}$) and 'healthy and underweight' participants ($r_s=-0.41$, $p=0.02$) but not females or 'overweight and obese' participants. No significant correlations were found by SES groups.

¹² r_s = data not normally distributed, analysed using Spearman Rank correlation

9.3.4.3 VFE-Ratio and fruit intake

The VFE-Ratio correlation with fruit intake was strengthened when the data were analysed within fruit ‘consumers only’ (Table 27). Fruit intake had a significant negative correlation with VFE ratio for both males and females ($r=-0.66$, $p<0.01$ and $r=-0.39$, $p=0.04$, respectively). Fruit intake was significantly negatively associated with VFE-Ratio in the ‘healthy and underweight’ group ($r=-0.54$, $p<0.01$) although no significant association was shown for the ‘overweight and obese’ group. Fruit intake was associated with VFE-Ratio for the high SES group ($r=0.47$, $p=0.03$) but not the low SES group.

9.3.4.4 VFE-Ratio and fruit and vegetable portions

The relationship between mean daily fruit and vegetable portions and VFE-Ratio was significant for males ($r=-0.64$, $p=0.01$) and ‘healthy and underweight’ participants ($r=-0.51$, $p<0.01$) but not females or ‘overweight and obese’ participants. For the low SES group, VFE-Ratio negatively correlated with fruit and vegetable portions ($r=-0.50$, $p=0.03$), although this relationship was not significant in the high SES group.

9.4 Summary

- Of the 15 food outlet classification categories, the most frequently visited were takeaways and fast food (visited by 62% of participants), convenience stores (44%) and supermarkets (40%).
- Overall, 58% of food outlet eating events relate to ‘less healthy’ food outlets.
- ‘Traditional eateries’ had the lowest mean energy density of the food outlet types.
- ‘Takeaway eateries’ had the highest total fat and saturated fat density of the food outlet types.
- ‘Convenience’ outlets had the highest levels of carbohydrate and sugars density and lowest levels of iron and fibre density of the food outlet types.
- A greater VFE-Count was significantly associated with higher mean daily energy density and alcohol intake.

- MFE survey results indicated that 'takeaway eateries' and 'convenience' outlets were the 'least healthy' food outlet types with significantly lower mean scores than 'traditional eateries' and 'grocery' outlets.
- A higher individual MFE score (or more healthful visited food environment) was significantly associated with higher protein intake.
- A higher VFE-Ratio (greater proportion less healthy food outlets: more healthy outlets) was associated with a higher mean energy density and lower intake of iron, fruit, and fruit and vegetable portions.

Chapter 10 Results: Relationship between the Exposure Food Environment and dietary intake, adiposity and socio-economic status

Chapter overview:

- Introduction
- Exposure Food Environment Count
- Exposure Food Environment Ratio
- Relationship between the Exposure Food Environment and recommended dietary intake
- Relationship between the Exposure and Visited Food Environments
- Summary

Exposure to food outlets was assessed using a 50 metre buffer applied to GPS waypoints recorded by individuals. As outlined in the methods chapter (section 4.5.1) only GPS data for study day one were used and waypoints with a recorded speed above 5 miles per hour were excluded. Two measures of the Exposure Food Environment (EFE) were calculated, EFE-Count and EFE-Ratio. This chapter describes the EFE-Count and EFE-Ratio for the study participants and explores the relationship between these measures and dietary intake. The relationship between exposure to food outlets and the visited food environment is also explored.

10.1 Exposure Food Environment Count

The EFE-Count provides an estimate of the number of food outlets an individual is exposed to. A total of 1550 food outlets¹³ were identified within participant GPS buffers. The mean EFE-Count was 34.4 food outlet exposures per person (SD =43.8, range =0–154). Figure 60 shows the EFE-Count distribution across the study population. The distribution was negatively skewed where the majority of participants had an EFE-Count of less than 50 food outlets.

¹³ This excludes food outlets identified as closed businesses, n=62 (6% of EFE food outlets)

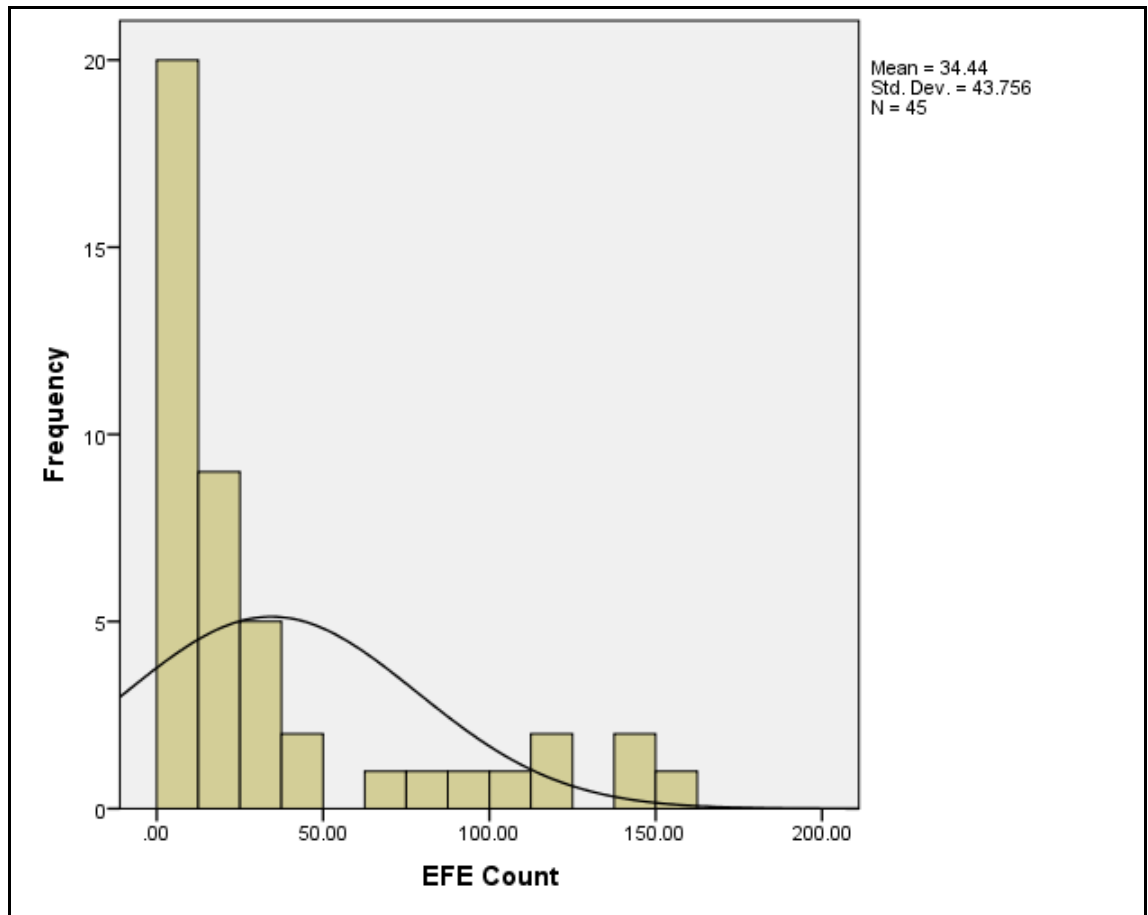


Figure 60 Histogram to show the variation in EFE-Count across the study population

Participant data representing the 25th percentile, median, and 75th percentile are mapped in Figures 60 to 62 to give examples of EFE-Count range.

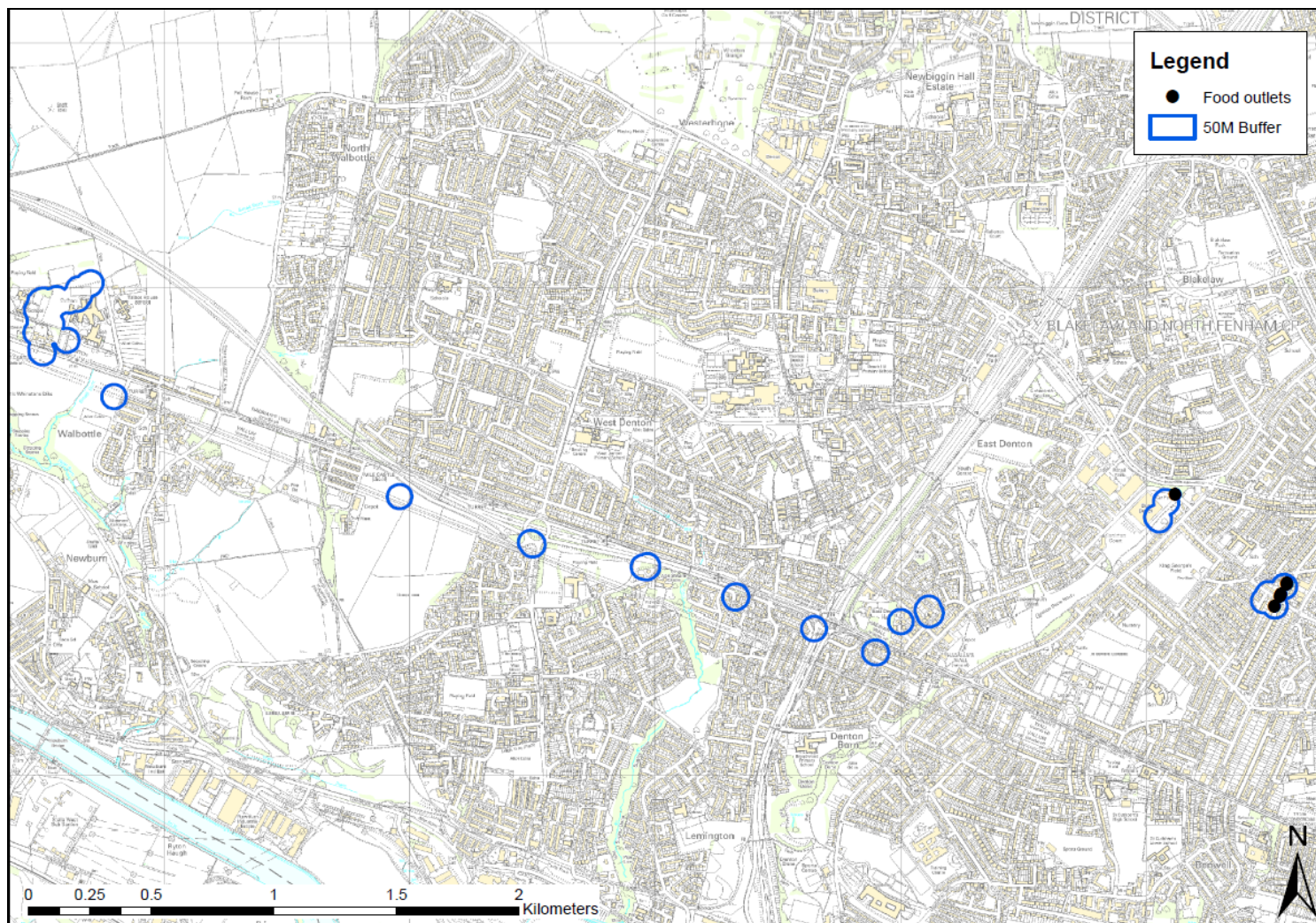


Figure 61 Map to show the calculation of the EFE-Count for a participant representing the 25th percentile (food outlet n=6)
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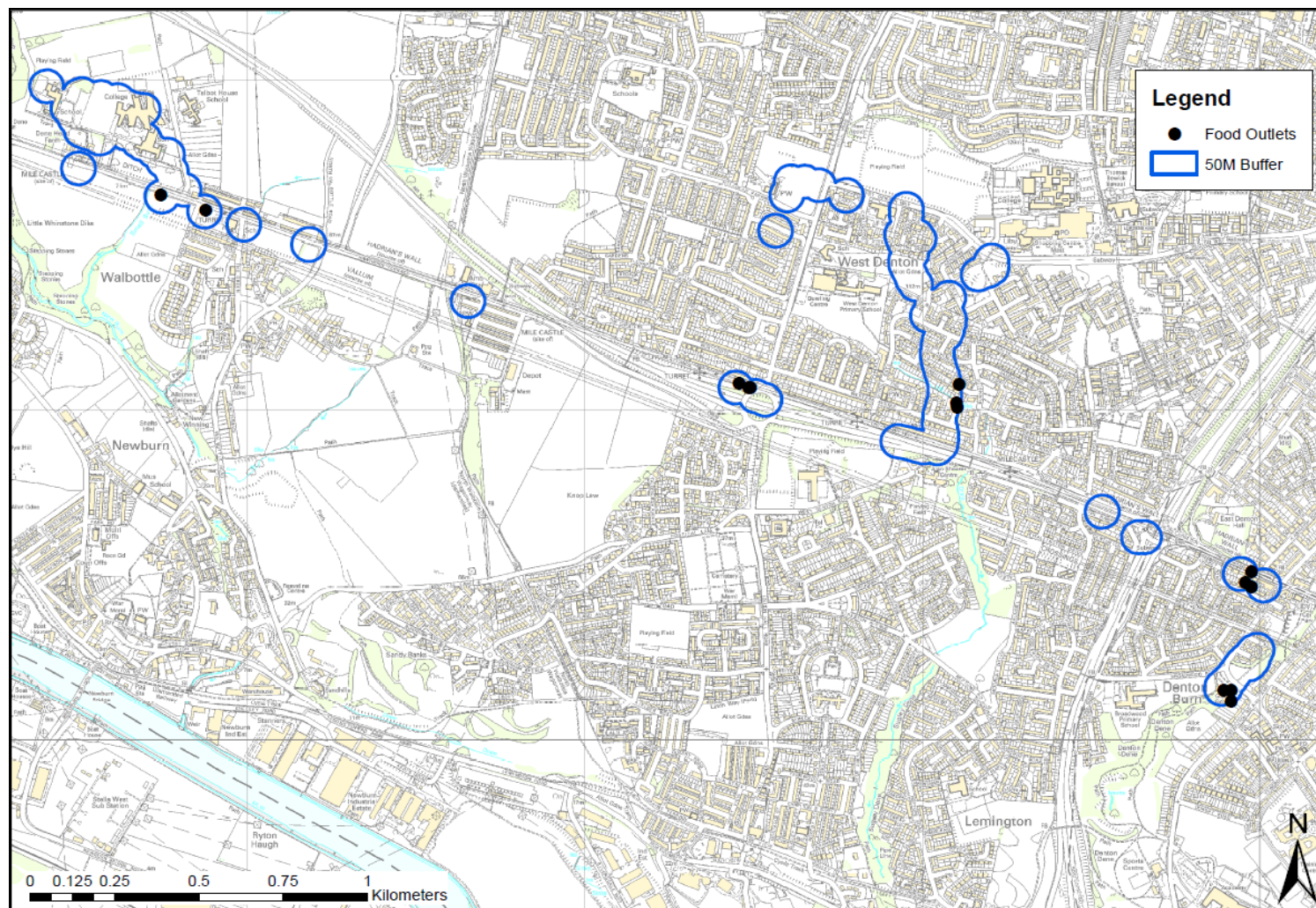


Figure 62 Map to show the calculation of the EFE-Count for a participant representing the median (food outlet n=14)

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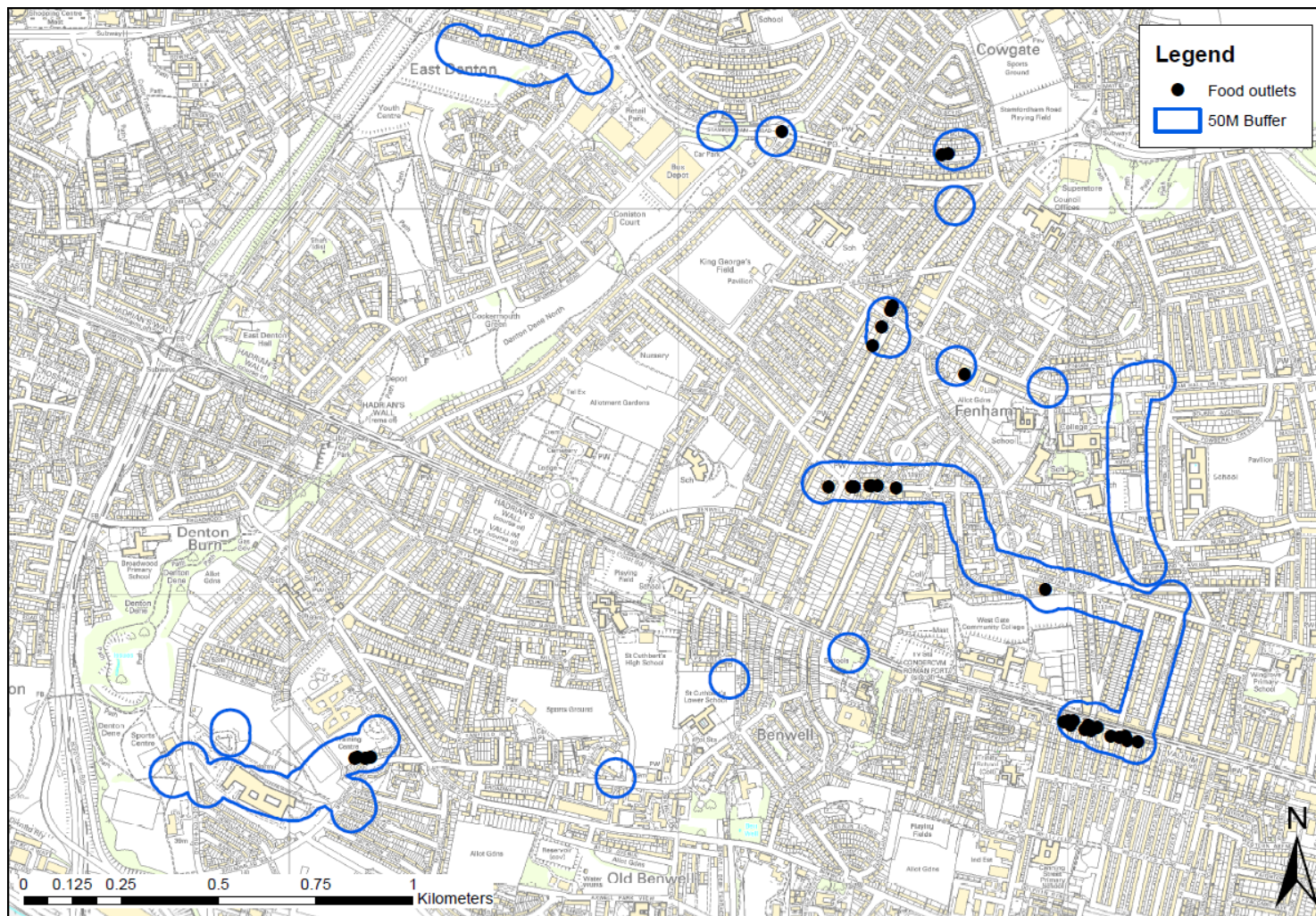


Figure 63 Map to show the calculation of the EFE-Count for a participant representing the 75th percentile (food outlet n=37)

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10.1.1 Relationship between EFE-Count, adiposity and socio-economic status

There was no significant correlation between EFE-Count and BMI ($r_s=-0.24$, $p=0.12$). EFE-Count was significantly positively correlated with SES ($r_s=0.43$, $p<0.01$). This suggests that individuals of lower socio-economic status are exposed to a greater number of food outlets.

Figure 64 shows the mean proportional contribution of each of the food outlet types to the EFE-Count. In one day, the 'average' participant was exposed to 34 food outlets; 29% of these were 'takeaway eateries'; 27% 'convenience & incidental outlets'; a quarter were 'traditional eateries'; 14% were 'grocery outlets'; and 2% were 'closed/private/age restricted outlets'.

Differences between the mean proportions of food outlet types were assessed for gender, BMI and SES groups. The least deprived SES group (high SES) was exposed to a higher proportion of 'traditional eateries' ($p<0.01$). The most deprived group exposed to a greater proportion of 'takeaway' food outlets ($p=0.03$). No other significant differences between the groups were observed.

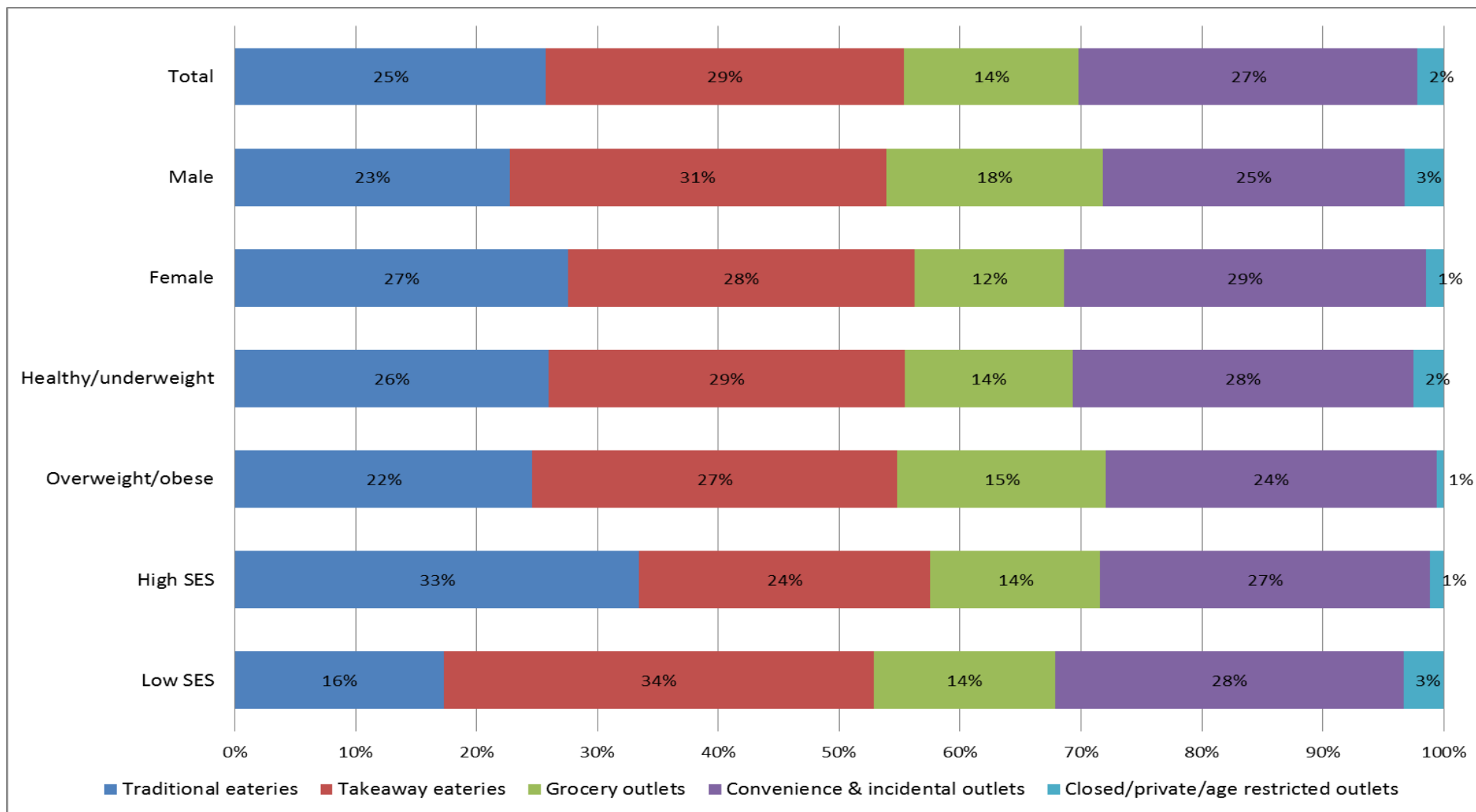


Figure 64 Mean proportional contribution of food outlet types to Exposure Food Environment (EFE) Count overall, by gender, BMI and SES groups

10.1.2 Relationship between EFE-Count and dietary intake

The relationships between EFE-Count and mean daily dietary intake are presented in Table 28. There were no significant associations between EFE-Count and dietary intake although the correlation between EFE-count and percent energy from saturated fat approached significance ($p=0.05$).

Table 28 Relationship between participants (n=45) mean daily dietary intake and total number food outlet exposures (EFE-Count)

Dietary intake/ day (unit)	EFE-Count	
	<i>r</i> score	<i>p</i> value
Total energy (MJ) ¹	0.22	0.16
Energy density (KJ/100g) ²	0.18	0.24
Protein (%E) ¹	-0.05	0.76
Total fat (%E) ²	0.22	0.16
Saturated fat (%E) ²	0.29	0.05
Carbohydrate (%E) ²	0.03	0.82
Total sugars (%E) ²	0.05	0.73
Fibre - NSP (g) ¹	0.16	0.29
Iron (mg) ¹	-0.03	0.85
Vitamin C (mg) ¹	-0.19	0.21
Alcohol (%E) ²	-0.19	0.21
- consumers only ^{2,3}	-0.31	0.17
Alcohol (g) ²	-0.13	0.38
- consumers only ^{2,3}	-0.16	0.48
Fruit (g) ²	-0.08	0.59
- consumers only ^{2,4}	-0.13	0.45
Vegetables (g) ¹	-0.11	0.48
Fruit & veg portions (n) ²	-0.02	0.92

¹Not normally distributed, analysed using Spearman Rank correlation (r_s)

²Normally distributed, analysed using Pearson correlation co-efficient (r)

³Alcohol consumers only; n=21

⁴Fruit consumers only; n=35

Highlight indicates significant correlation ($p<0.05$)

10.2 Exposure Food Environment Ratio

The EFE-Ratio is an assessment of the proportion of 'less healthy' outlets to 'more healthy' outlets. It was calculated based on the EFE-Count, excluding outlets classified as 'closed/private/age restricted outlets'.

The EFE-Ratio was calculated using the following equation:

$$\text{EFE-Ratio} = \frac{\text{'takeaway eateries' + 'convenience outlets'}}{\text{EFE-count} - \text{'closed/private/age restricted outlets'}}$$

An EFE-Ratio less than 0.5 indicated a 'more healthy' Exposure Food Environment with exposure to a greater proportion of traditional eateries and grocery outlets. An EFE-Ratio more than 0.5 indicated a 'less healthy' Exposure Food Environment with exposure to a greater proportion of takeaway eateries and convenience outlets.

The mean EFE-Ratio was 0.6 (SD=0.21) with 71% of participants having an EFE-Ratio about 0.5 indicating a greater prevalence of 'less healthy' food outlet exposure.

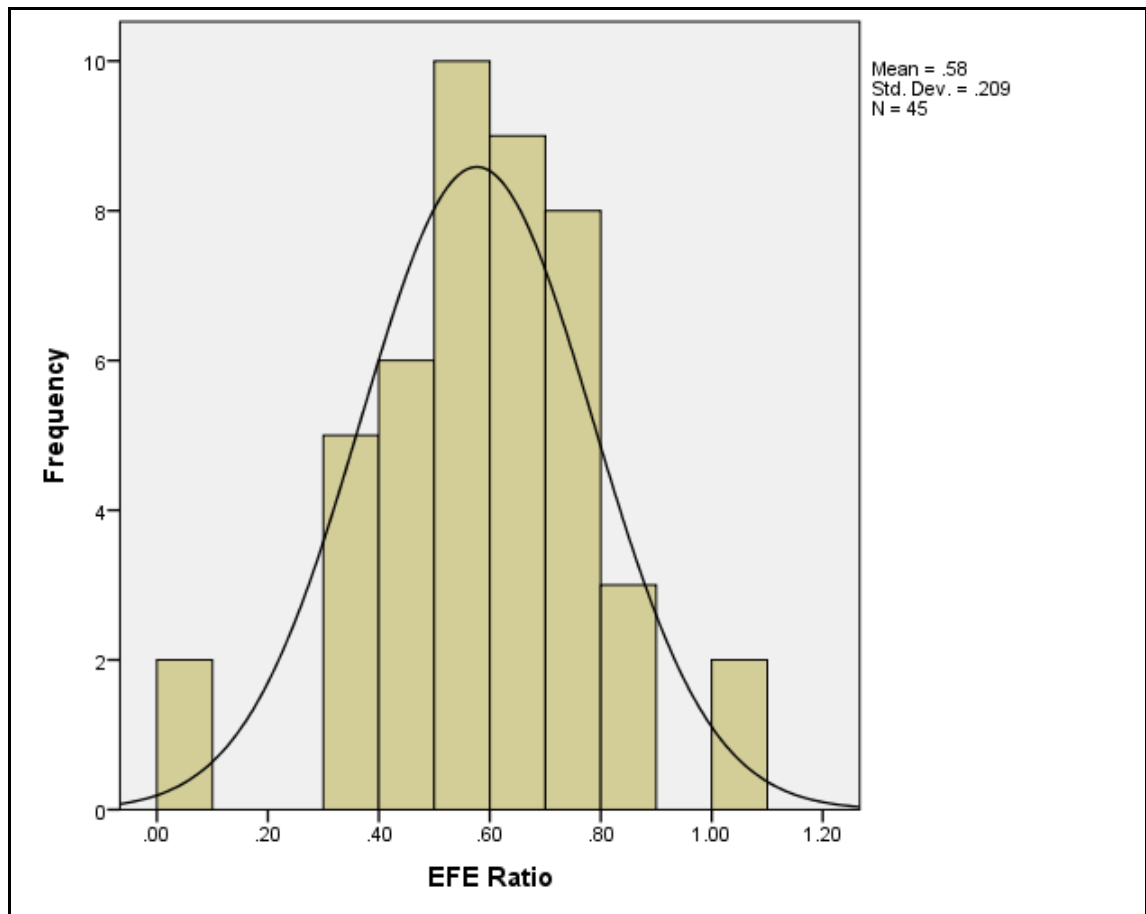


Figure 65 Histogram to show the variation in EFE-Ratio across the study population

10.2.1 Relationship between EFE-Ratio, adiposity and socio-economic status

There was no significant correlation between EFE-Ratio and BMI, $r=0.21$, $p=0.17$. Neither was there a significant correlation between EFE-Ratio and SES, $r=0.26$, $p=0.08$.

10.2.2 Relationship between EFE-Ratio and dietary intake

The relationships between EFE-Ratio and dietary intake are presented in Table 29. EFE-Ratio was significantly positively correlated with energy density. This suggests exposure to a less healthy food environment is associated with higher dietary intake of energy density. A significant negative correlation was identified between EFE-Ratio and iron intake suggesting exposure to a less healthy food environment was associated with a lower iron intake.

Table 29 Relationship between participants mean daily intake of food and nutrients and ratio of takeaway/convenience outlet exposures to total food outlets exposures (EFE-Ratio)

Dietary intake/ day (unit)	EFE-Ratio	
	<i>r</i> score	<i>p</i> value
Total energy (MJ) ¹	-0.12	0.44
Energy density (KJ/100g) ²	0.35	0.02
Protein (%E) ¹	-0.22	0.15
Total fat (%E) ²	0.01	0.95
Saturated fat (%E) ²	0.11	0.48
Carbohydrate (%E) ²	0.27	0.08
Total sugars (%E) ²	0.28	0.07
Fibre - NSP (g) ¹	-0.12	0.44
Iron (mg) ¹	-0.37	0.01
Vitamin C (mg) ¹	-0.16	0.29
Alcohol (%E) ²	-0.03	0.85
- consumers only ^{2,3}	0.15	0.52
Alcohol (g) ²	-0.01	0.94
- consumers only ^{2,3}	0.16	0.50
Fruit (g) ²	-0.18	0.23
- consumers only ^{2,4}	-0.16	0.37
Vegetables (g) ¹	-0.21	0.16
Fruit & veg portions (n) ²	-0.24	0.11

¹Not normally distributed, analysed using Spearman Rank correlation (r_s)

²Normally distributed, analysed using Pearson correlation co-efficient (r)

³Alcohol consumers only; $n=21$

⁴Fruit consumers only; $n=35$

Highlight indicates significant correlation ($p<0.05$)

10.3 Relationship between the Exposure Food Environment, socio-economic status, adiposity and recommended dietary intake

Participants were categorised into groups depending on their EFE count (above and below the median value of 14.0) and EFE ratio (above and below the value of 0.50).

Examining the association between the exposure food environment and SES, the lower SES group was associated with an EFE count >median ($X^2=6.41$, $p=0.01$) and an EFE ratio >0.5 ($X^2=4.87$, $p=0.03$). This indicates that those of lower SES are more likely to be exposure to a greater total number of food outlets and a greater proportion of takeaway/convenience outlets to restaurants/grocery.

In terms of dietary intake, an EFE count >median was associated with consuming above the recommended intake for percentage energy from both fat and saturated fat ($X^2=6.51$, $p=0.01$ and $X^2=8.01$, $p=0.01$, respectively). An EFE Ratio >0.5 was found to be associated with intake of fewer than two fruit and vegetable portions per day ($X^2=9.34$, $p<0.01$).

The dichotomised EFE count and EFE ratio variables were not found to be associated with energy intake above or below the recommended daily guidelines. Neither was there any significant association between EFE count and EFE ratio with BMI groups.

10.4 Relationship between the Exposure and Visited Food Environments

EFE-Count and EFE-Ratio as continuous variables were assessed for correlations with VFE-Count and VFE-Ratio. Being exposed to a greater number of food outlets (EFE-Count) was associated with recording a greater number of food outlet eating events (VFE-Count) ($r=0.37$, $p=0.02$). EFE-Ratio was significantly positively associated with VFE-Ratio ($r=0.47$, $p=0.001$), indicating that being exposed to a greater proportion of 'less healthy' food outlets is associated with a greater proportion of visits to 'less healthy' food outlets.

10.5 Summary

- The mean day 1 EFE-Count was 34 food outlets, the majority of participants were exposed to fewer than 50 food outlets within 50m of their recorded GPS waypoints.
- On one day, the average participant was exposed to a greater proportion of 'less healthy' food outlets than 'more healthy' food outlets.
- Participants from areas with lower IMD scores were exposed to a significantly greater proportion of 'traditional eateries' (more healthy) and significantly lower proportion of 'takeaway eateries' (less healthy) than those participants from areas with higher IMD scores.
- There were no significant associations between EFE-Count and dietary intake.
- A higher EFE-Ratio, indicating a 'less healthy' exposure food environment, was significantly associated with a higher energy density and lower vitamin C intake.
- The exposure and visited food environments were highly correlated. Participants with a higher EFE-Count were more likely to have a high VFE-Count. Similarly, those with a 'less healthful' EFE-Ratio were more likely to have a 'less healthful' VFE-Ratio.

Chapter 11 Results: Findings from qualitative individual interviews

Chapter overview:

- Introduction
- Interviewee characteristics
- Introduction of themes
- Theme 1: Eating out
- Theme 2: Takeaway food
- Summary of interview findings

This chapter presents the findings from the qualitative individual interviews. These interviews aimed to further investigate the factors which influence the food choice of young people, by talking through typical week and weekend days. Firstly, the characteristics of the sub-sample of participants interviewed are presented. This is followed by an introduction to the two themes discussed within the chapter; eating out, and takeaway food. Within this chapter, quotations and extracts from interviews are presented in boxes according to the thematic content. These are supplemented by a small number of additional quotations within the text. Quotations were selected to be illustrative or typical quotes from the young people.

11.1 Interviewee characteristics

Interviewees were purposefully selected and invited for interview based on gender, age, BMI, school and VFE-Count in order to include a range of backgrounds and to generate a variety of narratives and experiences of the food environment.

Six participants completed the qualitative interview; two male and four female participants, mean age 17 years (range 16-18). The mean BMI for the interview group was 24.0 (range 19.4–30.7), with a higher mean BMI recorded for the males than females (29.43 and 21.25, respectively). The six participants attended five different schools. Three of the schools were state schools (4 interviewees), one was an academy (1 interviewee) and one was a fee-paying private school (1 interviewee).

Drawing on the visited food environment (VFE) data, interviewees reported an average of 6.5 food outlet eating events over the 4-day food diary period. The inter-person VFE-Count range is deliberately large, 2–11 food outlet eating events per person, in order to obtain a range of experiences and opinions about obtaining food outside the home. The mean VFE-Count for interview participants was slightly higher than that reported for the total study population (4.7). However, the range explored in the interviews spanned the breadth of the total population VFE-Count range (0-13).

11.2 Introduction of themes

As outlined in the methods chapter (see section 4.7.3), the interview transcripts were open coded using a grounded theory approach and two key themes were identified in the data:

1. Eating out
2. Takeaway food

The above themes emerged from all of the interviews with young people. Eating out and takeaway food were talked about by the young people with regards to eating with either friends, family or both. The selected themes focus on acquiring food outside of the home. As a starting point for exploring the types of food outlets visited and used by young people, Table 30 contains details of the food outlets identified by each participant during their interview. These are identified as being visited with friends, family or alone.

Discussions surrounding food consumed during the school day or in the workplace were not included in these analyses. Other themes which were identified which could be explored in future work include school food and takeaway purchases from the school fringe environment.

It should be noted that the interview phase of the study succeeded the food diary collection phase and therefore at the time of the interview the researcher and participant had met twice previously. In this light, the researcher had already built some rapport with the young people and conversation often referenced previous (un-recorded) discussion and the data recorded by participants in the food diaries. However, analysis of the qualitative interviews

occurred prior to the in-depth quantitative analysis of the food diary data, therefore allowing the themes to emerge naturally.

Table 30 Food outlets identified within interview transcripts with regards to eating with friends, family and alone

Name	Friends	Family	Alone
Adam	McDonalds + alcohol Solomons (Indian takeaway) Iceland	Not mentioned	McDonalds
Amy	King Laus (buffet) Frankie and Benny's Nando's Fish and chip shop	Frankie and Benny's Restaurant + special occasion	Not mentioned
Charley	McDonalds KFC Big Lukes (buffet) Burger King	Greggs	Vending + bus station
Faye	Italian restaurant(s) Chinese restaurant Frankie and Benny's Pizza Hut Nando's	Italian restaurant Vietnamese restaurant Health club restaurant	Not mentioned
Nathan	Frankie and Benny's Pizza Hut Nando's TGI Fridays Cinema food McDonalds + cinema	Not mentioned	Not mentioned
Rebekah	McDonalds + cinema Pub Nando's Starbucks	Italian restaurant Chinese restaurant Starbucks	Not mentioned

11.3 Theme 1: Eating out

This section draws on the data within the 'eating out' theme. Emergent sub-themes identified the factors influencing the choice of food outlet and the types of meals ordered when eating out with friends and/or family. The primary type of outlet discussed is the restaurant. Within this chapter, the term 'restaurant' refers to those food outlets included in the classification tool categories 'Restaurant, Pub and Hotel Restaurant' and 'Takeaway and Fast Food' (in particular the 'instant fast food' sub-category) (Appendix L, Lake *et al.* (2010)). The conditions alluding to and the context within which food outlet (restaurant) and food (meal) choice decisions are made when eating out with friends or family are explored in the following sections.

Nathan, Amy, Rebekah and Faye all gave examples of times they ate out with their friends and/or families. Although Charley mentioned places she ate out with her friends, she did not elaborate on the factors influencing where she and her friends chose to eat or her food choices within these outlets. Therefore quotes from Charley's interview transcript are not included in this sub-section. Adam reported notably different eating out behaviours to the other young people which is discussed later in this sub-section.

11.3.1 Choice of food outlet

This section discusses the factors influencing the choice of food outlet visit for the purpose of eating out. There appeared to be a tendency for the young people to talk about eating out with their friends at well-known chain or franchised food outlets as opposed to unbranded or independent restaurants. Examples included full service restaurants (e.g. Frankie and Benny's, TGI Friday's) fast casual outlets (e.g. Nando's) and fast food outlets (e.g. McDonalds, KFC). Local all-you-can-eat buffet chain restaurants were also mentioned by interviewees (Table 30).

When discussing where they eat out in a friendship group situation, the young people referred to the group as a whole, "we". The interviewees did not voice an individual influence on the decision of where to eat out when with friends. Neither did they appear to show an individual level preference on the food outlet chosen. There seemed to be group conformity in the decision making process

with regards to food outlet choice, with a gravitation towards food outlets the group in question had dined at in the past (Nathan, Box 1).

Box 1 The influence of friendship groups on food outlet choice

Nathan

RT: Ok, so there are very specific places that you choose [to go with school friends]?

"Yeah Nando's is, like, I don't know everyone loves Nando's at the minute and everyone kind of goes there."

RT: That's the restaurant of choice?

"Yeah like most of my friends go to Nando's if they go out and stuff"

Faye

"Yeah, happy hours. Most of my friends go at happy hour. But also it depends what friends I go with. I went to [place name] with a group of girls and we always get a Nando's when we meet up. Some of them are in Uni and we don't actually see each other that much so we always get a Nando's, but with my main friends I think it depends who you're with and stuff."

RT: So do you have specific places that you go with different groups of people?

"Yeah"

Some of the young people highlighted the influence *different* groups of friends had on the choice of food outlet. Specific food outlets were often associated with socialising with particular friendship groups. This group connection had the potential to influence a meeting place; for example, Faye "*always*" met a group of friends, with whom she spent time travelling abroad, at a local Nando's branch (Box 1).

The relationship between young people and visited chain food outlets was multi-factorial. Chain restaurants often offer a brand with which the young people said they were familiar. By visiting a chain outlet the young people were aware in advance of the type of food served, and carried the knowledge that the price and quality of that food would be within an acceptable range.

When probed further about which members within friendship groups decided on places to eat, there was evidence that some group members had more influence than others. Amy, for example, explained that her friends exhibited similar characteristics to herself with regards to food choice, in particular with regard to the avoidance of certain food types. The decision of where to eat was

therefore based on the types of food available and their acceptability to the “fussy” individuals (Amy) amongst them. Specifically Amy talked about how she and her friends would go through the process of screening a restaurant’s menu before committing to a visit (Box 2). This process is increasingly viable given that most restaurants, particularly chains, publish their menu online.

Box 2 Friendship groups and the selection of new food outlets to visit

Amy

RT: Would your friends ever suggest you go somewhere new or anything like that? Or do you always go to sort of the same places?

“We’ve always been to the same places, but say if someone like if one of us says we should go somewhere else, we always look up the menu online if we can and have a look and see.

RT: ...what would you look at on the menu? What are the most important things when you’re choosing whether you would go there or not?

“Well say stuff like Nando’s, we were going to go there so we looked it up. But we knew it would sell chicken anyway and we all like chicken but when we realised when we looked it up that it was spicy chicken and stuff. So if we hadn’t looked it up we would have got there and no one would have liked anything.”

Faye

RT: Do you ever try anywhere new with your friends or do you tend to go to sort of the same sorts of places?

“We’d probably go somewhere new if one of us had been before like I don’t think we’d go somewhere new because we wouldn’t know the prices or what it’s like or anything, but yeah quite a lot of them just keep to the Hut so we’ll go to Pizza Hut.”

Note: Sections of longer quotes underlined for emphasis

Amy went to the extreme in *not* choosing where to eat with her friends. She said she passively allowed her best friend, whom she described as “*more fussy*” than herself, to make the decision on where to eat. By default, because her friend’s preferences were similar to her own, Amy was likely to find the menu in the selected outlet acceptable to her tastes. The type of restaurant selected did not seem to have as much importance as the individual meals available.

Supporting this view, Faye described her friendship group as only considering new food outlets that at least one person in the group had visited and enjoyed on a previous occasion (Box 2). A recommendation from a peer seemed to offer reassurance that the outlet would be a suitable choice. Faye indicated the importance of price and the quality of the food on offer, a sentiment echoed by

the other young people. The young people expressed a need to know what to expect, particularly with regards to price, prior to the visit.

11.3.2 Food (meal) choice

As discussed in the previous section, the young people identified chain outlets to be a popular choice when eating out with their friends. A standardised menu is a typical characteristic of a chain restaurant; where the same menu is available in each individual branch, irrespective of the geographic location. Although seasonal/regional variations and/or 'specials' are often available in chain restaurants, these are usually offered in addition to a stable menu in terms of meal types and price.

As with outlet choices, the young people appeared to follow a habitual pattern when it came to food choice when eating out. They reported making repeat menu choices when they dined at particular chain restaurants (Box 3). However, the data suggests that the process by which an individual decided on their 'usual' meal choice and the factors influencing that choice can vary. Nathan gave the impression that he had tried most of the menu options during previous visits to Frankie and Benny's and had thus narrowed down or simplified his options to include only a few of his favoured dishes (Box 3). In this context, Nathan's food choices could be seen to be based on his personal taste preferences, following previous exploration of the food options available to him.

Box 3 Making food choice decisions and repeat orders in chain restaurants

Nathan

"... I never usually vary it like I'll vary the main sometimes but usually it'll be between a BBQ wrap or a spicy wrap so it's never really that varied."

RT: it's sort of 'this is what I like so I'll stick to it'?

"Yeah I've tried loads of, I've tried pretty much all the menu in Frankie and Benny's and I just have what I like now."

Rebekah

"At McDonalds I get a medium chicken nugget meal, chips and a coke, from Nando's I get the medium chicken wraps with chips and water..."

Amy

"Say if I'm going to Frankie and Benny's it'll always be Spaghetti Bolognese, always the same."

RT: ok and how did you figure out that's the one that you like? Say you're in Frankie and Benny's, have you ever tried any of the other ones or is it just that you know?

"It's always been the same, I've tried a pizza there but I've always preferred the Bolognese."

Faye

RT: Would you order that in other Italians as well? Lasagne?

"Yeah I probably would, but in other Italians it would be more like you would order something else. But in Frankie and Benny's everyone's just like 'Faye do you want the lasagne?' Yeah, [it's] definitely my favourite."

In contrast, Rebekah, Amy and Faye were very specific with regards to the meals ordered in particular restaurants (Box 3). Where Nathan's choice was narrowed down to a pool of three or so items, there remained a choice to be made. However, the girls reported making the exact same food choice each time they visited the restaurants in question. Repeat ordering could be a form of comfort or security, and the data suggests that previous experience was a factor influencing food choice.

The possibility for mimicking of food choices outside of the home compared to those consumed in the home was also evident. Amy in particular, a self-labelled *"fussy eater"*, had a restricted list of foods she was willing to eat. Spaghetti Bolognese was a meal she mentioned during the interview as something she

enjoyed at home. Her selection of this dish at Frankie and Benny's could therefore have been influenced by prior exposure in a familial context.

11.3.3 Price, meal deals and sharing

When completing the food diary phase of the study, the young people were very aware of the price of food. Most were able to recall the cost of any purchases they had personally made over the 4-day food diary period. The interview data highlighted the price of food as an important factor to consider when choosing an outlet to dine at with friends and the foods selected therein. The young people appeared to be less aware of the cost of purchases made by their parents and others supplying them with food (see section 11.3.6). This section discusses the impact of price and meal deals on the selection of food outlets and meals within those outlets when eating out with friends.

The perception of the cost of food in particular outlets may influence the choice of food outlet. Rebekah spoke of visiting "*cheaper places*" when she goes out with her friends. It appeared Rebekah was making a comparison between the types of places she goes with her friends to those she visits with her parents, the more expensive outlets being those where she would not personally have to pay for the food. Although the young people interviewed indicated earning a small income for socialising, either from part-time work and/or a parental allowance, they were often working with a restricted budget. The young people therefore often set a limit on the price they were willing to pay for a meal out, with both Faye and Nathan indicating they would not spend more than £10 on a single eating event (Box 4).

Box 4 Cost of food and meal deals**Rebekah**

RT: You said McDonalds already [but] what kind of places would you go to with your friends? Pubs and stuff?

"McDonalds. We go to [local pub name] occasionally, Nando's, that's all I've been recently like just the kind of cheaper places."

Faye

"... money is a big thing so yeah I would make sure that the prices are ok and everything"

RT: And what is sort of an acceptable price for when you're going out with your friends?

"I think if a meal was more than, if the food was more than £6 I'd be a bit"

RT: For a main course?

"Yeah, because I think in Frankie and Benny's its £6 or something like that then I'll probably just get tap water because it saves money and then we probably don't get a dessert so overall I wouldn't spend more than a tenner or £8."

Nathan

"You get a starter and a main or a main and dessert for £10 or something. And what I do is have my friend, I'll get the starter and the main meal and he'll get the dessert, and we'll share the starter have a main each and then share the dessert."

RT: ok with the same friend is it?

"yeah and then it'll be we'll have garlic bread or something for our, but obviously we're just splitting it it's just a tiny little bit each, then we'll have our main which I usually get a Louisiana hot wrap which is really nice and it's like a spicy chicken wrap thing with salad and chips and then for our dessert we either have the cinnamon waffle or we'll have the brownies."

Rebekah

"...If I got pizza somewhere it's like half pizzas and things cos I couldn't eat a full one."

Note: Sections of longer quotes underlined for emphasis

The data suggest there are several strategies in play when young people were looking to get the best value for money. Ordering "*tap water*" (Faye) rather than other drinks, for example, or avoiding ordering desserts and other extra items. Taking advantage of happy hours, meal deals and sharing food were also key strategies that emerged from the data.

Happy hours were mentioned by participants with regards to the choice of outlet, depending on the time of day the visit was to take place. For example, Nathan mentioned a "*happy hour*" deal at Frankie and Benny's (Box 4) which

meant that two courses could be obtained for the same price a main course would cost at other times (e.g. main plus starter or dessert for £10). If the eating event was therefore planned to occur prior to 6pm, Frankie and Benny's was chosen as food was ordered in the meal deal timeframe. However, if the eating event fell outside of the happy hour menu time, another outlet in the geographic vicinity was often chosen instead. It appears from the data that happy hour offers make certain food outlets more accessible to young people in terms of affordability (Box 4).

Sharing a meal equated to sharing the cost for the young people, particularly in terms of getting the (perceived) greatest value for money (Nathan, Box 4). Sharing food was also seen as a way to control portion size and food waste. Rebekah talked about ordering half portions or sharing a pizza, a strategy that ensured she only ordered, and subsequently paid for, an amount of food she was able to consume (Box 4). The over ordering of food was something she avoided perhaps being seen as a waste of money but also a waste of food if her appetite did not allow her to finish the meal.

Nathan also showed restriction of portion sizes by sharing both starter and dessert and only having a *"little bit each"*. The researcher was aware that Nathan followed a calorie restricted diet to try and lose weight at the time of interview. With this in mind, sharing food could be a strategy Nathan adopted in order to reduce the amount of food he consumed without missing out on the full eating out experience of having multiple courses. The concept of sharing was dependent on the willingness of others to partake in the sharing activity. The decision about who to share food with was therefore dependent on a number of factors including the cost of food options, appetite, and the likelihood of making the same food choice as friends, sometimes requiring negotiation and compromise.

11.3.4 Eating out in conjunction with other social activities

Eating out was often talked about by the young people in conjunction with doing other activities with their friends such as going to the cinema, the theatre or attending meetings (e.g. youth council). Often these activities were completed at the weekend rather than after school or on a weekday. It appeared that

linking social activities together allowed the young people to interact for longer time periods.

Nathan, Rebekah and Amy all talked about eating out with their friends when they went to the cinema, through purchasing snack foods at the cinema venue or taking the opportunity to visit food outlets for a meal en route to or from the venue (Box 5). Purchasing fast food was a recurring theme linked with going to the cinema, with the visit occurring prior to the cinema trip. Nathan and Rebekah both mentioned McDonalds, Rebekah indicating that fast food was chosen when the time available to eat was limited (Box 5).

Box 5 Eating out and cinema visits

Nathan

"I'll always go out on a Saturday if I'm not doing anything so I'll either go to the pictures and have cinema food or eat a McDonalds which is bad."

Rebekah

RT: ...so what's different about Friday night?

"I might go out with my friends or something and like, if we go to the pub or something I might have a meal there. If we're out just shortly after school, or like last Friday I went to the cinema so we just got a McDonalds just before that. And then often I'll go out on the Saturday as well maybe now usually on the Sunday actually as well, I'll stay in most of that."

Amy

"...say if I'm going out with my friends and stuff say I'm going to the pictures or something if they want to go out after then I would go but normally if we're going to the pictures I just buy like a bag of jellies** or something and just eat them in the pictures and that's really it."*

RT: Ok so what places would you sort of go after the pictures?

"It's normally like a Chinese place or like say Frankie and Benny's or somewhere like that."

*pictures – local term for cinema **jellies – local term for sweets

Time appeared to be a factor influencing choice of outlet with regards to other activities; the time available to obtain and eat food may be restricted due to cinema showing and/or travel times. Where Nathan and Rebekah spoke of obtaining fast food prior to cinema visits, Amy indicated that she and her friends went out for food *after* attending the cinema (Box 5). More traditional style restaurants, as opposed to fast food, were mentioned with regards to dining out

after the cinema, where the eating event was not time pressured in the same way it would be prior to a cinema trip.

The data suggest that the geographic location of food outlets in relation to the cinema and transport links was a factor the young people considered when selecting a food outlet. The restaurants Amy mentioned (Box 5) are both housed within the same complex as the cinema in Newcastle city centre. McDonalds is located further afield, although within a ten minute walk of the cinema. Perhaps more importantly, McDonalds is located on the walking route connecting the cinema with a number of local public transport routes (metro station and bus stops). Visiting food outlets located close to the cinema and on transport routes was therefore convenient and time efficient.

For Rebekah, a conjoined trip to a pub and the theatre appeared to echo the process for other participants of linking food outlet choice with visiting the cinema. She reported visiting a pub prior to a theatre trip, the principles for selection echoing those of fast food and the cinema (Box 5). The pub was located close to the theatre making it a geographically convenient selection. The pub was also low cost and provided a fast service, comparable to that associated with fast food style restaurants.

11.3.5 Eating out and alcohol

Adam was different from the other interviewees as he did not talk about eating out with his friends or family. It should be noted that Adam was the eldest interviewee in the group, the only participant aged over the legal UK drinking age of 18 years. Activities Adam outlined were drinking alcohol and playing pool when out with friends, and playing computer games and ordering takeaways at home (Box 6). Adam also worked the greatest number of hours of those interviewed with a part time job (and being over 18 likely had a higher rate of pay) and therefore possibly had a larger disposable income from personal sources as opposed to relying on parental allowances.

Box 6 Young peoples' views on alcohol**Adam (1)**

RT: Do you ever sort of go out for tea and stuff with your friends? Like go out?*

"Not really. We were discussing this the week actually how we never go out for a meal. I think we're going out for one after Christmas, but we've realised we'll go out for like a game of pool and a few drinks or whatever but we've never gone out like for food in a restaurant or anything."

Adam (2)

RT: Say you go out drinking and stuff, just say you go out for a few beers would you ever get any food on the way home or anything like that?

"It depends how much we've drank really. If you go out for a fair few drinks and you're just like feeling a bit hungry you might go on to food, let's go to McDonalds or whatever. Actually if we're going to get fast food it'll be McDonalds because I've got my discount thing."

Faye

"I wouldn't go out in town because I'm not 18 yet and I feel a bit awkward but I have been out in pubs and stuff, sometimes yeah sometimes go to pubs, it just depends like where we go."

RT: So do some of your friends go out in town but you wouldn't go?

"Yeah, I don't know, I think the majority of them don't yet but most of them have been out a couple of times and more and more of us are becoming 18 so"

*Tea – local term for evening meal

Alcohol was, however, associated with food for Adam when he talked about purchasing "*fast food*" when out with his friends. Adam's use of the term "*fast food*" suggested that the speed of acquirement was a consideration when obtaining food when under the influence of alcohol. Fast food outlets are often the only outlet types open late in the evening when bars and pubs close and therefore choice of outlet might be limited. McDonalds was mentioned specifically although other local and chain "*fast food*" outlets would be open for business. Adam discussed the use of a "*discount card*" (Box 6) enabling him and his friends to purchase food more cheaply at McDonalds¹⁴. Adam reported in his food diary using the discount card when alone during the day to purchase a soft drink, indicating that the reduced price could also be a factor influencing his outlet choice at other times.

¹⁴ A McDonalds employee discount card was previously discussed with the researcher during the food diary collection interview.

In contrast to Adam, Faye, aged 17 years at the time of interview, talked about *not* going out to drink alcohol with her friends but acknowledged that it is an activity likely to become more frequently suggested as more of her peers turn 18 (Box 6). Going to the pub with friends was depicted by Faye as an occasional activity, something she perhaps partakes in to fit in with and conform to peer norms. However, it is not an activity she felt particularly comfortable with doing. This was not a view mentioned by any of the other participants. It could be that the young people interviewed were different in terms of their alcohol consumption and views of alcohol behaviours to the young people who did not partake in the interview phase of the study. This was not, however, assessed at the interviewee selection phase.

11.3.6 Eating out with parents

The interviews confirmed the questionnaire data, suggesting that young people eat out in restaurants more frequently with their friends than their families, with only half of the participants talking about eating out with their families during their interview. Faye, Rebekah and Amy all indicated “*special occasions*” as a time they would dine out with their parents/family (Box 7). Amy noted that eating out with her family, particularly with her mother who “*doesn’t like socialising*” (Amy), would be an event organised in advance. However, in addition to *special occasions*, Faye suggested that her family would visit restaurants when her parents decided they “*can’t be bothered*” to prepare food for the family.

Box 7 Eating out in restaurants with family

Amy

RT: Would you go [to restaurants] with your mum and dad?

"Yeah, it's normally on a Christmas where we meet up with all the other family and my mam will go out then... but we'd never like randomly go out, it's never like that."

Faye (1)

"...with my family it's a special occasion really or if we fancy it or my parents can't be bothered to make tea then we just go out."

RT: And what kind of places do you go with your parents?

"Well we'd never been to this place [Italian restaurant] before but my dad was like 'oh I've heard this place is nice', so we went along..."

My parents are always trying to find new sort of places but generally to quite a lot of Italians because my brother likes Italian food..."

Rebekah

RT: On what kind of occasions would you go [to restaurants with your family]?

"Well like birthdays, it's just occasions if people fancy a meal out but it's not that often really."

RT: ...and what kind of places would you go to with them?

"Italian restaurants, Chinese, just like generally more like expensive places I couldn't afford normally because my parents would be paying for it so... they would decide normally where we go."

Faye (2)

"...there's a Vietnamese restaurant we sometimes go to as well... but it's really expensive so it just depends like what we've spent money on that month..."

Note: Sections of longer quotes underlined for emphasis

Parents, rather than the young person, made the decisions on where the family go out to eat although the choice of restaurant accounted for the taste preferences of different family members. Faye spoke of her parents' preference for trying new restaurants; however the family appeared to visit different restaurants within the same cuisine type taking into account her younger brother's preference for Italian food (Box 7). There was a tendency for cuisine types, such as Chinese and Italian, rather than business names to be mentioned when talking about eating out with family. In contrast to discussions

about eating out with friends, chain restaurants were notably missing from these discussions regarding eating out with family.

As with eating with friends, the choice of food outlet with family depended on cost of food and the available budget. Restaurants visited with family were generally described by the young people as being more expensive when compared to those they would visit with their friends and that parents would pay for the meal (Rebekah, Box 7). Faye was aware that the choice of restaurant was influenced by the cost of the outing, with the more expensive options (e.g. *Vietnamese restaurant*, Box 7) saved for when the family budget would allow.

11.3.7 Eating out summary

The qualitative data suggested that the selection of a food outlet for dining out with friendship groups was based on social acceptability and group consensus, economic cost, the occasion, and convenience in terms of both timing and geography. The particular outlet selected often depended on the group of people attending, with different outlets associated with different friendship groups. Most often the same outlet was selected for repeat visits. By visiting different outlets with different friendship groups, it is implied that the young people may eat different foods dependent on who they are dining with. However, this concept was not specifically explored in the interviews. The data suggest that new outlets were unlikely to be chosen without prior vetting through menu evaluation via the Internet or through personal recommendation.

The price of meals was a consideration, especially where the young people were paying for meals using their own allowance or earnings. The value of the food seemed to be closely linked with price; happy hours seemingly offered a time when restaurant meals were more attainable for some. The timing and purpose of the event also played a role with different outlets selected where additional activities, such as the cinema, were part of the social event. It appeared that the food choice was somewhat predetermined by the food outlet selection. Recurring visits to the same food outlets resulted in the repeat ordering of meals within those outlets. The food choices made by the young people often reflected the foods they consumed at home.

The young people did not directly choose food outlets when dining out with their families, their parents made the decision on when and where to eat. Family preferences and price were considerations although the restaurants selected were perceived by the young people to be more expensive than those used when eating out with friends.

11.4 Theme 2: Takeaway food

When examining the food diaries completed by the young people, obtaining food from takeaway food outlets appeared to be a common occurrence. Therefore, a topic of particular interest for further exploration during the interview phase was takeaway foods. During the semi-structured interview, all participants were asked to talk about takeaway food and all of the young people confirmed they ate takeaway food with their family and/or friends.

The term ‘takeaway’ was not defined by the researcher in the questioning and therefore the young people interpreted and expressed the meaning of this term in their own way. On examining the data, ‘takeaway food’ can be defined as hot, ready to eat food, not requiring any further preparation or cooking, for example burgers, chips, pizza, noodles, purchased from a food outlet and consumed elsewhere e.g. at home.

Three sub-themes were identified in the data and are discussed in the following sections: conditions leading to takeaway eating events, takeaway food outlet choice, and food/meal choices made within takeaway food outlets.

Nathan, Amy, Rebekah and Faye all gave examples of times they ate takeaway food with their families and with their friends. Charley told the interviewer that she did not eat takeaway food with her friends, only with her family. In contrast, Adam reported only consuming takeaway food with his friends and not with his family.

11.4.1 Conditions leading to takeaway eating events

Lack of time and enthusiasm to prepare food were the main reasons the young people gave for their parents making takeaway food purchases for their family. Takeaway food for the family was perceived by the young people as an easy option with their parents resorting to takeaways when they *“can’t be bothered”*

(Faye and Rebekah, Box 8) or it was an “*inconvenient time*” (Rebekah, Box 8). In addition, the data indicated that takeaways were more likely to be consumed over the weekend rather than during the week, particularly on Friday and Saturday evenings (Box 8).

Box 8 Reasons for and frequency of use of takeaway food outlets for home consumption

Faye

“More often my dad will get one [a takeaway] than my mum, because my mum’s often away on courses. Then because my dad gets home late from work, so he comes home about 6 o’clock which is generally too late and if we can’t be bothered to make anything that’s when we get a takeaway. And if there’s like a special occasion like passing exams or something then we’ll get one.”

Rebekah

“I guess if someone can’t be bothered to prepare food or it’s like an inconvenient time or something we just go there.”

Nathan (1)

“[We’re] more likely [to get a takeaway] on a weekend like Friday, Saturday or Sunday, no definitely not Sunday. Friday or Saturday”.

Charley

“Probably once a week.”

Nathan (2)

“I wouldn’t say often but regularly if there’s a difference, it’s not like every week but I’d say once every two weeks”

Note: Sections of longer quotes underlined for emphasis

Some takeaway food was seen as a treat for the family or something to have on “*special occasions*” perhaps providing a more affordable route of ‘eating out’ than visiting a restaurant. However, the data suggest that eating takeaway food at home was not restricted to ‘special occasions’ but was a fairly regular occurrence. Nathan and Charley point out that their families eat takeaway food on a weekly or fortnightly basis (Box 8). This implied that family takeaway eating was a routine behaviour, occurring more frequently than eating out at restaurants and that food provision behaviour at weekends was different to that exhibited during the week.

Less detail about the conditions leading to takeaway consumption with friends were given by the young people. House parties with groups of friends resulted in takeaway food being ordered, indicating a method of easily providing food for a large number of people (Nathan and Faye, Box 10, p232). Takeaway food with friends was also discussed in terms of during the school day, although is not included in the current analysis.

11.4.2 Factors influencing choice of takeaway food outlet

The analysis brought to light a number of factors which influence the choice of food outlet used for takeaways. These included who is involved in the takeaway eating event (family, friends etc.), geographic convenience, time available, price, quality and value, and the taste preferences at the individual, peer group and family unit levels.

Cuisine types were most often used by the young people to describe takeaway food outlets, e.g. Chinese and Indian. However, when prompted for more detail by the interviewer, all interviewees were able to name and locate specific takeaway food outlets they have used in the past. Branded or chain outlets were a much less dominant theme when talking about takeaway food than within the 'eating out' theme. Domino's Pizza was the only chain takeaway outlet mentioned and this was with reference to ordering takeaway with friends (Faye, Box 10, p232). Fewer branded takeaway outlets are located within local communities and therefore it could be that extra charges such as delivery are avoided if food is ordered from independent outlets closer to home.

With regards to takeaway food outlet choice, it appeared that parents and guardians had the final decision on which food outlets were used. The data suggest that parents have preferences for particular cuisines that the young people do not always share. For example, Nathan and Rebekah said they liked Indian takeaways but their families did not share their tastes and therefore Chinese takeaway outlets were often chosen instead (Box 9). They also both indicated that the Chinese takeaway outlets were located closer to their home than the Indian outlets and therefore proximity to the outlet and the convenience of obtaining the takeaway food appeared to be the dominating influence. If the outlet was close to home, food could be collected in person and brought home in a timely manner i.e. whilst it was still hot. Walking was the most commonly

mentioned transport method when talking about collecting takeaway food. Although some of the young people indicated that their parents collected food by car, none of the young people mentioned delivery as a means of obtaining food.

Box 9 Takeaway food outlet selection with family

Amy (1)

"Well it's at the top of the street I've always went to the same one and its [food outlet] on [street name] that's where I go all the time and I've been there for like years so I know the people and stuff like that."

Charley

"I think it's that they [parents] like the pizza place so they go there like all the time."

Nathan

RT: So your grandma and granddad don't like [Indian takeaway]?

"No they don't like it, plus I just think that the Chinese and stuff is more convenient for them cos there's two right near [to home] and a fish and chip shop."

Rebekah

"We have like fish and chips takeaways at home... Sometimes have a Chinese takeaway as well and I like Indian but my parents don't so we don't often have that. There's like two Chinese takeaways round the corner from my house, it's pretty easy."

Amy (2)

"Well when my Mam gets takeaway it's usually just Chinese on the weekend but it's mainly just chips and gravy and stuff. But say she wants a takeaway during the week, it's always an Indians, where I don't eat the Indians so I'd eat the food in the house while they [family] eat the takeaway"

Note: Sections of longer quotes underlined for emphasis

The young people stated that their parents obtained takeaway food from specific outlets indicating some degree of preference and/or loyalty to these outlets. As local residents, there are often societal bonds with the owners or workers at particular takeaway food outlets. The data suggest that both parents and young people, as regular customers, had built up rapport with takeaway outlet staff and this encouraged multiple visits to those outlets (Amy (1), Box 9). In addition, a sense of community and support for local businesses may influence the decision to use takeaway outlets close to home.

Amy suggested there was a compromise scenario in play when deciding on a takeaway outlet if members of the family had conflicting food preferences. She explained that she did not eat certain food stuffs and as a result would be excluded from family takeaway events where Indian cuisine was chosen (Box 9). However, when food was ordered from the Chinese takeaway, her parents made allowances for Amy's preferences above other family members and food was ordered at a time convenient to her. By doing this, Amy was able to be involved in the takeaway experience but also distance herself from foods she did not like, in particular those ordered by her parents and brother. Nevertheless, her parents ultimately had the final decision on the takeaway outlet used.

The type of takeaway cuisine acquired appeared to be influenced by the foods routinely available to and consumed by the family during 'normal' home food provision. For example, Nathan mentioned "*never*" having takeaway pizza as this was a food type he reported consuming at home cooked from frozen. Similarly, Adam talked about purchasing frozen pizza from a local supermarket to cook at his friends' home rather than purchasing a takeaway pizza. Ease of preparation could be a factor in the decision not to obtain takeaway pizza, with limited skills and time required to cook a pizza from frozen and relative in-expense when compared to takeaway options. In addition, the location of outlets is likely to influence the decision not to obtain takeaway pizza, the outlets perhaps being located further away from the home.

As with family takeaways, food outlet location appears to be an important factor when deciding where to get takeaway food with friends. The Indian takeaway is "*round the corner*" from Nathan's friends home (Box 10), which was a similar situation for Adam, who told the interviewer that the takeaway was less than a five minute walk away from his friend's home. Ease of acquirement in terms of travel distance and proximity were, therefore, potential factors in outlet choice.

Box 10 Takeaway food outlet selection with friends**Nathan**

"Usually if we're at a party we get takeaways... if I'm round at theirs [friends] then Indians cos there's an Indians just round the corner so we'll just have Indian."

Adam

"[it's] the nicest Indians I've ever been to in my life and it's £4.50 for curry and rice so we might go there sometimes."

Faye

"Yeah we split it [the cost] or some people will get a deal and they'll pay separately for theirs and we'll pay. But at our house if my parents pay on the card and then we sort of club together and give them the money back... Domino's is a huge favourite."

"Dominos is really expensive so we just get that when friends come round."

Price and value for money were factors considered by the young people, particularly when selecting takeaway food outlets to visit with friends. Adam pointed out the cost of curry and rice, a complete meal, signifying he felt this was a deal or good value for money. Faye on the other hand, felt that Domino's Pizza was an expensive choice of takeaway outlet reserved for when a group of friends were sharing the cost (Box 10).

11.4.3 Takeaway food (meal) choice

Although the young people did not appear to have much of an influence over the choice of takeaway food outlet for a family meal, they were usually given the opportunity to order their own choice of meal. As with the 'eating out' theme, the young people exhibited a repeat ordering behaviour trait, a behaviour that also appeared to be true for their parents (based on the young people's perception of what their parents order). In addition to their food orders, the young people were able to recall the food choices regularly made by their parents/ guardians from specific takeaway food outlets (Nathan and Rebekah, Box 11).

Box 11 Selection of meals from takeaway outlets**Rebekah**

"I like chicken fried rice, like duck sometimes. My Mam and Dad like king prawns and green chilli and garlic, I think it's called, and we get the free prawn crackers"

Faye

"I don't really like Chinese...because I like duck pancakes and my Dad thinks they're really expensive so I generally always have house fried rice which is not very exciting. But yeah Indian is generally favourite."

Nathan

"We always have the same"

RT: same order?

"Yeah, if it's Chinese we'll get like, we'll split it so we'll have rice on a plate. I don't know how much portions"

RT: That's fine don't worry

"We'll have rice and then chips and then there'll be the chicken curry which has got like onions and stuff in... and that's it cos we used to get chow mein and egg fu yung as well, and then I said I don't like chow mein and I don't even like egg fu yung, so they [grandparents] just stopped getting it. So then sometimes they get it and they have it on their plate and I always only have the rice, the chips, the chicken and then now and again a bit of extra chow mein will be hoied on my plate. But I don't like it that much so I never have it."

In addition to restricting choice through selecting food outlets, parents were able to restrict their adolescent's food choices through other ways. Faye was not allowed to order what she wanted to eat from the Chinese takeaway and therefore shows distaste for the cuisine overall (Box 11). The refusal of her *"duck pancake"* request by her father was, in Faye's perception, down to expense and she was encouraged to make an alternative choice. Duck pancakes are often consumed as a shared starter and it could be that her father sees this as an additional expense or that as a meal, the product is not good value for money with a lower quantity of food provided for a higher price.

For Nathan, having a takeaway meal was a family social event. Sharing takeaway food allowed him to socially interact with his grandparents (with whom he lived) as a family unit (Box 11). Nathan reported eating alone and not at the same time as his grandparents at all other meal occasions in the home and therefore takeaway meals have the potential to provide family contact time that otherwise might not exist.

11.4.4 Takeaway food summary

Location and convenience were important influences on takeaway food purchases with food outlets closest to the home the favoured choice. The young people perceived their parents to prefer takeaway cuisine types where the food outlets were located close to the home. The selection of takeaway food outlet for the family was a decision primarily made by parents, who also generally paid for the food. Young people were generally allowed to make their own food choices within the takeaway environment, however, there were times when these choices were modified or restricted by parents. The selection of meals appeared to follow the same repeat order pattern seen with chain restaurant dining. Although different takeaway outlet choices in terms of cuisine type appeared to be made with friends compared with family, convenience of outlet location and the price of food were considered in both situations.

11.5 Summary of interview findings

- A purposefully selected sample of participants (n=6) were interviewed using a grounded theory approach to further explore the drivers of food choices in this population.
- Two themes emerging from the interview data were selected for detailed analysis: eating out and takeaway food.
- Factors that influenced where young people ate out with friends included acceptability and group consensus with regards to the restaurant choice, occasion, cost and geographic and time convenience.
- Habitual visits to the same restaurants (in terms of chain outlets) were a theme when eating out with friendship groups.
- Eating out with friends was often linked to other activities such as going to the cinema and this influenced which food outlet was visited.
- When eating out with family, it was parents who made the decision of when and where to eat although personal preferences of the young people and other family members were taken into account.
- The young people perceived price to be an influencing factor on where their parents chose to eat out with the family.

- Geographic location and convenience were important factors in takeaway food outlet use with outlets closer to home being perceived by young people to be their parents favourite.
- Autonomy of food choice was generally reported with young people making their own food choices although for both restaurant and takeaway eating repeat ordering of specific meals was a recurrent theme.

Chapter 12 Discussion and conclusions

Chapter overview:

- Identifying the food environment of young people at the individual level
- Use of individual food environment ratings and the relationship between the food environment and health outcomes
- Exploring the drivers of food choice in young people
- Strengths and limitations of the study
- Recommendations for improving the food environment
- Suggestions for future research
- Overall conclusions

The overarching aim of this study was to explore whether, and to what extent, the food environment to which a young person is *exposed* has an influence on individual food intake. This was addressed using a mixed method approach to identify the sources of food used by young people and the contribution of those sources to dietary intake and diet quality. Second to home, food outlets were found to be an important food source for young people and as such were explored further in terms of the types of food outlets visited and the nutritional quality of eating events sourced from these outlets. Further, the relationship between the number and variety of visited food outlets was explored in relation to total dietary intake and adiposity. This study was the first to explore the food outlet environment to which young people aged 16-18 years in the North East of England are exposed at an individual level using GPS and GIS techniques. Finally, the factors influencing food outlet choice and the food choices therein were explored using qualitative interviews, adding context and insight to the quantitative data collected in the earlier stages of the research.

This discussion chapter presents the research evidence for each of the study objectives, setting the findings within the context of previous research in the food environment field. This is followed by a discussion of the strengths and limitations of the research methods. The chapter concludes with a statement of the main findings in relation to the main study aim and recommendations for further work.

12.1 Identifying the food environment of young people at the individual level

This section discusses the findings answering the first study objective:

Objective 1: To identify the physical food environment of 16-18 year olds living in Newcastle using a mixed method approach to 'map' and record use of and exposure to food environments at an individual level.

The findings on the relative importance of different types of food sources used by young people including identifying the frequency with which each food source was used and the contribution of each source to dietary intake are discussed below. The healthfulness of eating events is compared to results of previous studies. The section goes on to explore the food outlet environment in greater detail, discussing the frequency of use of different types of food outlets and the nutritional content of eating events obtained from food outlets. The importance of differentiating between food source and eating location, a methodological strength of this study, is highlighted.

12.1.1 Importance of the home to dietary intake

All participants used the home as a food source at least once over the study period, confirming the importance of the home as a source of food for young people. Sixty-two percent of eating events were sourced from the home. This was similar to findings reported in a study of 18-23 year olds in the USA where 59% of eating events were sourced from home (Laska *et al.*, 2010a). Home sourced eating events had the most favourable nutrient densities providing the lowest energy density, highest nutrient density of protein and fibre and higher levels of micronutrients than all other food sources. These findings were consistent with those reported by Adamson *et al.* (1996), where foods consumed at home had a higher nutrient density of protein and micronutrients and lower nutrient density of fat and non-milk extrinsic sugars than foods sourced from outside the home.

The home was found to be an important source of fruit and vegetables, with 72% of vegetable intake and 65% of fruit intake sourced from home. However, 22% of participants did not consume any fruit over the 4-day study period. The

majority of food sourced from home was also consumed at home (86%); 10% was consumed at school as packed lunches or snacks. Overall, 58% of eating events were consumed in the home (eating events assessed by eating location), comparable to a study conducted in the USA where 56% of eating events were consumed in the home (n=802, age=12-17 years) (Zoumas-Morse *et al.*, 2001).

This research adds to the evidence base for home continuing to be an important source of food for young people. The use of home as a food source was found to vary by gender with females reporting a significantly greater proportion of home-sourced eating events than males. Home provided the most healthful nutrient density of eating events. However, over a third of eating events were sourced outside of the home and the impact of these sources on the adolescent diet warranted further exploration.

12.1.2 Friends' and relatives' homes as a source of food

The influence of friends' and relatives' homes as a food source is understudied in the literature but was included in the current study. This food source included dual homes (such as split parent families), grandparents and other extended family member homes, alongside friends' homes. A quarter of participants reported having such 'dual' homes; the number of lone parent households is on the rise in the UK (Office for National Statistics, 2012) and therefore the impact of spending time at more than one home on dietary intake is potentially important.

Over half (53%) of participants reported at least one eating event sourced from a friend or relatives' home over the 4-day study period and 8% of eating events were obtained from these sources. This was in line with other study findings where adolescent girls (mean age 16 years) reported eating at friends' homes an average of 3.5 times over a 7-day period (Cohen *et al.*, 2012) and 37.5% of children of Latino background reported consuming food from a friend, neighbour or relatives' home at least once per week (Ayala *et al.*, 2008).

There are few studies assessing the contribution of foods from friends' and relatives' homes to total dietary intake. In terms of nutrient density, eating events sourced from friends' and relatives' homes had an energy density and

nutrient density comparable to other out-of-home food sources (food outlets, school and work); although overall friends' homes contributed to only 7% of the total energy intake. Supporting these findings, Cohen *et al.* (2012) indicated that friends' homes may be a source of less healthful foods for adolescents with snack foods and soft drinks more frequently sourced from friends' homes than food outlets.

Friends' and relatives' homes were also an important source of alcohol for the young people. Those who reported consuming alcohol during the study period (n=21) obtained a mean of 34% of their alcohol intake (g/day) from friends' and relatives' homes. Source of alcohol may vary by age, with different sources used depending on whether the individual was legally able to purchase alcohol for themselves. Only three participants were aged over 18 at the time of study completion and therefore the sample group was too small to draw any meaningful conclusions.

12.1.3 Young peoples' use of the school food environment

A systematic review of out-of-home eating by Lachat *et al.* (2012) found that for the majority of studies conducted with an adolescent population, school was the most important source of food outside of the home providing between 9% (Lin *et al.*, 1999) and 16% (Zoumas-Morse *et al.*, 2001) of daily energy intake. School was the food source for 14% of eating events on weekdays in the current study, the second most important out-of-home food source after food outlets. Nine percent of total diet energy intake was attributable to food sourced from school although this was calculated based on intake over 4-days including weekends and therefore this figure may underestimate the contribution of school food to total energy intake on weekdays only. This is lower than earlier UK figures reported by Adamson *et al.* (1996) where school food contributed to 14% of total energy intake. However, these figures were reported for a younger age range (11-12 years) than the present study population and older adolescents are more likely to source food from outside of the school grounds (Sinclair and Winkler, 2008). Perhaps unsurprisingly, the majority of eating events sourced from school was also consumed at school (97%).

Adamson *et al.* (1996) found that for younger UK adolescents, of meals sourced outside of the home, those sourced from school were closest in terms of

nutrient density to meals obtained from home. In contrast, this current study found that school eating events had a significantly higher mean energy density and lower nutrient density of fibre and iron than eating events sourced from home. It is possible that different types of food are available within the secondary school food environment of the current study, compared to the findings of Adamson *et al.* (1996) where the school food environment referred to that within middle schools (age range= 9-13 years). This highlights the need to improve the nutritional composition of food choices available in secondary school, an issue the School Food Plan is addressing (Dimbleby and Vincent, 2013).

As a food source, school appeared to be more important for those of lower SES, with those individuals residing in areas of lower deprivation reporting a significantly lower proportion of school sourced eating events than those who lived in areas of higher deprivation (5% compared with 12%, $p=0.02$). Some of the participants may have received free school meals thereby contributing to the difference in school eating events by SES groups; however data regarding free school meal uptake were not collected in this study.

The data for this study were collected during the 2011/2012 school year. It is possible that the contribution of the school food environment to the dietary intake of young people could increase following the introduction of mandatory post-16 education in 2013 (Department for Education, 2012b). However, the school food standards (Children's Food Trust, 2013) only apply to those young people studying at sixth form colleges attached to secondary schools not to those in academies or other educational institutions. This is set to change in September 2014 when disadvantaged students attending sixth form and further education colleges will be entitled to free school meals (Deputy Prime Minister's Office and Department for Education, 2013). There is still potential for schools to provide healthier food choices and improve the diet quality of students particularly if closed gate policies are adopted (Neumark-Sztainer *et al.*, 2005; Sinclair and Winkler, 2008).

Overall, 9% of eating events were sourced from school and 17% of eating events were consumed at school. By eating location, half of eating events were sourced from school, 35% from home and 11% from food outlets. This suggests

that food outlets may be less important as a source of food for school located eating events than has been previously reported by others (Wills *et al.*, 2005; Sinclair and Winkler, 2008). However, it is likely that the 'in transit' and 'other' eating location categories included eating events consumed away from the school premises during break times thereby underestimating the food outlet eating event consumed during and around the school day.

12.1.4 Frequency and type of food outlet use

Food outlets were the most important out-of-home food source for young people in this study. Over a third (38%) of eating events were sourced outside of the home and half of these were obtained from food outlets, equating to one in five eating events. Only two participants (4%) did not report using a food outlet over the 4-day study period highlighting the importance of food outlets as a food source for the majority of the young people. There was no significant difference in the proportion of food outlet eating events recorded on week and weekend days showing their role as an important food source across the whole week.

Eating events sourced from food outlets showed the greatest variation in terms of where the food was consumed. Only a quarter of food outlet eating events were also consumed within the food outlet suggesting that the majority of food young people obtain from food outlets is consumed off the premises as a 'takeaway'. Almost a quarter of food outlet eating events (23%) were consumed at home, again highlighting the importance of differentiating between the source of food and the eating location. A study of the trends in food sources and eating location in the US attributed the increase in fast food intake in children and adolescents between 1994 and 2006, to an increase in fast food consumed at home (Poti and Popkin, 2011). In addition to the food outlets used for home food consumption, 11% of food outlet eating events were consumed at friends' and relatives' homes, broadening the influence of food outlets on 'home' consumption. Many studies include fast food and takeaway eating events purchased for the household within analysis of food 'at home' (Poti and Popkin, 2011; Lachat *et al.*, 2012), which could underestimate the contribution of these sources to the dietary intake of individuals.

Eating meals on-the-move has been suggested as a behavioural trait of young people (Laska *et al.*, 2010a) and this was no different for the population studied

here. Emphasising the variety of eating locations for food outlet sourced eating events, 17% of food was consumed in 'other locations' such as outdoors or at unspecified locations and another 10% of was consumed 'in transit' such as whilst walking or travelling in a car or on public transport.

Consuming meals outside of the home has been consistently linked with poorer total diet quality (Lachat *et al.*, 2012; Jaworowska *et al.*, 2013) and foods obtained outside the home have been reported to have poorer nutritional quality than those sourced from home (Poti and Popkin, 2011; Cohen and Bhatia, 2012). Food outlet eating events contributed to 27% of the total energy intake of young people in this study. Eating outside of the home has been shown to be an important source of energy intake for adolescents (Lachat *et al.*, 2012) although few studies have attempted to attribute energy and nutrient intake to their specific food sources. Those that have did not adopt the same methods of analysis and as a result may not be strictly comparable. Adamson *et al.* (1996) found that 30% of total energy for 11-12 year olds was attributable to foods consumed outside of the home. However, with the exception of purchases made by the child themselves, takeaway meals were classified as household food purchases and therefore included in the home food nutritional analysis. Foods outside of the home also included school food which, contrary to the current study, was closer in nutritional composition to the home than other out-of-home sources (Adamson *et al.*, 1996).

Eating events sourced from food outlets were 35% more energy dense than those sourced from home. Food outlet eating events had the least healthful nutrient density profile of the food sources investigated being highest in energy density and total fat and low in fibre, iron and vitamin C. In terms of energy density, all out-of-home eating events were less healthful than those sourced from home, however only food outlet and school eating events were significantly more energy dense than home eating events ($p < 0.01$). While not reporting energy density, Zoumas-Morse *et al.* (2001) found that the energy content of restaurant eating events was 55% higher than eating events at home and higher in fat and saturated fat. The authors also reported that eating events consumed at school, work, day care, or a friend's home were not statistically significantly different from meals eaten at home (Zoumas-Morse *et al.*, 2001). It should be noted the study by Zoumas-Morse *et al.* (2001) had a much larger

age range than the current study and included children and adolescents aged 7-17 year olds.

This study confirmed the assumption that eating events sourced from food outlets are less healthful than those sourced from home. Given that 20% of eating events were sourced from food outlets, further investigation into the types of food outlets and the contribution of those outlets to the energy and nutrient density of food outlet eating events was undertaken.

In recent years, the majority of studies assessing access to and use of food outlets have focused on fast food consumption. This study found a high contribution of fast food and takeaway outlets to the food outlet eating events. The most commonly reported food outlet type, as categorised using the food outlet classification tool (Lake *et al.*, 2010), was 'takeaway and fast food' which was used at least once over the 4-day study period by 62% of participants.

Some other studies have also attempted to assess in more detail the types of outlets used by young people. In an example from the US, Harris *et al.* (2011) assessed the fast food consumption of 14-18 years olds by outlet types. The most popular fast food outlets were 'burgers and fries' (62.9%), 'pizza parlour' (53.1%) and 'sandwich and sub shop' (45.7%) (Harris *et al.*, 2011). The study used a broad definition of fast food including outlets such as coffee shop and snack bars within larger food stores. The food environment in this USA study differs in terms of cultural definitions of food outlets when compared with those adopted in the current study which used a much stricter definition of fast food (Lake *et al.*, 2010). Harris *et al.* (2011) did note that very few participants (3%) reported not visiting a fast food outlet in the past month which falls in line with this study's finding that only 4% of participants did not visit a food outlet over the 4-day study period.

A close second to fast food and takeaway outlets was convenience stores, used by 44% of the young people and making up a quarter of food outlet eating events. Supermarkets were also a popular choice (40%) indicating the importance of investigating the full breadth of food outlet types used by young people. In the US, Poti and Popkin (2011) reported a shift from fast food to food stores as the main source of out-of-home food for children and adolescents (aged 2-18 years). The current study was strengthened in the collection of data

from young people regarding use of all types of food outlets. Although takeaway eateries were the most popular outlet type by count, they made up only a third of the total food outlet eating events demonstrating that young people use a wide variety of food outlet types. Focusing solely on fast food, as many studies do (Jaworowska *et al.*, 2013), would therefore have excluded over half of the food outlet eating events recorded by the young people in this study.

Previous research has indicated that males, particular in younger age groups, visit fast food and takeaway outlets more frequently than females (Larson *et al.*, 2010; Kerr *et al.*, 2012). The current study found similar results, although the differences were not statistically significant.

Food stores are starting to play an important role with many offering convenience 'ready to eat' foods comparable to those available from fast food outlets (Creel *et al.*, 2008; Sharkey *et al.*, 2011). Gustafson *et al.* (2013) found that 75% of adults reported making a food purchase from a supermarket at least once per week, compared with 23% of participants reporting fast food purchases in the same timeframe. The young people in the current study reported use of supermarkets at a less frequent rate and fast food outlet use at a more frequent rate than those reported by Gustafson *et al.* (2013). The study participants all lived with adult family members and therefore the less frequent use of supermarkets than adults is likely due to lack of responsibility for household food purchases.

It appeared that a higher rate of food outlet use was reported in the food diaries than the study questionnaires although this was not tested using statistical analysis. Within the HFEQ, 38% of participants reported consuming takeaway or fast food at home and 36% reported these foods away from home more than once per week. It is therefore possible that studies using questionnaire methods to assess fast food intake may underestimate the use of food outlets and thus the impact these may have on the diet. Data from the LSQ suggested that participants were more likely to dine out at fast food restaurants when with their friends than with their family. Anecdotally, the use of independent fast food and takeaway outlets was more prevalent than the use of national chain outlets. Sinclair and Winkler (2008) reported a similar trend when assessing the use of school fringe outlets and (Jaworowska *et al.*, 2013) highlighted the need to

investigate the nutritional composition of meals from independent fast food outlets.

This study has confirmed that eating events sourced from takeaway eateries and convenience outlets had a nutrient density less favourable to health than traditional eateries and grocery outlets. Takeaway eatery eating events were high in fat and saturated fat density although these were not significantly different to eating events sourced from traditional eateries or grocery outlets. Convenience outlet eating events were significantly lower in protein, fat and saturated fat density than all other food outlet sources but significantly higher in carbohydrate and sugars density. The mean nutrient density of sugars of convenience outlets was over twice that of grocery outlet eating events. Convenience outlet eating events were also lowest in nutrient density of iron.

The variation of nutrient density according to the food outlet types could potentially be explained by the types of foods consumed from these outlets. Although a food group analysis was not within the scope of this study, pictorial evidence collected by the participants (presented in Figure 44-45) indicated that foods from takeaway eateries included fried items such as chips and meat products such as burgers contributing to the high fat and saturated fat figures. Foods from convenience outlets included energy drinks and sweet pastries, which would provide the high levels of sugars seen with relatively little contribution to micronutrient intake. Many studies use grocery stores to indicate the availability of 'more healthful' foods but the current study did not support this; grocery stores had the highest mean energy density of the food outlet types.

This is an important finding for future public health policy; current initiatives have focused on large multi-national chains such as McDonalds when in reality young people are using local outlets with much greater frequency. Many chain outlets (including Wetherspoons, Pizza Express, Subway and McDonalds) have signed the public health responsibility deal (Department of Health, 2013b) and as a result provide calorie labelling on menus and have made some recipe reformulations to make healthier food choices easier for the consumer. This research suggests that such initiatives should also be rolled out across the independent sector if they are to benefit this age group. However, previous

research has shown that the provision of nutritional labelling does not influence the majority of adolescents to change their food choices when eating out (Elbel *et al.*, 2011). In light of this, reformulation of products available to make them healthier may be a more successful approach to changing the diet of young people.

As discussed above, the nutrient density of eating events from takeaway eateries and convenience outlets were markedly different and variations in the types of food outlets used according to gender could warrant further exploration. If different outlets are used by males and females, there may be benefit in the targeting of specific interventions for healthy eating to each gender. For example, interventions targeted at males might focus on reducing fat intake from takeaway outlets, and for females the emphasis could be on reducing sugars intake from convenience outlets.

12.2 Use of individual environment ratings and the relationships between the food environment and health outcomes

This section discusses the combined results of Objectives 2 and 3 as stated below:

Objective 2: To rate the healthiness of food environments which participants visit so calculate individual food environment ratings.

Objective 3: To examine relationships between individual dietary intake, anthropometric and socio-demographic measures and visited and exposure environment variables.

A unique aspect of this study is that it assessed the *visited* and *exposure* food environments of young people using a variety of measures identified via participant completed food diaries and GIS methods. The density and variety of food outlets visited by young people was assessed using the VFE-Count and VFE-Ratio. Similarly, the density and variety of food outlets to which young people were exposed was assessed using the EFE-Count and EFE-Ratio. For VFE food outlets, measuring food environments surveys were completed to give an indication of the healthiness of the consumer food environment within these outlets. An individual MFE score was calculated for each participant based on

the VFE outlet score, resulting in a unique assessment of the consumer food environment linked to the individual. The relationship between each of these measures and diet, adiposity and socio-demographic measures is discussed in this section.

This is the first study to use prospective diary methods to investigate the relationship between the frequency of food outlet eating events and dietary intake. Previous studies in young people have found that reported intake of fast food is associated with higher total diet intakes of energy, fat, saturated fat and lower intakes of protein, fibre and vitamin C (Paeratakul *et al.*, 2003) and that higher reported frequency of fast food consumption is associated with higher fat and saturated fat intake and lower micronutrient intake (French *et al.*, 2001). The findings of this study, however, did not detect the same relationships. The frequency of reported food outlet use, as assessed using the VFE-Count, had a null association with the majority of the dietary intake variables assessed. The VFE-Count was significantly associated with energy density of the total diet suggesting that those who reported a greater number of food outlet eating events had a more energy dense diet although the correlation was relatively weak ($r=0.34$, $p=0.02$). Total energy intake was weakly associated with VFE-Count although this relationship was not statistically significant ($r=0.27$, $p=0.07$).

The VFE-Count gave an indication of the total use of all food outlet types over the study period. Other studies have used proxy measures, such as questionnaires, to assess both dietary intake and frequency of food outlet use (Fraser *et al.*, 2011). Previous work has focused on assessing the relationship between the fast food outlet used and dietary intake (French *et al.*, 2001) and as such is of limited comparability to the present study.

The healthiness of the VFE food outlets was objectively assessed by researchers using the MFE surveys; surveys were completed for 84% of food outlets eating events recorded by participants. Surveys were scored based on the availability and variety of food choices. Foods included in the MFE surveys represented foods commonly consumed by adolescents. Based on food outlet classification type, the MFE survey scores were significantly lower (an indication of a less healthy food environment) for convenience outlets and takeaway eateries than grocery outlets and traditional eateries. This finding was important

leading into the calculations of the VFE-Ratio and EFE-Ratio which used food outlet classification types as a proxy measure of food outlet healthiness. This builds on methods used by others using ratios such as the RFEI and PFEI to indicate variety present within community food environments (Spence *et al.*, 2009; Truong *et al.*, 2010).

The individual MFE score and VFE-Ratio attempted to indicate the potential for individuals to make healthful food choices within the environment they choose to visit. The food outlet healthfulness is, of course, just one of a range of factors influencing individual food choice and subsequent dietary intake from food outlets.

The cut-offs used to estimate 'more healthy' and 'less healthy' consumer food environments using surveys are a work in progress with the measures used to assess this concept varying across the literature (National Cancer Institute, 2012). There is no set measure of healthiness; for example, (Gustafson *et al.*, 2013) used median NEMS scores to differentiate between more and less healthy food stores. In the current study, MFE scores of different food outlets types were used as a crude assessment of the food choice environment. Generally within the food environment field, there is a need for improved and comparable measures of the consumer food environment in relation to healthiness, adaptable for different population groups (Minaker *et al.*, 2012). The MFE surveys were adapted versions of the NEMS surveys, focusing on the availability of foods commonly consumed by young people (mainly on-the-go and takeaway type items).

Few studies have assessed the impact of the consumer food environment on individual dietary intake or adiposity, and none have investigated this in adolescents. One example is a study by Gustafson *et al.* (2013) who reported a significant negative association between the availability of healthy food choices within supermarkets and consumption of sugar sweetened beverages (OR=0.65, $p<0.05$). However, no previous work has attempted to link the healthiness of consumer environment food choices to which individuals are exposed tied specifically the outlet they report using.

This is the first study to calculate an individual score based on the objective measurement of food choices available within the consumer food environment. However, there was limited evidence of a relationship between the individual MFE score and health outcomes. Young people with a higher individual MFE score, suggestive of a more healthful consumer food environment, had a higher percent energy intake of protein. Individual MFE score was also significantly correlated with alcohol intake but only for those individuals who consumed alcohol ($n=21$). In this group a more healthful individual MFE score was associated with lower alcohol intake (g). Individual MFE score was not found to be associated with BMI. These findings are consistent with those reported in a systematic review by Gustafson *et al.* (2012) who found mixed evidence of a relationship between the consumer food environment, dietary intake and adiposity.

The VFE-ratio used the results of the MFE surveys as an additional proxy measure of the healthiness of the visited food outlet environment i.e. the impact of visiting greater proportion of more: less healthy food outlets on diet. However, on average, fewer than five food outlet eating events were recorded per person and as such the use of ratios was limited. The VFE-Ratio calculation was often equal to zero or one and so was not normally distributed. Sixty-seven percent of participants had a VFE-Ratio above 0.5 indicating that they visited a greater proportion of takeaway and convenience outlets (less healthful) than traditional restaurant and grocery outlets (more healthful).

This study found limited evidence of a relationship between the VFE-Ratio of individuals and their dietary intake. There was a significant relationship between VFE-Ratio and energy density suggesting that individuals who visit a greater proportion of 'less healthy' food outlets had more energy dense diets although the correlation was moderate. Another moderate correlation was seen for vitamin C, the young people with a higher VFE-Ratio were more likely to have a lower intake of this nutrient. This appears to be driven by fruit intake as higher intakes of both fruit only and fruit and vegetable portions were associated with visiting a higher proportion of 'more healthy' food outlets.

This study employed a new method to assess the exposure to food outlets in the context of the community food environment, in an adolescent population.

The use of GPS and GIS techniques to assess accessibility/exposure to food outlets is a current and emerging field. Previous studies using buffer GIS techniques to investigate the relationship between access to different types of food outlet and diet and adiposity outcomes have shown mixed results (Caspi *et al.*, 2012). This study aimed to identify the food outlets to which young people are exposed day-to-day at an individual level using a combination of GPS technology and GIS analysis techniques. Despite using a more pin-pointed approach to identifying the EFE, the study results were in line with those currently reported in the literature in that limited evidence of a relationship between exposure to food outlets and dietary intake or adiposity was found.

The EFE-Count measure was an indication of the density of food outlets contained within the 50m buffer around participant's activity space, as defined by the day one GPS waypoints. There was no significant relationship between the EFE-Count and any of the dietary intake variables explored, nor was there a significant association with BMI.

Accounting for exposure to different food outlet types, the EFE-Ratio assessed exposure to 'less healthy' outlets in relation to 'more healthy' outlets using the same method employed for the VFE-Ratio. Unlike the VFE-Ratio, the EFE-Ratio was normally distributed, indicating that participants were likely to be exposed to a variety of both 'less' and 'more' healthy outlets and few were exposed to only 'more healthy' or 'less healthy' outlets. Two significant relationships were uncovered; participants exposed to a higher proportion of 'less healthy' food outlets had a more energy dense dietary intake and lower intake of iron.

In an American adult population, Gustafson *et al.* (2013) also found no associations between food venue availability within GPS based activity spaces and dietary intake variables. However, the food venue availability measure only included retail food stores; no restaurant outlets were included. Similarly, Christian (2012) found few associations between food outlet access within GPS based activity space and dietary intake. Whole grain intake was significantly higher amongst those who were exposed to a greater proportion of more healthful food outlets and a similar relationship was seen for fruit and vegetables although this was not significant. Intake of red meat, fried potatoes and added sugars were not associated with food outlet access (Christian,

2012). Both these studies employed much larger buffers to calculate the activity space of individuals than the present study; 0.5 miles (Gustafson *et al.*, 2013) and 500m (Christian, 2012) compared to 50m.

In the current study SES was significantly correlated with EFE-Count with those living in more deprived areas exposed to a greater number of food outlets. The EFE-Ratio was also associated with SES indicating that those living in more deprived areas were exposed to a greater proportion of takeaway outlets and those living in less deprived areas were exposed to a greater proportion of traditional outlets (such as restaurants). There was also a significant association between SES and dietary intake. Those living in more deprived areas consumed a diet that was more energy dense, higher in saturated fat and lower in fruit and consumed fewer fruit and vegetable portions.

Other studies have noted the differences in access to outlets across areas of differing levels of deprivation. For example, in New Zealand Day and Pearce (2011) found that areas surrounding schools in more socially deprived areas contained a higher number of takeaway and convenience outlets although the same relationship was not reported in Scotland (Ellaway *et al.*, 2012). At the individual level, SES had been shown to be associated with risk of multiple health risk behaviours (Hardy *et al.*, 2012). It could be that those of lower SES have poorer dietary intake due to their food environment being less conducive to making healthy food choices.

Finally, in relation to food outlet exposure and access, this research found that greater exposure to food outlets (assessed for study day one) was associated with a higher frequency of food outlet visits over the 4-day study period. It was also observed that those exposed to a greater proportion of 'less healthy' food outlets were also more likely to visit a greater proportion of 'less healthy' food outlets. These findings do not imply a causal association, as a number of additional factors can influence the food outlet choice and subsequent food choice made by young people. Aspects of the social, cultural and economic environment which also influence food outlet and food choice are explored within the next section of this discussion chapter.

12.3 Exploring the drivers of food choice in young people

This study adopted a mixed method approach using both quantitative and qualitative methods to explore the food environment of young people. The following section discusses the drivers of food choice in young people using findings from the qualitative interview phase of the study. The final study objective as stated below is addressed:

Objective 4: Use qualitative methods to explore and understand the drivers of food choice in terms of the food environment of young people.

A grounded theory approach was used to collect data on the day-to-day food sources and meal choices of adolescents and the context of the food environment. Two themes emergent from the data were selected for further exploration; eating out, and takeaway food.

The main factors influencing the choice of food outlets and meal choices ran parallel for both eating out and takeaways with friends and family. These factors were price and convenience (in relation to both time and geography) and the acceptability of the food choices to the social situation. Young people reported eating out at fast food and other restaurants more frequently with friends than with family but the opposite appeared to be true for takeaway meals consumed at home venues.

The young people interviewed indicated a preference for making repeat visits to the same types of food outlet. When talking about eating out with friends, many of the outlets mentioned were branded chains such as Nando's and Frankie and Benny's. The use of branded outlets was also talked about with regards to takeaways with friends, with Domino's pizza chain the venue of choice in this case. In addition, the choice of food outlet appeared to vary depending on the group of friends the individual was dining with. There was often group consensus on which food outlets were visited. This is comparable to findings from the Health Behaviour in School-age Children which found that 81.5% of 15 year olds agreed that they decided together with their peers what activities to do in their spare time (Brooks *et al.*, 2011).

Focus groups conducted by Stead *et al.* (2011) with 13-15 year olds indicated that choosing branded products was good for young peoples' social image and acted as a 'safeguard' against bullying and unwanted attention. The authors found that young people perceived that by consuming a particular brand, the desirable characteristics of that brand (such as popularity) were transferred to the consumer. It should be noted that the brands and foods themselves were mostly those of lower dietary quality. The focus groups discussed branded products for school lunchboxes although the themes had commonality with the present study. The concept of fitting in with peers is particularly important in the adolescent age group and conforming to social norms regarding food choice is one way young people might do this (Story *et al.*, 2002).

Regardless of what options are available within food outlets, individuals often have the opportunity to make their own decisions about what they choose to purchase and subsequently consume based on their own desires and food preferences. During the qualitative interviews, some of the young people talked about their food preferences and being "*fussy eaters*". The descriptions of foods acceptable and/or not acceptable to the population were not unique to this study (Stevenson *et al.*, 2007).

Autonomy of food choice was important, with young people reporting making their own food choices when ordering food from restaurants and takeaways. The interview findings suggested that young people often made repeat orders of specific meals, only changing their choices according to the outlet visited. It is also possible that trying something new or different could detract from the social occasion of eating out with friends. The convenience of repeat ordering could mean young people are saving time by not thinking too long about their food choice decisions and that the food is ordered and subsequently arrives more quickly to satisfy hunger. This concept was also reported by Yamamoto *et al.* (2005) who also found that customers of restaurants want to order particular items usually because they appeal to their personal taste and hunger levels.

Price was also a factor associated with food outlet and meal choices for young people, particularly when with friends and using their personal allowance. The economic cost of eating outside of the home may also be associated with repeat ordering habits. Adolescents tend to operate within a restricted budget,

which limits the food choices they can afford to make. In a study investigating the influence of nutrition labelling on food choice, Yamamoto *et al.* (2005) concluded that adolescent 'unwillingness' to change fast food orders may be due to cost being of greater importance than calorie and fat information. In addition, making a new or unknown food choice may introduce risk of food going to waste if disliked and subsequently left uneaten. This would have consequences economically in the cost of the uneaten food which could be seen as low value for money and a waste of allowance resource, and in terms of individual satiety where by leaving food hunger levels remain high.

Although cost might limit young people to the less expensive menu items when with friends, they might have unlimited choice when dining out with their parents (Yamamoto *et al.*, 2005). The current study suggested that young people were more likely to dine at local, non-chain restaurants when with their family and indicated that variation in meal choices could occur in these conditions. However, takeaway meal choices with family appeared to follow the pattern of repeat meal ordering, with young people suggesting that their parents (and grandparents) also exhibited these behaviours in these situations.

Adding to the concept of price as an important consideration for adolescent food choice, "happy hour" deals were often mentioned. Although these menus may have reduced choice when compared to *à la carte* offerings, they could be perceived by the young people to offer a better deal by offering two or three courses for a set price. The same might be said for 'dollar menus' in fast food outlets (Yamamoto *et al.*, 2005) (known as 'saver menus' in the UK).

Powell (2009) considered the impact of fast food costs and availability on adolescent BMI. The analysis of data collected as part of the US National Longitudinal Survey of Youth (NLSY97) suggested that price and not availability of fast food had the greatest impact on adolescent BMI with individuals of lower socio-economic status being most sensitive to fast food prices.

Convenience of food acquisition in term of timeliness and geographic location appeared to be important factors influencing food outlet choice in particular. Eating out was often done in conjunction with other social activities such as going to the cinema and therefore the proximity of outlets to the other venue(s) was inferred as a deciding factor. Elbel *et al.* (2011) investigated the factors

influencing choice of fast food restaurant in the US and found that ease and location mattered to the young people more than price. Ease of obtaining food mattered 'some/a lot' for 57% of young people (n=168, age 13-17 years), location mattered to the same degree for 48% compared with 30% for price.

In the UK, Wills *et al.* (2005) found that the speed with which adolescents could acquire food was an important factor when choosing food outlets. The young people indicated a strong dislike for queuing for food purchases during the school day, showing a desire to maximise the time they could spend socialising with their peers.

The themes of time and geographic convenience were also apparent within the takeaway food analysis with the young people perceiving parental preference for takeaway outlets located close to the family home. Takeaway appeared to be an important characteristic of the family routine with young people indicating consuming takeaway food at home more frequently than eating out with their family. Quantitative results from this study indicated that a quarter of food outlet eating events were consumed in the home and takeaway and fast food were the most frequently used outlet type. The use of local non-branded outlets for takeaways with family was highlighted within the interview data; cost and convenience were identified as important factors for using these outlets.

The theme of takeaway food at home may have benefited from conducting interviews with parents, which was beyond the scope of this study. It is clear that although the young people had some autonomy in their food choices from takeaways, parents still controlled food intake via restriction of choice. It would be interesting to uncover the parental perspective, to explore the adolescent interpretation that restriction of their food choice was due to cost; but there could be other factors, such as provision of a filling meal, in play. In addition the influence of adult role models including parents and teachers could be explored with a focus on whether young people mimic their food outlet use. For example, the use of school canteens by teachers may encourage students to use these outlets rather than sourcing food from school fringe outlets. Observing adult behaviours in this context was not completed within the current study.

12.4 Strengths and limitations of the study

This section of the discussion addresses the limitations of the study with a focus on acknowledging the strengths and weaknesses of each of the methods employed.

12.4.1 Strengths

This study was observational in design and therefore presents a snapshot of the eating behaviours of young people at a particular point in time. The data were analysed descriptively, providing an observational account of young people's food choice. Although associations between the environment and diet could be explored, the data cannot be used to indicate a causal effect and should not be interpreted as such. For example, it cannot be said that an increase in energy density of the diet is caused by, or directly linked to, an increase in the number of food outlets visited.

A holistic approach was taken with regards to assessing the food environment. Using a food diary method enabled both the food source and eating location to be identified in addition to the specific food outlet types used by young people. Working up from individual participant data allowed for the identification of food sources important to them without making assumptions with regards to the types of food outlets they use. Although fast food and takeaway outlets made up a significant proportion of food outlets eating events, convenience stores and supermarkets were also important food outlet types and were not necessarily the source of 'more healthful' foods. In addition, by conducting qualitative interviews, details of the drivers of food choice were elicited indicating that although location of food outlets in terms of convenience was a central theme, other factors such as social occasion, cost and other activities were important.

This study adopted a primary data collection method with regards to identifying and recording the location of food outlets. This is generally considered as a 'gold standard' approach in that the data is timely and verified by the researcher. This ensured that outlets were systematically, and therefore consistently, categorised in accordance with the food outlet classification tool (Lake *et al.*, 2010). As the food outlet data were collected via primary methods, the classifications were based on the characteristics of the outlet recorded on

site reducing the risk of misclassification errors, such as those made when classifying by name only or categories reported by others. In addition, using a geo-tagging method allowed for greater accuracy in recording the location of food outlets whereas secondary databases often rely on mapping outlets using postcode centroids (Charreire *et al.*, 2010).

Diaries benefit from reduced recall bias in comparison to other methods in that the data is recorded in real time and does not rely on memory. The energy intakes of the study participants were within a feasible range and similar to those reported in the NDNS (Department of Health, 2011b; Department of Health, 2012). The dietary intake results were therefore accepted at face value.

This study illustrates proof of concept for using GPS technology with young people in exploring the food environment. Going forward, taking into account the lessons learnt in this research study could prove useful for advances in the field. The GPS method was acceptable for use with this age group; all participants recorded some GPS data indicating that they carried the logger with them for at least some of the study period. Pilot study data indicated that 17% of time was recorded using the GPS device which shows good accuracy when approximately 20% of time is spent indoors where GPS would not be expected to work (World Health Organization, 1999; Kornartit *et al.*, 2010). It can therefore be concluded that GPS is a good approach identifying the activity space of young people.

Even with consideration of the human errors involved in primary data collection, it is likely that it was more accurate than that contained within secondary databases (Lake *et al.*, 2010; Fleischhacker *et al.*, 2013). During pilot work, a database containing location details for 14,772 food outlets obtained from 23 local councils in the North East of England (Burgoiné, 2010) were used to establish the potential extent of the EFE for individuals. Although prior work concluded that data obtained from local councils is the most accurate secondary source of data on food outlet location, better than the Yellow Pages, it is still only 84% accurate (Lake *et al.*, 2010). Primary fieldwork provides the most accurate up to date method of data collection. However, due to the fast changing nature of the food environment, even data collected through primary methods can become out of date quickly. This is especially true in the current

economic climate with food outlet closures noticeable, particularly where small local businesses are concerned.

A GPS buffer of 50m was employed in this study which was much smaller than others using GPS data to assess food outlet access (Christian, 2012; Burgoine and Monsivais, 2013; Gustafson *et al.*, 2013). The aim was to assess access to food outlets at the street level giving a measure of actual exposure on the routes travelled by participants. Pilot testing identified 50m as an appropriate buffer size to capture those food outlets present on each side of a street whilst minimising inclusion of those located on surrounding streets not seen by individuals. Using primary geo-tagged data on food outlet locations was paramount to the small buffer size being effective. A larger buffer size is required when using secondary data based on postcode centroid as the inaccuracies in location need to be accounted for. This study was able to accurately establish actual rather than potential food outlet exposure.

Technology is constantly evolving with new developments in methods for assessing health behaviours regularly emerging in the literature. This study found that using Ecological Momentary Assessment (Shiffman *et al.*, 2008) methods was particularly useful when working with young people, taking advantage of their 'tech savvy' aptitude. Responses to study text messages were used as a recall tool within the current work although these could be explored in terms of conducting a content analysis. Both study and reminder text messages were useful in keeping the young people engaged in the research and may also have indirectly acted as reminders to carry the GPS logger and complete the food diary.

12.4.2 Limitations

Perhaps the most important limitation of this study was the small sample size, which limited the statistical power; caution must therefore be applied when interpreting the results presented. A descriptive approach was taken to the statistical analysis but should a greater sample size be collected, multi-level logistic regression modelling could be applied to the data adjusting findings for potential confounding factors such as gender, age and socio-economic status.

The sample size was small in comparison with other studies although the data collected was in-depth and explorative in nature. Multiple methods, some novel for the field, were employed, giving light to a detailed examination of the food environment of young people. The study sample was not representative of young people in general. The subsample of participants selected for the qualitative interview study sample was not representative of either the study sample or young people in general. However, effort was made to ensure the young people selected for interview were from a wide range of backgrounds to allow a variety of experiences to be explored and insights generated.

With the exception of one individual, all participants were recruited through schools, and all were in full time education. The results therefore cannot be applied to the wider population of young people although 76% of the 16-18 years age group is in full time education, those of alternative education/employment status, for example, unemployed, in full/ part time employment or in college education, are missing from this analysis. Almost half of the participants were recruited directly through AS/A Level classes in health and social care and sports science. In addition, gatekeepers at schools not visited directly by the researcher may have targeted the study information at particular students. It is therefore possible that these individuals were more healthful than the general population of the same age group.

Overall, the study suffered a poor response rate and data collection was conducted over a longer period than anticipated. The study had a good retention rate with very little data lost through non-compliance once participants provided consent. Recruitment through the school environment posed logistical challenges in that certain times of the school year needed to be avoided such as exam periods and school holidays. An upcoming exam period was a contributing factor to participants declining an invitation to complete a qualitative interview and as such very few of the participants invited to interview completed this phase of the study.

It is possible that the poor response rate was due to perceptions of a large participation burden in terms of measures required and time. Although the study employed a large number of measures, reducing participant burden was at the forefront of developing the data collection methods. A reduction in the accuracy

and longevity of the GPS data collected was forgone for not requiring participants to recharge the loggers. The number of questionnaires could have been reduced as some of the information collected was not analysed or presented in this thesis. In particular, the LSQ could have been reduced in length as it was much longer than both the AFHC and HFEQ and these could have been administered as a single questionnaire. If the study were to be repeated, new methods of dietary data collection such as the online 24 hour recall system or online questionnaires could be used.

Although schools and colleges were the main target for recruitment, other avenues for recruitment were explored. Contact was made with youth groups, leisure centres, sports teams, workplaces, apprenticeship providers although no participants were recruited via these routes. There is a growing trend for using social networking websites, such as Facebook and Twitter, to raise awareness of studies and recruit participants. Computer and internet use has been steadily on the rise, 88% of 16-24 year olds used a computer daily in 2013 compared with 63% in 2006 (Office for National Statistics, 2013b). Perhaps more importantly, the rise in mobile internet use has increased dramatically in recent years, particularly in the younger age groups with 89% of 16-24 year olds having access to mobile internet in 2013 compared to 43% in 2010 (Office for National Statistics, 2013b). Social networking is the most popular internet activity with 93% of young adults having used some form of social network website in the past (Office for National Statistics, 2013b). Studies using social media for recruitment of participants are emerging in the literature (Fenner *et al.*, 2012; O'Connor *et al.*, 2014) and this method should be considered as a potential recruitment method in future work.

While a preferred method, using food diaries to collect dietary behaviour is not without limitations. Firstly, being a prospective method there is risk of bias in the data collection. Food diaries can be subject to reporting bias and the act of keeping a diary may impact eating behaviour with individuals reporting more socially 'desirable' dietary intakes (Cohen *et al.*, 2012). Overweight and obese individuals are more likely to under-report total dietary intake (Macdiarmid and Blundell, 1998), and this behaviour was also noted in this study where BMI was inversely correlated with energy density and saturated fat intake (%E).

There are limitations in the calculation of dietary intake that should be taken into account. Firstly, it is possible that the data presented an over-estimate the amount of fruits and vegetables consumed. Fruit juice was included in the intake analysis without a cap on intake levels. Portions of fruit and vegetables were calculated from total weight consumed using 80g of intake as a single portion regardless of the variety of intake, for example 160g of banana would be counted as two portions of fruit and vegetables. Despite the potential over-estimation, participants reported consuming significantly fewer fruit and vegetable portions than reported in the NDNS (Department of Health, 2011b; Department of Health, 2012), the potential over-estimation only highlighting the low consumption rate in this population group.

The energy density calculation was based on the total diet energy and food weight and included the intake of beverages in addition to food. It is therefore likely that the energy density figures are 'diluted' and provide a conservative measure of diet quality. Beverages such as water, tea, coffee and diet drinks contain little or no energy but may contribute substantially to the total weight of food consumed. This limitation also applied to the nutrient density calculations. As a result, many of the nutrient density measures had a minimum value of zero. A beverage could be the sole food item of an eating event thereby skewing the figures in terms of underestimating the energy density from the various food source types. Comparisons between sources are unaffected as the measure was applied across the board.

Although eating events were assigned to individual participants, the nutrient density of food sources and food outlet types was calculated at the group level. As a result, the nutrient density measures do not take into account the inter-person variation in intake. An alternative method could have been employed whereby the nutrient density was calculated for each food source by participants. However, there was great variation in the number of participants reporting use of each food source and food outlet type and discussions with a statistician, it was decided that the sample size of each group was too small to conduct the appropriate statistical tests (Friedman's 2-way ANOVA by ranks test, non-parametric statistical test of the differences between mean values for more than two related samples).

Both the mean and median values for nutrient densities were reported for each food source and food outlet type. Some eating events were very high in particular nutrients (e.g. protein) and therefore very large confidence intervals were reported. Extreme outliers in the data were investigated by referring back to the food diaries, where individual foods influencing the high nutrient density of these outlier eating events were highlighted, for example exercise recovery protein shakes.

As in other studies, it was noted that participants appeared to have difficulties with determining the exact locations of the places they visited (Bohte and Maat, 2009). Some of the young people could not recollect which food outlet had been used for a particular eating event. An example was a participant who described visiting a fish and chip shop in a popular seaside town on the North East coastline. There were a number of these outlets in the area and the participant was unable to specify which particular outlet had been used and therefore it was excluded from the MFE score calculations. Due to this recall failure, MFE surveys were not completed in all VFE food outlets, however this equated to only 6% of food outlet eating events.

There were a number of limitations relating to the use of ratios to calculate food environment predictor variables. Both the VFE and EFE ratios relied on the assumption that takeaway eateries and convenience outlets were less healthful food outlets than traditional eateries and grocery outlets. Although the MFE survey results indicated this to be the case, no cut-offs for the survey scores were established and therefore the interpretation of these results should be undertaken with caution.

A limitation of this study was the failure to assess which food choices were available within the school environment. School eating events were closer in nutrient profile to other out of home sources. Exploring the types of outlets young people used within the school environment, such as canteens, tuck shops and vending machines may highlight why the eating events were different to those consumed at home. It could be that the foods consumed were snacks foods as opposed to complete meals, although analysis at this level was beyond the scope of the current study.

The retracing of participant GPS data was time and resource intensive and therefore limited to those areas where participants were traveling at a speed less than five miles per hour. It was assumed that food outlet 'exposures' at slower speeds would have a greater impact on the food choices of young people (Neuhaus, 2011) although it is also possible that this was not the case (Christian, 2012). In addition, young people are more likely to use active forms of transport such as walking, buses and cycling than other ages groups (Department of Transport, 2013) and as such are likely to be exposed to a smaller 'activity space' than adults. In this study, any GPS waypoints with a recorded speed of over 5mph were excluded, thereby reducing the total area to be retraced by the researcher to establish food outlet exposure. It would be interesting to see how the food environment might differ if this speed criteria were not applied.

The 50m buffer size is much smaller than other studies using GPS/GIS techniques to identify exposure to food outlets (Christian, 2012; Gustafson *et al.*, 2013). A recent study by Burgoine and Monsivais (2013) used a 100m buffer where study participants indicated using active transport on their home to work commute. This was due to the need to keep the measure at a local level i.e. no wider than the road travelled on. It could be that using a GPS buffer of 50m alongside the primary data collection method underestimates the food environment to which an individual is exposed leading to the null findings reported in this study. However, recent studies using much greater buffer sizes around GPS data have also reported null findings between the food environment and diet (Gustafson *et al.*, 2013).

Participants were not required to re-charge the GPS device in order to reduce participation burden and in light of this it was accepted that data loss through battery life would be a limitation. In hindsight, the impact of approach was greater than expected. There was large variation in the number of complete days of GPS data recorded by the participants ranging from one to four (or more) days. It is possible that those individuals with GPS data recorded across a greater number of days were less active over the study period, with the device spending more time in 'sleep' mode. In contrast, those who recorded fewer days of data may have been more active at the start of the study period resulting in the battery life waning more quickly. The GPS data was restricted to a single day of

data collection, to ensure that the EFE-Count and EFE ratio were comparable between participants.

As discussed in Appendix E, battery life and GPS data recording can vary for a number of reasons beyond the control of the participant or the researcher including cloudy weather and tall buildings obstructing satellite reception. Since the testing for this research was conducted, a paper has been published with detailed guidance on selecting and testing GPS devices for use in health research (Kerr *et al.*, 2011). Finally, there is no guarantee that the young people carried the logger with them at all times. Other studies have verified GPS data using travel diaries (Oliver *et al.*, 2010), however, this was considered to be beyond the scope of the study.

The identification of food outlets was often difficult where the area being assessed was new for the researcher i.e. they held little or no local knowledge of the area. It is therefore possible that some food outlets were missed when retracing the GPS routes. This is particularly possible where entrances to food outlets were via 'hidden' passageways or courtyards or the food outlet in question was not located on the street/eye level. However, being not at the street level, it is unlikely that adolescents would be 'exposed' to these outlets in passing unless they were aware of the outlet existence via other means. The EFE-count provided a modest estimate of food outlet exposure on a much smaller scale to that adopted by other studies.

Reflecting on the qualitative interview data, it is unlikely that saturation of themes was reached due to the small sample size included. It is impossible to draw generalisable conclusions from these data although they do provide an insight into the factors influencing individual food choices in this particular group of young people. A greater number of themes may have emerged from the qualitative interview data should more individuals have been interviewed and not all of the emergent themes were explored fully within this thesis. Exploration of the qualitative data surrounding school food, for example, would provide a greater understanding of food environment interactions.

Finally, the multi-method approach taken to this research was both a strength and a weakness. Training was undertaken in both quantitative and qualitative

methods encompassing software training in ArcGIS and NVivo analysis programmes. With a background in public health nutrition, GIS was a skill particularly difficult to master within the PhD timeframe.

12.5 Policy recommendations for improving the food environment

A substantial proportion of the diet of young people is sourced from food outlets and it has been reported here and elsewhere that these eating events tend to be of lower nutritional value than those from other sources such as the home. An industry focus on changing the composition of foods commonly consumed by this age group could have a greater impact than trying to change the diet through other methods. Providing nutritional information has been shown to have little impact on the food choices made by young people (Yamamoto *et al.*, 2005; Elbel *et al.*, 2011). The tendency for young people to make repeat or habitual food choice decisions may also play a part in this and therefore changing the formula of commonly ordered meals might have a positive impact on dietary intake from these sources.

This study found that school food made up a lower proportion of eating events than previous studies and that eating events sourced from schools had a higher nutritional value than food obtained from food outlets (although not as healthful as home). One in ten eating events sourced from food outlets were consumed on school premises highlighting the importance of the school fringe on the access young people have to food. Access to takeaway and fast food around UK schools has been a hot topic in recent months. In May 2013, a public consultation was launched when Salford Council proposed a ban on any new food outlets within half a mile of a school serving fried food before 5pm (Salford City Council, 2013). In addition, a local council in Scotland has introduced 'exclusion zones', banning mobile food vans from trading within 250m distance of schools (North Lanarkshire Council, 2014).

Public Health England recently produced a briefing document on access to fast food surrounding schools (Public Health England, 2013). Should these planning restrictions be put in place, the controls would only apply to new fast food outlets and not those currently operating within the outlined areas. This approach will not improve the food environment around schools; merely prevent

the situation from getting worse. As these results show, young people visit a wide variety of food outlets. Expanding restrictions to include convenience stores in addition to fast food may have greater effect.

Knowing what food choices are available compared to the food choices actually made by individuals is important in the development of effective intervention strategies. A comparison study of food choices made by adolescents in McDonalds and Subway highlighted the impact of perceptions of healthy eating in relation to food outlet environment. Although Subway was objectively a healthier menu, the choices made were not statistically different in term of energy content to those made in the 'less healthy' environment of McDonalds (Lesser *et al.*, 2013). The public health responsibility deal (Department of Health, 2013b) has encouraged multinational companies such as McDonalds and Subway to offer healthier food options and provide nutritional information. However, these changes are unlikely to impact the diet of young people who, as shown in the current study, make repeat orders of their favourite meals without necessarily considering the nutritional content. Reformulation of products to make them healthier in conjunction with increased education on leading a healthier lifestyle may have a greater impact.

Perhaps more importantly, this research showed that young people more frequently obtain food from local takeaways as opposed to the large multinationals companies. Raising awareness of healthy food environments in relation to these smaller businesses is therefore needed. Local authorities now have 'toolkit' documents available to help address this issue (Department of Health, 2013a).

In addition, the development of interventions targeting gender groups might be more appropriate than a 'catch all' approach to encourage healthier food choices in young people. This study highlighted that females tended to use more convenience stores and consumed a diet higher in sugars, whereas males used more takeaway and fast food outlets.

In a review of the consumer food environment and health, Glanz *et al.* (2012) suggest that interventions to change the food store environment may have a greater impact on diet if focused more heavily on the marketing aspects

(product, price, place and promotion) of food rather than simply making more healthy choices available. A systematic review of the effect of food advertising on children's food choices found that food promotion affects food preferences, purchasing and consumption behaviours independent of other factors (Hastings *et al.*, 2003). Some information relating to promotions for 'less healthy' food items were collected in this study as part of the MFE food outlet surveys. The relationship between the presence of promotions and dietary intake overall and from the particular outlets warrant further exploration. However, it has been noted that it is very difficult to establish a link between marketing and dietary intake in the real world setting (Hastings *et al.*, 2003).

Recent debate has focussed on the potential effect the application of a 'fat tax' on high fat and sugar foods and drinks would have on the obesity epidemic in the UK (Oliver *et al.*, 2012). Evidence suggests that taxing sugar sweetened beverages by at least 20% is likely to have a significant impact in reducing obesity and diet-related diseases (Oliver *et al.*, 2012). Young people in particular are price sensitive consumers (Wills *et al.*, 2008; Share and Stewart-Knox, 2012), they are also the highest consumers of sugary soft drinks (Department of Health, 2012). Taxation on these products therefore may have a significant impact on the diet of young people, reducing quantity and frequency of consumption.

12.6 Suggestions for future research

Much of the data collected as part of this PhD research was not included within this thesis. This section outlines further analysis that could be conducted using study data in addition to suggestions for improving the research if it were to be repeated.

With a larger sample size, the energy and nutrient density of eating events by food source and food outlet type could be explored taking into account individual level variation. The current study based the calculations on eating events as a proxy measure of meals. Nutrient density of each food source as a contribution to individual daily intake might also be an avenue for exploration.

Alcohol intake was found to be significantly associated with adiposity and the alcohol intake figures were more closely related to those seen in adults than

young people (Department of Health, 2012). Research suggests that many people are unaware of the calorie content of alcoholic drinks (National Obesity Observatory, 2012) and that alcohol consumption often leads to unhealthy food choices (Yeomans, 2010) and thus overall energy intake (Dennis *et al.*, 2009). Further work, both quantitative and qualitative, could be conducted to explore the relationship between alcohol intake and adiposity in young people and the environmental context, particularly the social environment, in which alcohol is consumed.

Three questionnaires were used in this study and only a small proportion of the data collected was presented here. The data could be used to further explore the relationship between the availability of foods in the home and dietary intake of those foods. In addition, lifestyle factors such as physical activity and sedentary behaviour levels could be explored in relation to dietary intake and adiposity. In addition, research suggests a relationship between sleep duration and obesity risk. A systematic review found consistent evidence that short sleep duration was strongly associated with current and future obesity risk in children (Patel and Hu, 2008). Inadequate sleep duration and poor sleep quality in adolescents may be important factors to consider in the prevention of obesity (Gupta *et al.*, 2002) and future exploration into food environment factors relating to obesity in young people should include a measure of sleep duration and quality and adjust for this as a confounding factor.

The geographic location of visited food outlets was recorded but not used in the study analysis. Further analysis might include investigating the location of food outlets visited by young people in relation to their home and/or school. Anecdotally, those individuals attending schools with fewer food outlets located in the immediate surrounding area appeared to make use of the school canteen more frequently than those individuals with a greater number of food outlets close to school. Although the data are available, this analysis requires GIS skills in road network analysis which was beyond the scope of the present study. In addition the dietary intake of those individuals obtaining food from school canteens, food outlets and home during the school day could be explored further.

The economic cost of food appeared to be important in the choice of food outlets visited by the young people with their friends. The cost of food obtained from food outlets was recorded by participants in the food diaries. An analysis of the cost of food energy from different food outlet types could therefore be conducted and would be particularly interesting to explore in relation to socio-economic status.

Although this study was able to identify the food sources for individual eating events and identify occasions where food was obtained for takeaways, the food diary did not explicitly assess how food was obtained from these outlets. The method of transport used was recorded in the diary but this was not analysed in the present study. The food environment continues to evolve, more recently Internet websites and smartphone applications such as HungryHouse¹⁵ and JustEat¹⁶ have increased 'on the go' access to fast food and takeaway for home consumption and therefore the modes of ordering food may be worth investigating in future research.

Finally, in addition to fast food and takeaways, this research highlighted the importance of identifying the full scope of food outlets used by young people and the food choice made therein. Further exploration of the types of foods consumed within food outlets, in conjunction with nutritional analysis, may help to identify specific popular food products which could be targeted for reformulation.

12.7 Overall conclusions

This study highlighted the importance of describing the food environment of young people both in terms of where food is sourced and where food is consumed as these are not necessarily the same environment. For food outlet eating events in particular, there was great variation in where food was consumed. This was evenly split between consumption within the outlets premises, at home as takeaways and 'on-the-go' either in transit or other outdoor locations.

¹⁵ <http://hungryhouse.co.uk/> Accessed 09/12/2013

¹⁶ <http://www.just-eat.co.uk/> Accessed 09/12/2013

There was a large variation in the type of food outlets used by young people and the assessment of use of all food outlet types, such as different types of food stores and restaurants, is recommended for research to progress in the food environment field. Focus solely on access to and use of fast food, for example, has the potential to largely underestimate the use of food outlets especially considering that some outlets types often considered as proxy measures of a healthful food environment are the source of less healthful eating events.

Food outlets make up a significant proportion of eating events recorded by young people and the energy and nutrient density of these eating events are less healthful than those sourced from the home. Young people who are exposed to a greater number of food outlets also use a greater number of food outlets. This is related to area level deprivation, with those in more deprived areas being exposed to a greater number of food outlets as assessed by the individual level GPS data.

Although few significant relationships between the visited or exposed food environments with dietary intake were found, exploration of the factors influencing food outlet choice using qualitative methods added depth and context to these null findings. A combination of quantitative and qualitative findings suggest that the food environment to which a young person is exposed day-to-day may not particularly impact their immediate food choices and it is the social aspects and pre-formed habits of choosing where to eat that influence the choices. Habitual food choices made within the context of dining out with friends or ordering takeaway with family may be more highly influenced by the economic cost, convenience and locality of food outlets in conjunction with group conformity and loyalty to outlets over the availability of outlets within the used geographic space.

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List of Appendices

The appendices associated with this thesis are included on the disc provided.

- A. Lifestyle Questionnaire (LSQ)
- B. Home Food Environment Questionnaire (HFEQ)
- C. Adolescent Food Habits Checklist (AHFC)
- D. Personal communication regarding GPS devices
- E. GPS device testing and selection
- F. Consent form
- G. Information leaflet
- H. Parent letter (pilot study)
- I. Food diary
- J. Food photographs guidance and GPS device instruction leaflet
- K. Data collection checklist
- L. Food outlet classification tool (V8)
- M. Measuring Food Environments user guide
- N. Measuring Food Environments surveys
- O. Individual interview topic guide
- P. Covering letter to schools
- Q. Recruitment poster
- R. Food outlet location fieldwork data collection sheet
- S. Food outlet classification and geo-coding rules

Lifestyle Questionnaire



ID number

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Ethnic Origin

What is your country of birth? *Please tick one box.* [LS_Q1a]

- ☐ England
- ☐ Northern Ireland
- ☐ Republic of Ireland
- ☐ Scotland
- ☐ Wales
- ☐ Other

If other, please specify: _____ [LS_Q1b]

What is your ethnic group? *Please tick one box.* [LS_Q2a]

- ☐ White British
- ☐ White Irish
- ☐ Any other white background
- ☐ White and Black Caribbean
- ☐ White and Black African
- ☐ White and Asian
- ☐ Any other mixed background
- ☐ Indian
- ☐ Pakistani
- ☐ Bangladeshi
- ☐ Any other Asian background
- ☐ Caribbean
- ☐ African
- ☐ Any other black background
- ☐ Chinese
- ☐ Other ethnic group

If other, please specify: _____ [LS_Q2b]

Your Family

All families are different (for example, not everyone lives with both their parents, sometimes people live with just one parent, or they have two homes or live with two families) and we would like to know about yours.

Please answer the first question for the home where you live all or most of the time and tick the people who live there. Please do not include yourself. [LS_Q3]

- ☐ Mother
- ☐ Father
- ☐ Stepmother (or father's/ mother's girlfriend)
- ☐ Stepfather (or mother's/ father's boyfriend)
- ☐ Grandmother
- ☐ Grandfather
- ☐ Brother(s) - How many _____ (including any half/step/foster brothers)
[LS_Q3_NumBro]
- ☐ Sisters(s) - How many _____ (including any half/step/foster sisters)
[LS_Q3_NumSis]
- ☐ I live in foster home or children's home
- ☐ Someone or somewhere else: please write it down _____
[LS_Q3_NameOther]

How many days a week do you live at this address? days. [LS_Q4]

Do you have another home or another family, such as the case when your parents are separated or divorced? [LS_Q5]

- ☐ No – go to Jobs & Transport Section, page 4
- ☐ Yes – complete section below

If yes, how often do you stay there? [LS_Q6]

- ☐ Half the time
- ☐ Regularly but less than half the time
- ☐ Sometimes
- ☐ Never

Please tick all the people who live there: [LS_Q7]

- ☐ Mother
- ☐ Father
- ☐ Stepmother (or father's/ mother's girlfriend)
- ☐ Stepfather (or mother's/ father's boyfriend)
- ☐ Grandmother
- ☐ Grandfather
- ☐ Brother(s) How many _____ (including any half/step/foster brothers)
[LS_Q7_NumBro]
- ☐ Sisters(s) How many _____ (including any half/step/foster sisters)
[LS_Q7_NumSis]
- ☐ I live in foster home or children's home
- ☐ Someone or somewhere else: please write it down _____
[LS_Q7_NameOther]

Jobs and Transport

Do you have a job at the moment? [LS_Q8]

- ☐ No
- ☐ Yes, full time
- ☐ Yes, part time

If you work part time, how many hours/week do you usually work? [LS_Q9]

Tell us here: **hours per week**

Do you do any unpaid voluntary work at the moment? [LS_Q10]

- ☐ No
- ☐ Yes – if so, how many hours/week do you usually work? [LS_Q10_Hours]

Tell us here: **hours per week**

Does your family own a car, van or truck? [LS_Q11]

- ☐ No
- ☐ Yes, one
- ☐ Yes, two or more

Do you have access to any of the following? *Tick all that apply.* [LS_Q12]

- ☐ Car
- ☐ Motorcycle
- ☐ Scooter
- ☐ Other (please state _____) [LS_Q12_OtherState]

Do you have a licence to drive/ride any of the following? *Tick all that apply.*
[LS_Q13]

- ☐ Car
- ☐ Motorcycle
- ☐ Scooter
- ☐ Other (please state _____) [LS_Q13_OtherState]

Food

How often do you buy something to eat outside the home? Please include things like sweets and drinks that you buy yourself.

Please tick the boxes below that apply most to you. [LS_Q14]

- ☐ Everyday.
- ☐ Every other day.
- ☐ Weekdays only
- ☐ Weekends only
- ☐ Other. Please specify: _____ [LS_Q14_OtherSpecify]

Thinking about the past few months, how often have you done the following things? [LS_Q15]

1. Went to McDonalds, Pizza Hut, KFC or another fast food restaurant with my family. *Please tick one box.* [LS_Q15a]
 - ☐ Never or rarely
 - ☐ Less than once per week
 - ☐ About 1-3 times per week
 - ☐ About 4-6 times per week
 - ☐ Everyday
2. Went out to another kind of restaurant or café for a meal with my family. *Please tick one box.* [LS_Q15b]
 - ☐ Never or rarely
 - ☐ Less than once per week
 - ☐ About 1-3 times per week
 - ☐ About 4-6 times per week
 - ☐ Everyday
3. Went to McDonalds, Pizza Hut, KFC or another fast food restaurant with my friends. *Please tick one box.* [LS_Q15c]
 - ☐ Never or rarely
 - ☐ Less than once per week
 - ☐ About 1-3 times per week
 - ☐ About 4-6 times per week
 - ☐ Everyday

4. Went out to another kind of restaurant or café for a meal with my friends.

Please tick one box. [LS_Q15d]

- ☐ Never or rarely
- ☐ Less than once per week
- ☐ About 1-3 times per week
- ☐ About 4-6 times per week
- ☐ Everyday

Television and Computers

About how many hours a day do you usually watch television (including DVDs and videos), play games on computer/ games console (e.g. PlayStation, Xbox etc.) or use a PC or laptop to chat online, browse Internet etc. in your free time? [LS_Q16]

Please tick one box for weekdays and one box for weekends.

Weekdays [LS_Q16a]

- ☐ None at all
- ☐ 2 hours or less a day
- ☐ 3-4 hours a day
- ☐ 5-6 hours a day
- ☐ 7 hours or more a day

Weekends [LS_Q16b]

- ☐ None at all
- ☐ 2 hours or less a day
- ☐ 3-4 hours a day
- ☐ 5-6 hours a day
- ☐ 7 hours or more a day

Physical Activity

Physical activity is an activity that increases your heart rate and makes you get out of breath some of the time.

Physical activity can be done in sports, school activities, playing with friends, or walking to school/work. Some examples of physical activity are running, brisk walking, rollerblading, biking, dancing, skateboarding, swimming, football, basketball and surfing.

For this question, add up all the time you spent in physical activity each day.

Over the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day? [LS_Q17]

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6
- ☐ 7

Dieting Behaviours

At present are you on a diet or doing something else to lose weight? [LS_Q18]

- ☐ No, my weight is fine
- ☐ No, but I should lose some weight
- ☐ No, because I need to put on weight
- ☐ Yes

Do you think your body is...? [LS_Q19]

- ☐ Much too thin
- ☐ A bit too thin
- ☐ About the right size
- ☐ A bit too fat
- ☐ Much too fat

Smoking and Alcohol

Have you ever smoked tobacco? (At least one cigarette, cigar or pipe) [LS_Q20]

- ☐ Yes
- ☐ No

How often do you smoke tobacco at present? [LS_Q21]

- ☐ Everyday
- ☐ At least once a week, but not everyday
- ☐ Less than once a week
- ☐ I do not smoke

At present, how often do you drink anything alcoholic, such as beer, wine or spirits like vodka, gin or rum? Try to include even those times when you only drink a small amount. [LS_Q22]

1. Beer [LS_Q22a]

- ☐ Everyday
- ☐ Every week
- ☐ Every month
- ☐ Rarely
- ☐ Never

2. Wine [LS_Q22b]

- ☐ Everyday
- ☐ Every week
- ☐ Every month
- ☐ Rarely
- ☐ Never

3. Spirits/ liquor (e.g. vodka, gin, rum) [LS_Q22c]

- ☐ Everyday
- ☐ Every week
- ☐ Every month
- ☐ Rarely
- ☐ Never

4. Alco-pops (e.g. Smirnoff Ice, Bacardi Breezer) [LS_Q22d]

- ☐ Everyday
- ☐ Every week
- ☐ Every month
- ☐ Rarely
- ☐ Never

5. Cider [LS_Q22e]

- ☐ Everyday
- ☐ Every week
- ☐ Every month
- ☐ Rarely
- ☐ Never

6. Any other drink that contains alcohol [LS_Q22f]

- ☐ Everyday
- ☐ Every week
- ☐ Every month
- ☐ Rarely
- ☐ Never

Family Activities

Here is a list of things which some families do together. How often do you and your family usually do each of these things all together? [LS_Q23]

1. Watch TV or a DVD/ video together [LS_Q23a]

- ☐ Everyday
- ☐ Most days
- ☐ About once a week
- ☐ Less often
- ☐ Never

2. Play indoor games together [LS_Q23b]

- ☐ Everyday
- ☐ Most days
- ☐ About once a week
- ☐ Less often
- ☐ Never

3. Eat a meal together [LS_Q23c]

- ☐ Everyday
- ☐ Most days
- ☐ About once a week
- ☐ Less often
- ☐ Never

4. Go for a walk together [LS_Q23d]

- ☐ Everyday
- ☐ Most days
- ☐ About once a week
- ☐ Less often
- ☐ Never

5. Go places together [LS_Q23e]
- ☐ Everyday
 - ☐ Most days
 - ☐ About once a week
 - ☐ Less often
 - ☐ Never
6. Visit friends or relatives together [LS_Q23f]
- ☐ Everyday
 - ☐ Most days
 - ☐ About once a week
 - ☐ Less often
 - ☐ Never
7. Play sports together [LS_Q23g]
- ☐ Everyday
 - ☐ Most days
 - ☐ About once a week
 - ☐ Less often
 - ☐ Never
8. Sit and talk about things together [LS_Q23h]
- ☐ Everyday
 - ☐ Most days
 - ☐ About once a week
 - ☐ Less often
 - ☐ Never

Friend Activities

Think about the group of friends with whom you spend most of your leisure time. How often do you do any of the following activities with your friends during your spare time? [LS_Q24]

1. Listen/dance to music [LS_Q24a]
 - ☐ Don't do this activity
 - ☐ 2-3 times a month or more
 - ☐ About once a week
 - ☐ 2 times a week or more
2. Study/ do homework [LS_Q24b]
 - ☐ Don't do this activity
 - ☐ 2-3 times a month or more
 - ☐ About once a week
 - ☐ 2 times a week or more
3. Do sports [LS_Q24c]
 - ☐ Don't do this activity
 - ☐ 2-3 times a month or more
 - ☐ About once a week
 - ☐ 2 times a week or more
4. Play (board games, computer games, arcade games, etc.) [LS_Q24d]
 - ☐ Don't do this activity
 - ☐ 2-3 times a month or more
 - ☐ About once a week
 - ☐ 2 times a week or more
5. Talk with friends, face to face [LS_Q24e]
 - ☐ Don't do this activity
 - ☐ 2-3 times a month or more
 - ☐ About once a week
 - ☐ 2 times a week or more

6. Chat over the Internet [LS_Q24f]
- ☐ Don't do this activity
 - ☐ 2-3 times a month or more
 - ☐ About once a week
 - ☐ 2 times a week or more
7. Go for a walk [LS_Q24g]
- ☐ Don't do this activity
 - ☐ 2-3 times a month or more
 - ☐ About once a week
 - ☐ 2 times a week or more
8. Go out and party (pub, disco, in the street, in the park) [LS_Q24h]
- ☐ Don't do this activity
 - ☐ 2-3 times a month or more
 - ☐ About once a week
 - ☐ 2 times a week or more
9. Go to the cinema, theatre, or to a concert [LS_Q24i]
- ☐ Don't do this activity
 - ☐ 2-3 times a month or more
 - ☐ About once a week
 - ☐ 2 times a week or more
10. Perform artistic activities (play an instrument, paint, rehearse with your theatre group, etc) [LS_Q24j]
- ☐ Don't do this activity
 - ☐ 2-3 times a month or more
 - ☐ About once a week
 - ☐ 2 times a week or more
11. Volunteering [LS_Q24k]
- ☐ Don't do this activity
 - ☐ 2-3 times a month or more
 - ☐ About once a week
 - ☐ 2 times a week or more

12. Do nothing special, just hang out [LS_Q24l]

- ☐ Don't do this activity
- ☐ 2-3 times a month or more
- ☐ About once a week
- ☐ 2 times a week or more

13. Other, please write what _____ [LS_Q24m]

- ☐ Don't do this activity
- ☐ 2-3 times a month or more
- ☐ About once a week
- ☐ 2 times a week or more

Thank you for your time 😊

Home Food Environment Questionnaire

This questionnaire was designed to cover the following topics around the adolescent home food environment:

- Eating behaviour in the home e.g. snacking in front of TV
- Self-efficacy e.g. prepare or help to prepare own food
- Food availability in the home
- Food rules
- Food providers e.g. who does food shopping and where

Individual questions were taken from the following validated questionnaires:

- Neopean Kids Growing Up – Students Questionnaire [1]
- DEPA [2]
- Health Behaviours in School Aged Children (HBSC) survey [3]
- My Place, My Plate, My Perspective [2]

Questions regarding home food availability were adapted from Gattshall *et al* [4] using data on food popular with older adolescents collated from the NDNS [5] and a study by Foster *et al* at Newcastle University [6].

The questions remained unchanged as far as possible although wording was changed for some questions, for example changes from American to UK English.

The questionnaire was administered via a purposefully built Microsoft Access database.

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Home Food Environment Questionnaire

Name: _____ ID No: _____

Q: Thinking about the past few months, how often did you do the following things?
Please tick one answer for each. [1]

1. I ate breakfast at home
 - ☐ Never or rarely
 - ☐ Less than once/week
 - ☐ About 1-3 times/week
 - ☐ About 4-6 times/week
 - ☐ Everyday
2. I ate dinner at home
 - ☐ Never or rarely
 - ☐ Less than once/week
 - ☐ About 1-3 times/week
 - ☐ About 4-6 times/week
 - ☐ Everyday
3. I made or helped to make my own breakfast
 - ☐ Never or rarely
 - ☐ Less than once/week
 - ☐ About 1-3 times/week
 - ☐ About 4-6 times/week
 - ☐ Everyday
4. I made or helped to make my own lunch
 - ☐ Never or rarely
 - ☐ Less than once/week
 - ☐ About 1-3 times/week
 - ☐ About 4-6 times/week
 - ☐ Everyday
5. I made or helped to make my own dinner
 - ☐ Never or rarely
 - ☐ Less than once/week
 - ☐ About 1-3 times/week

- ☐ About 4-6 times/week
 - ☐ Everyday
6. I ate dinner in front of the television
- ☐ Never or rarely
 - ☐ Less than once/week
 - ☐ About 1-3 times/week
 - ☐ About 4-6 times/week
 - ☐ Everyday
7. I ate snacks while watching television
- ☐ Never or rarely
 - ☐ Less than once/week
 - ☐ About 1-3 times/week
 - ☐ About 4-6 times/week
 - ☐ Everyday
8. I ate take-away or fast foods at home (e.g. pizza, hamburgers, French fries)
- ☐ Never or rarely
 - ☐ Less than once/week
 - ☐ About 1-3 times/week
 - ☐ About 4-6 times/week
 - ☐ Everyday
9. I ate take-away or fast foods away from home (e.g. pizza, hamburgers, French fries)
- ☐ Never or rarely
 - ☐ Less than once/week
 - ☐ About 1-3 times/week
 - ☐ About 4-6 times/week
 - ☐ Everyday
10. I shopped or I helped to shop for food and other groceries
- ☐ Never or rarely
 - ☐ Less than once/week
 - ☐ About 1-3 times/week
 - ☐ About 4-6 times/week
 - ☐ Everyday
11. I cleaned-up or I helped to clean-up after a meal
- ☐ Never or rarely

- ☐ Less than once/week
- ☐ About 1-3 times/week
- ☐ About 4-6 times/week
- ☐ Everyday

12. I decided or I helped to decide what our family would eat for a meal

- ☐ Never or rarely
- ☐ Less than once/week
- ☐ About 1-3 times/week
- ☐ About 4-6 times/week
- ☐ Everyday

Q: How often are the following true? Please tick on answer for each. [1]

1. Fruits and vegetables are available in my home

- ☐ Never
- ☐ Sometimes
- ☐ Usually
- ☐ Always

2. Vegetables are served at dinner in my home

- ☐ Never
- ☐ Sometimes
- ☐ Usually
- ☐ Always

3. We have 'junk food' in my home

- ☐ Never
- ☐ Sometimes
- ☐ Usually
- ☐ Always

4. We have fruit juice in my home

- ☐ Never
- ☐ Sometimes
- ☐ Usually
- ☐ Always

5. Potato chips and other salty snack foods are available in my home

- ☐ Never

- ☐ Sometimes
- ☐ Usually
- ☐ Always

6. Chocolate or other lollies are available in my home

- ☐ Never
- ☐ Sometimes
- ☐ Usually
- ☐ Always

7. Soft-drink is available in my home

- ☐ Never
- ☐ Sometimes
- ☐ Usually
- ☐ Always

8. Foods I really like are available in my home

- ☐ Never
- ☐ Sometimes
- ☐ Usually
- ☐ Always

9. I can eat whatever I like at home

- ☐ Never
- ☐ Sometimes
- ☐ Usually
- ☐ Always

10. There is always plenty of food to eat in my home

- ☐ Never
- ☐ Sometimes
- ☐ Usually
- ☐ Always

Q: Does your parent or guardian have the following rules about your eating, whether your parent or guardian tells you often or not? Please tick and answer for each rule.
[DEPA] [2]

1. Limited portion sizes at meals

- ☐ Yes
- ☐ No

- ☐ Sometimes
- 2. No meals while watching TV/DVDs
 - ☐ Yes
 - ☐ No
 - ☐ Sometimes
- 3. No snacking while watching TV/DVDs
 - ☐ Yes
 - ☐ No
 - ☐ Sometimes
- 4. No sweet snacks
 - ☐ Yes
 - ☐ No
 - ☐ Sometimes
- 5. No fried snacks (such as crisps)
 - ☐ Yes
 - ☐ No
 - ☐ Sometimes
- 6. Must help with meal preparation at home
 - ☐ Yes
 - ☐ No
 - ☐ Sometimes
- 7. Must help with clean-up after meals at home
 - ☐ Yes
 - ☐ No
 - ☐ Sometimes

8. Must eat dinner with family at home

- ☐ Yes
- ☐ No
- ☐ Sometimes

9. Limited fast food

- ☐ Yes
- ☐ No
- ☐ Sometimes

Q: Thinking about the past month, how often did you have the following foods in your home? Please tick one answer for each) [4][Note: Foods were selected based on popular food consumed by young people [6, 7]]

1. Apples

- ☐ Never
- ☐ Rarely
- ☐ Sometimes
- ☐ Frequently
- ☐ Always

2. Pears

- ☐ Never
- ☐ Rarely
- ☐ Sometimes
- ☐ Frequently
- ☐ Always

3. Citrus fruits e.g. oranges

- ☐ Never
- ☐ Rarely
- ☐ Sometimes
- ☐ Frequently
- ☐ Always

4. Bananas

- ☐ Never
- ☐ Rarely
- ☐ Sometimes
- ☐ Frequently

- ☐ Always
5. Canned fruit in juice or syrup
- ☐ Never
 - ☐ Rarely
 - ☐ Sometimes
 - ☐ Frequently
 - ☐ Always
6. Carrots
- ☐ Never
 - ☐ Rarely
 - ☐ Sometimes
 - ☐ Frequently
 - ☐ Always
7. Tomatoes
- ☐ Never
 - ☐ Rarely
 - ☐ Sometimes
 - ☐ Frequently
 - ☐ Always
8. Salad vegetables
- ☐ Never
 - ☐ Rarely
 - ☐ Sometimes
 - ☐ Frequently
 - ☐ Always
9. Peas (including frozen and canned)
- ☐ Never
 - ☐ Rarely
 - ☐ Sometimes
 - ☐ Frequently
 - ☐ Always
10. Baked beans
- ☐ Never
 - ☐ Rarely

- ☐ Sometimes
- ☐ Frequently
- ☐ Always

11. Green leafy vegetables e.g. spinach

- ☐ Never
- ☐ Rarely
- ☐ Sometimes
- ☐ Frequently
- ☐ Always

12. Carbonated soft drinks, NOT DIET, e.g. Coca Cola

- ☐ Never
- ☐ Rarely
- ☐ Sometimes
- ☐ Frequently
- ☐ Always

13. Carbonated soft drinks, DIET, e.g. Diet Coke

- ☐ Never
- ☐ Rarely
- ☐ Sometimes
- ☐ Frequently
- ☐ Always

14. Fruit juice

- ☐ Never
- ☐ Rarely
- ☐ Sometimes
- ☐ Frequently
- ☐ Always

15. Chips

- ☐ Never
- ☐ Rarely
- ☐ Sometimes
- ☐ Frequently
- ☐ Always

16. Pizza

- ☐ Never
- ☐ Rarely
- ☐ Sometimes
- ☐ Frequently
- ☐ Always

17. Chicken & turkey dishes

- ☐ Never
- ☐ Rarely
- ☐ Sometimes
- ☐ Frequently
- ☐ Always

18. Meat pies and pastries e.g. sausage roll

- ☐ Never
- ☐ Rarely
- ☐ Sometimes
- ☐ Frequently
- ☐ Always

19. Savoury snacks e.g. crisps

- ☐ Never
- ☐ Rarely
- ☐ Sometimes
- ☐ Frequently
- ☐ Always

20. Yoghurt

- ☐ Never
- ☐ Rarely
- ☐ Sometimes
- ☐ Frequently
- ☐ Always

21. Chocolate & biscuits

- ☐ Never
- ☐ Rarely
- ☐ Sometimes
- ☐ Frequently

☐ Always

Q: Who most influences what you eat? Please tick the boxes below that most apply to you [MPMPMP] [2]

☐ Parent(s)/guardian

☐ Brother(s)/sisters(s)

☐ Friends

☐ Spouse/partner

☐ Child/children

☐ Someone else (Please state who) _____

☐ No one but myself

Q: Who does the food shopping for your household? Please tick the boxes below which most apply to you. [MPMPMP] [2]

☐ Parent(s)/guardian

☐ Brother(s)/sisters(s)

☐ Friends

☐ Spouse/partner

☐ Someone else (Please state who) _____

☐ No one but myself

END OF QUESTIONNAIRE

The Adolescent Food Habits Checklist (Johnson *et al.*, 2002)

1. If I am having lunch away from home, I often choose a low-fat option.
True/False/I never have lunch away from home

Point given for True, adjust for N/A

2. I usually avoid eating fried foods. *True/False*

Point given for True

3. I usually eat a dessert or pudding if there is one available. *True/False*

Point given for False

4. I make sure I eat at least one serving of fruit a day. *True/False*

Point given for True

5. I try to keep my overall fat intake down. *True/False*

Point given for True

6. If I am buying crisps, I often choose a low-fat brand. *True/False/I never buy crisps*

Point given for True, adjust for N/A

7. I avoid eating lots of sausages and burgers. *True/False/I never eat sausages or burgers*

Point given for True, adjust for N/A

8. I often buy pastries or cakes. *True/False*

Point given for False

9. I try to keep my overall sugar intake down. *True/False*

Point given for True

10. I make sure I eat at least one serving of vegetables or salad a day.
True/False

Point given for True

11. If I am having a dessert at home, I try to have something low in fat.
True/False/I don't eat desserts

Point given for True, adjust for N/A

12. I rarely eat takeaway meals. *True/False*

Point given for True

13. I try to ensure I eat plenty of fruit and vegetables. *True/False*

Point given for True

14. I often eat sweet snacks between meals. *True/False*

Point given for False

15. I usually eat at least one serving of vegetables (excluding potatoes) or salad with my evening meal. *True/False*

Point given for True

16. When I am buying a soft drink, I usually choose a diet drink. *True/False/I never buy soft drinks*

Point given for True, adjust for N/A

17. When I put butter or margarine on bread, I usually spread it thinly. *True/False/I never have butter or margarine on bread*

Point given for True, adjust for N/A

18. If I have a packed lunch, I usually include some chocolate and/or biscuits. *True/False/I never have a packed lunch*

Point given for False, adjust for N/A

19. When I have a snack between meals, I often choose fruit. *True/False/I never eat snacks between meals*

Point given for True, adjust for N/A

20. If I am having a dessert or pudding in a restaurant, I usually choose the healthiest one. *True/False/I never have desserts in restaurants*

Point given for True, adjust for N/A

21. I often have cream on desserts. *True/False/I don't eat desserts*

Point given for False

22. I eat at least three servings of fruit most days. *True/False*

Point given for True

23. I generally try to have a healthy diet. *True/False*

Point given for True

Adolescent Food Habits Checklist Scoring (Johnson *et al.*, 2002)

Score 1 point for every 'healthy' response.

Adjust for 'not applicable' and missing responses using the following formula:

AFHC Score = no. healthy responses x (23 / no. completed)

Reference

Johnson, F., Wardle, J. and Griffith, J. (2002) 'The Adolescent Food Habits Checklist: reliability and validity of a measure of healthy eating behaviour in adolescents', *European Journal of Clinical Nutrition*, 56(7), pp. 644-649.

**Personal communication regarding use of Global Positioning Systems
technology in health research**

Name	Institution	Content	Date of correspondence
Dr Michael Heasman	North East Public Health Observatory, Wolfson Research Institute, Durham University	Use of GPS enabled smartphones.	May 2010
Dr Ashley Cooper	Reader in Exercise and Health Science, University of Bristol	Advice regarding GPS device choice – QStarz BT1000. Used Garmin watches with children in the PEACH project.	June 2010 (via Amelia Lake)
Dr Jenna Panter	MRC Epidemiology Unit, Cambridge	Advice regarding GPS device choice. Qstarz BT Q1000x used in Commuting and Health study. Garmin Forerunner 205 used with children in the SPEEDY study.	June 2010.
Prof Roger Mackett	Centre for Transport Studies, University College London	QStarz GPS devices used in Cambridgeshire Guided Bus on physical activity	June 2010 (via Amelia Lake)
Dr Richard Bevan	School of Biology, Newcastle University	Advice regarding small GPS loggers - 'I-gotU' GPS logger used to study feeding patterns in fish eating birds.	July 2010 (via Susan Hodgson)
Dr Melanie Hingle	Department of Nutritional Sciences, University of Arizona	Advice regarding use of GPS enables smartphones – experience using HTC Touch Pro2	August 2010 (via GPS-HRN website forum post)

Global Positioning Systems device testing and selection

Appendix overview:

- Introduction
- GPS device specifications
- GPS enabled smartphones and mobile phone tracking
- Identifying and testing 'off the shelf' GPS loggers
- Conclusions and device selection
- References

'A Global Position System (GPS) is a device that uses a satellite system to pinpoint a stationary location on the earth to a latitude and longitude coordinate' (Thornton *et al.*, 2011). The use of GPS devices in health research has become increasingly common, particularly in relation to travel and physical activity measures (Jones *et al.*, 2009; Maddison *et al.*, 2010; Krenn *et al.*, 2011). A number of GPS devices were considered for use in the study. This appendix discusses the process of identifying the important specifications and performance requirements for a GPS device for this study and the testing and selection of a device best suiting these criteria.

1.1 GPS device specifications

It is important to select equipment specific that is fit to the study purpose (Kerr *et al.*, 2011). Therefore the first task in selecting a device was to determine and prioritise the requirements of such a device to fit the research objectives. The device must provide the best possible data for the research and be acceptable to the target population with minimum impact on behaviour and participation burden.

Lee and Wolf (2004) provide a useful list of factors to consider when choosing a GPS device for research purposes. Kerr *et al.* (2011) also published practical guidance for selecting a GPS device for health research. The authors advised testing of devices to ensure they are fit for the research purpose, as

‘manufacturer specifications do not always reflect true performance in the field’ (Kerr *et al.*, 2011).

Lee and Wolf (2004) identified the following seven factors to consider when selecting a GPS device:

- Accuracy and sensitivity
- Battery life
- Fix time
- Data storage capacity
- Ease of use
- Appearance
- Affordability

Kerr *et al* (2011) also identified device sensitivity and accuracy, battery life, and fix time to be the three most important factors to consider when selecting a GPS device for use in health research. The following sections define and describe the requirements of this study for each of the seven factors.

1.1.1 Accuracy and sensitivity

There is a need for a GPS device that records waypoints with a high degree of sensitivity and accuracy. Device sensitivity is determined by chipset type, sensitivity rating (dBm) and number of channels available for satellite fix. There are 24 satellites orbiting the earth, not all are visible to a GPS device at all times. The greater the number of satellites the GPS can fix to, the more accurate the waypoint recording will be. A device with a greater number of channels available for satellite fix is likely to have a higher accuracy in GPS waypoint recording.

A number of environmental factors can influence the accuracy of GPS recording including physical structures such as high rise buildings, tree cover and tunnels, and weather with cloud cover reducing satellite connectivity and waypoint accuracy. For high accuracy, devices should be set to record waypoints at the lowest possible epoch rate so that the maximum amount of data can be recorded. For example, recording at 15 second epochs will show increased sensitivity when compared to recording at 60 second epochs.

1.1.2 Battery life

Studies running over several days often require participants to recharge their GPS device overnight (Stopher *et al.*, 2008; Bohte and Maat, 2009) or change the battery (Oliver *et al.*, 2010) in order to ensure battery life for the duration of the study. Kerr *et al.* (2011) note that this criterion should form part of the participant expectations of a study involving GPS. However, due to the nature of this study, the ideal device would have a battery life allowing for 96 hours (4 days) continuous logging without the need to recharge the device. GPS devices with battery power saving features were sought to try to achieve this and to decrease participant burden and encourage usual behaviour.

1.1.3 Fix time

Fix time refers to the time taken for a GPS device to obtain a satellite fix. This can be referred to as cold, warm and hot fix times. A cold fix time refers to the time lapse between turning the device on and the first satellite fix when the device has had no previous satellite connection. Warm and hot fix times will be faster than cold fix times as they rely on previously recorded locations. Faster fix times lead to increased accuracy in trip recording.

It is common practice to ask participants to wait for up to one minute for a satellite fix when the device is first switched on or when leaving buildings. This technique has the potential to reduce acceptability of the method for young people, impacting recruitment and/ or adherence to the study protocol. Devices were therefore tested for satellite fix time in everyday scenarios.

Not requiring participants to wait for a satellite fix could result in some data loss through delayed fix, especially if they are moving in motorised vehicles prior to a fix being established. There was a need to encourage usual behaviour and asking participants to wait upon leaving building has the potential to induce a behaviour change and not measure 'free living' behaviour. The method proposed here has since been reported in a study by Christian (2012) stating similar reasons for the method choice.

1.1.4 Data storage capacity

The data storage capacity, or device memory, should be considered when collecting data over longer time periods without downloading data from the device. The more frequently data points are collected; the more storage space will be required.

The maximum number of waypoints that could be collected in this study is 345,600. This estimate was calculated based on continuous waypoint logging at one second epochs over 96 hours (4 days). However, in order to conserve battery life, epoch intervals of 5 and 10 seconds were tested.

1.1.5 Ease of use

There was a requirement of the device itself and any associated software to be easy for the researcher to use. Configuration and special functions such as power saving easy needed to be easy to locate and use from a researcher perspective. The device would ideally be tamperproof to participants.

The extracted data format should be suitable for use in ArcGIS software without the need for excessive data manipulation. Automatic data cleaning features should be appropriate and straight forward to apply. As the majority of GPS devices are aimed at the general public consumer, the devices should all be reasonably simple to use. However, a lack of manufacturer support may be apparent as devices were not specifically designed for use in health research where device performance expectations may be higher (Kerr *et al.*, 2011).

1.1.6 Appearance

Taking into account the comments made by young people at the Beacon North East workshops (see methods development chapter); the device needed to be small in size with an attractive modern design to encourage engagement with the data collection method. It was preferable for the device to be worn hidden from view but maintain a high level of data accuracy and sensitivity in this position.

1.1.7 Affordability

The outgoing cost for the purchase of GPS device should be within the study budget. A limit of £100 per unit was set, to include charging equipment, protective cases etc.

1.2 GPS enabled Smartphones and mobile phone tracking

Mobile smartphone devices were considered for use in this study in order to integrate the use of GPS with the text messaging and photography data collection. However, their use was rejected following testing for the reasons stated below:

- Waypoint accuracy was poor in comparison to a purpose build GPS device
- Battery life was very poor with a need for participants to recharge the smartphone everyday
- High initial cost of equipment outside of the study budget limit
- There was a need to develop specialist software to run GPS as a background application

Mobile phone tracking companies were also approached and considered method of GPS data collection. Tracking works on a triangulation system where the location of a mobile phone is calculated based on the proximity to radio signals in conjunction with GPS satellites. This allows tracking of mobile phones in real time, the data is sent to an external server rather than being stored on the device itself. This method was priced outside of the study budget and raised concerns regarding data security and the ethical implications of tracking participants in 'real time'.

With these factors in mind, the decision was made to use an 'off the shelf' GPS logger for the purpose of this study. The next section describes the identification of loggers to trial, the testing of those loggers and the selection of a logger for testing in the pilot study.

1.3 Identifying and testing 'off the shelf' GPS loggers

A literature review was conducted to identify other studies using GPS. The purpose of this was to identify the logger models used in health research and explore the conditions and settings in which they were used. At the time (from January 2010), GPS in health research was on the rise, however, the number of research papers published were relatively few. The number of publications emerging in the literature has increased considerably over the past few years (Krenn *et al.*, 2011; Zenk *et al.*, 2011).

After consultation with a number of experts in the field of GPS research (see appendix D), two devices were selected for testing:

- I. Qstarz BT-Q1000XT Bluetooth Data Logger GPS Receiver
- II. i-gotU GT-600 Motion Detecting GPS Travel Tracker

Both devices have been used in previous studies (Newcastle University Press Office, 2010; Ogilvie *et al.*, 2010). A comparison of the features boasted by each device in the manufacturer provided information can be seen in Table 1.

Table 1 Key features of GPS loggers, as stated by manufacturers on their packaging and websites (QStarz International Co. Ltd., 2006; MobileAction, 2010)

	QStarz BT-Q1000XT	i-gotU GT-600
Chipset	MTK II	SiRF Star III
Sensitivity rating (minus figures, lower = better)	-165 dBm	-159 dBm
Tracking channels	66	20
Battery life	Up to 46 hours*	60 hours (at 10s intervals)
Power saving function	Vibration sensor	Motion detector
Time schedule function	In NAV mode only	Yes
GPS fix from cold start (s)	<35	<35
GPS fix from hot start (s)		
Storage capacity (Mb)	Not stated	64
Storage capacity (waypoints)	400,000	262,000
Recharge time	3 hours	2 hours
Software	QTravel	@trip PC
Weight (g)	64.7	37
Dimensions (mm)	72.2 x 46.5 x 20	46 x 41.5 x 14 mm
Cost (£)	86.80	49.99



Figure 1: QStarz BT-Q1000XT (left) and i-gotU GT-600 (right)

The QStarz logger appears to be the more functional device following a comparison of the two devices based on the manufacturer's information (QStarz International Co. Ltd., 2006; MobileAction, 2010). QStarz had more desirable ratings for accuracy and sensitivity than i-gotU. Both devices boasted adequate storage capacities and short time to cold start fix. Again, both devices featured a power saving function.

Both loggers were small in physical dimensions and weight; however the i-gotU device was just over half the size of the QStarz and could therefore be carried more discreetly. In terms of cost, the i-gotU is the more economical option. In addition, both devices had the option to pre-set recording times so data was logged within pre-defined time points. The i-gotU also benefited from an on/off button disabling function reducing the risk of data tampering.

Based on the manufacturer information, there were pros and cons to both devices. Kerr *et al* (2011) recommend researchers conduct their own device testing to ensure the equipment is fit for purpose. With the manufacturer specifications and the ideal logger requirements in mind, numerous tests were carried out to determine the functionality of the two loggers. The loggers were configured to be as close in function as possible in all tests and the performance for the i-gotU and QStarz were compared (using the specifications

previously outlined) with the aim of selecting the most appropriate logger to use in the study.

The loggers were tested in a number of day to day scenarios by fellow researchers and additional volunteers (RT, AL, RG and LG). Data was extracted and analysed by RT. The following sections outline the methods and results for each test, concluding with an overall summary of the strengths and weaknesses of each device and selection of the study logger.

1.3.1 Test one

This test aimed to compare the battery life between the QStarz and i-gotU loggers configured to record waypoints at 10 second epochs. The devices were set up to be as similar as possible, the power saving features of both loggers were inactive. Against manufacturer instructions, the loggers were powered on indoors and therefore the time to first waypoint recorded (satellite fix) was likely to be much greater than stated in the specification information. The devices were switched on and carried in front pocket of a handbag until both devices batteries were exhausted. Table 2 outlines the configuration and test results for both loggers.

Table 2 Test one, device settings and results

	QStarz	I-gotU
Tester ID	RT	RT
Epoch interval (s)	10	10
Memory full	Stop log	Circular log disabled
Power saving mode	Disabled	Disabled
Other	Switch to LOG mode	Button control disabled
Start date	21/10/2010	21/10/2010
Device on time (h:m)	14:00	14:00
First waypoint recorded (h:m:s)	15:05:57	15:10:00
End date	23/10/2010	22/10/2010
Last waypoint recorded (h:m)	04:13:22	12:46:52
Total waypoints	12,274	6349
Waypoints cleaned	646	806
No. tracks	2	1
Total running time (h:m)*	37:08	21:36
Total running time (d:h:m)	1d 13h 8m	0d 21h 36m
Hours data recorded (h:m:s)**	34:05:24	17:38:24
Missing data (h:m:s)***	03:02:36 (8.1%)	03:57:36 (18.3%)

*total running time = end date/ time minus start date/ time

**hours data recorded = total waypoint recorded/ 6/ 60

***missing data = total running time minus hours data recorded

The key findings from this test were:

- QStarz demonstrated a much longer battery life than the i-gotU, with a difference of 16 hours, 32 minutes.
- QStarz recorded the first waypoint approximately 5 minutes before i-gotU, indicating a faster satellite cold fix time.
- There was a greater loss of data seen with the i-gotU device.
- It was easier to identify where satellite signal loss occurs in the QStarz data as a new 'track' is formed in the QTravel software. Signal loss would need to be manually identified in the i-gotU data as only one track was presented in the @trip software.
- Some difficulties occurred in the transfer of data from the devices to the PC. This resulted in a loss of the original data and therefore no maps have been produced from this test to illustrate waypoint accuracy and sensitivity.

1.3.2 Test two

Following test one, test two set out with the following aims:

- To compare battery life between the QStarz and i-gotU GPS loggers when power saving modes are enabled.
- To compare track accuracy between the QStarz and i-gotU GPS loggers.
- To test the effectiveness of timing schedule functions on the loggers for a 4-day period

Both devices were set up to test the time schedule functions of the device, the loggers were configured to 'switch on' at 06:00 on 03/11/2010, record for 4 days then 'switch off' at midnight on 06/11/2010.

In this test, the power saving functions of the GPS devices were activated. Details of the functions are explained in Figure 2, adapted from the manufacturer descriptions.

Figure 2 A comparison of the power saving functions for GPS devices

QStarz	i-gotU
(QStarz International Co. Ltd., 2006)	(MobileAction, 2010)
A vibration detector is functioned for power and waypoint saving. It detects physical movement of the device and when the device has not moved for more than 10 minutes it enters a sleep mode. When sleep mode is activated the logging of waypoints is disabled. The device automatically wakes-up when "significant movement" is detected. The manufacturer suggests that the device is shaken to wake to avoid data loss through missing tracks.	The motion detector function claims to make "daily logging much easier and power efficient". The device automatically powers-off when it is motionless sparing up to 20% extra logging time. The device automatically re-activates when motion is detected.

AL was provided with the two devices on 28/10/2010 and asked to carry the devices at all times until 06/11/2010. The QStarz device was switched to 'LOG' during the hand over meeting with AL on 28/10/2010. AL was instructed to carry the devices in the outside pocket of a handbag or coat used daily. AL was asked not to purposefully shake the devices in order to test the 'wake-up' function of both devices in a free-living scenario. No further instructions were provided. Figure 3 and Figure 4 show screenshots of the settings applied within

the software. Table 3 outlines the settings applied to each device and the results from test two.

Figure 3 Screenshots from QTravel, configuration of QStarz device for test two

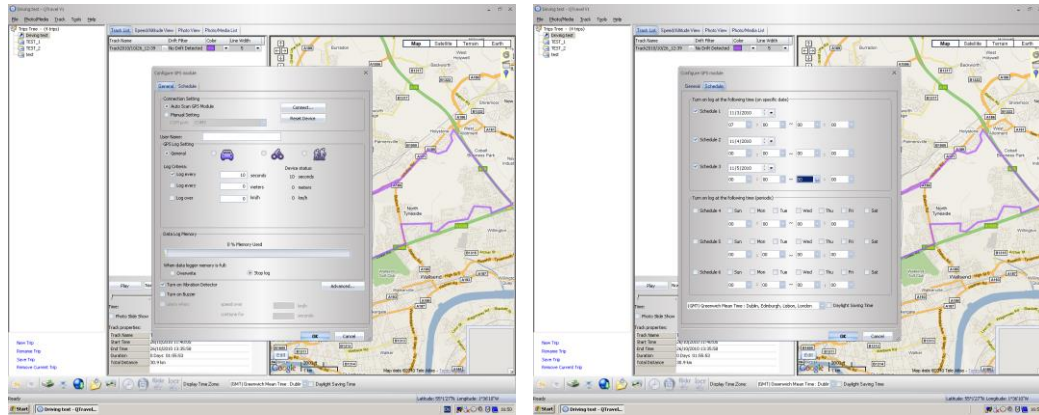


Figure 4 Screenshots from @trip, configuration of i-gotU device for test two

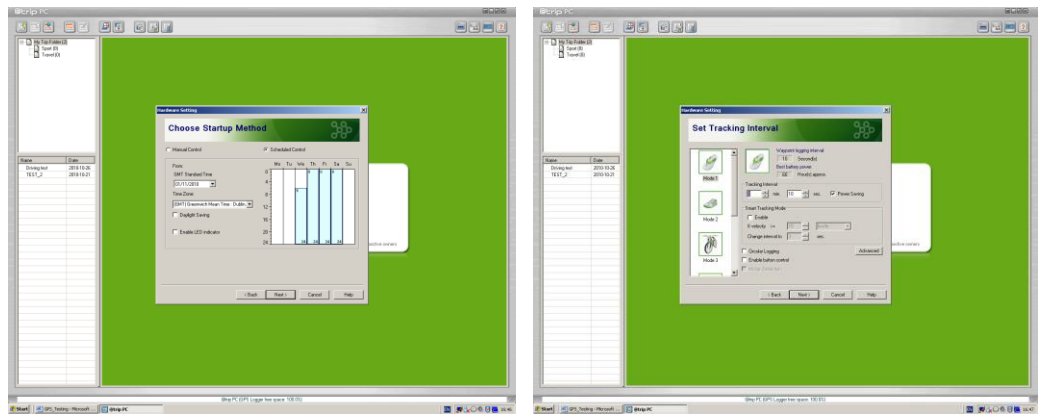


Table 3 Test two, device settings and results

	QStarz	I-gotU
Tester ID	AL	AL
Scheduled start date	03/11/2010	03/11/2010
Scheduled device on time (h:m)	06:00	06:00
Epoch interval (s)	10	10
Memory full	Stop log	Circular log disabled
Power saving mode	Enabled	Enabled
Scheduled end date	06/11/2010	06/11/2010
Scheduled end time (h:m:s)	23:59:59	23:59:59
Other	n/a	Button control disabled
Actual start date	28/10/2010	03/11/2010
First waypoint recorded (h:m:s)	14:46:34	06:29:43
Actual end date	03/11/2010	04/11/2010
Actual end time (h:m:s)	15:48:55	16:11:12
Total waypoints	6972	4957
Waypoints cleaned	3263	786
No. tracks	14	1
Total running time (h:m)*	145:02	33:41
Total running time (d:h:m)*	6d 01h 02m	1d 9h 41m
Hours data recorded (h:m:s)**	19:22:12	13:46:11
Missing data (h:m:s)***	125:39:48 (87%)	13:12:30 (39%)

*total running time = end date/ time minus start date/ time

**hours data recorded = total waypoint recorded/ 6/ 60 (decimal time converted to h:m:s)

***missing data = total running time minus hours data recorded

Table 4 Test two timing function results

Day	Day/date	Time	QStarz	i-gotU
1	28/10/2010 Thursday	First waypoint	14:46:34	Not scheduled
		Last waypoint	21:32:25	
2	29/10/2010 Friday	First waypoint	06:29:54	Not scheduled
		Last waypoint	18:50:34	
3	30/10/2010 Saturday	First waypoint	09:27:54	Not scheduled
		Last waypoint	21:46:14	
4	31/10/2010 Sunday	First waypoint	11:17:35	Not scheduled
		Last waypoint	22:22:46	
5	01/11/2010 Monday	First waypoint	03:43:29	Not scheduled
		Last waypoint	03:52:49	
6	02/11/2010 Tuesday	First waypoint	Did not carry	Not scheduled
		Last waypoint		
7	03/11/2010 Wednesday	First waypoint	08:38:36	06:29:43
		Last waypoint	15:48:55	23:59:48
8	04/11/2010 Thursday	First waypoint	-	00:00:22
		Last waypoint		16:11:12
9	05/11/2010 Friday	First waypoint	-	Scheduled. No data
		Last waypoint		
10	06/11/2010 Saturday	First waypoint	-	Scheduled. No data
		Last waypoint		

Note: AL did not carry the GPS devices on days 5 and 6 due to travel outside the study area.

This test was designed to trial the schedule functions of the GPS devices. The schedule function on the QStarz device was only active when the device was in 'NAV'¹ mode. This, however, did not save on battery power as the device continued to obtain satellite fixes without recording waypoints. In this test the device was set to 'LOG' and the first waypoint was recorded soon after the device was turned on, not at the time scheduled.

The QStarz device recorded data on six days. The device was not carried on days 5 and 6 due to AL travelling outside of the study area (London). Table 4 shows the device entering sleep mode when static as would be expected overnight. There was however, some satellite fix and failure of the power saving

¹ When switched to NAV mode the BT-Q1000XT can be used to navigate with handheld devices (PDA/ smartphone/ laptop) and the LOG function will be enabled if the present time is within the preset time schedule (REF booklet)

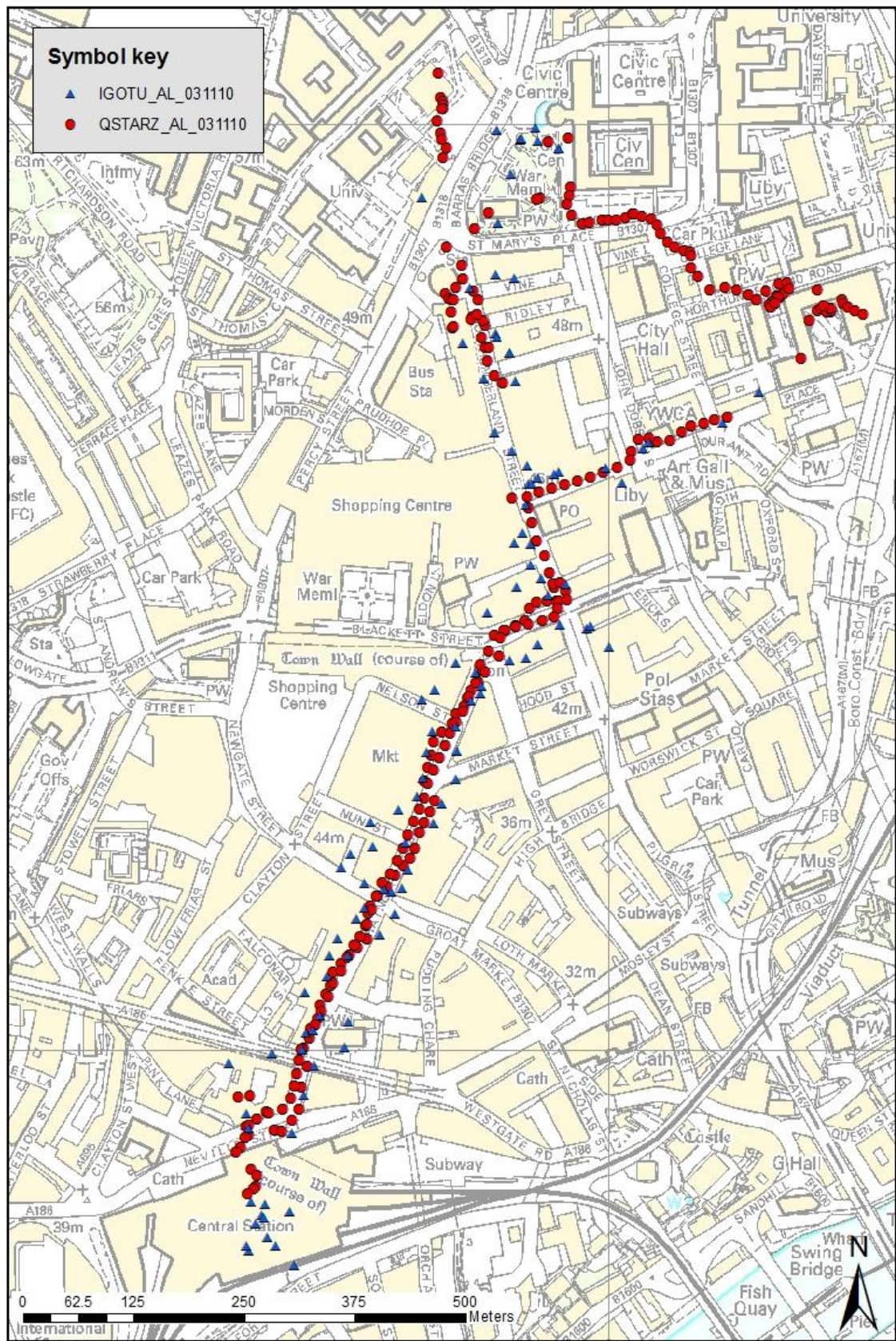
function overnight on day 5, where waypoints were recorded over a period of a few minutes.

The power saving mode in the i-gotU device appeared to be less sensitive than the QStarz. It appears that the function failed to activate as the device continued to log waypoints throughout the night. This resulted in a short battery life with the device only logging data on two days. The i-gotU did automatically switch on at the pre-scheduled time. The device benefits also from the deactivation of the central control button. This ensures that the device cannot be accidentally or purposefully deactivated.

Both devices were active on 03/11/2010, data collected by each device on this day was mapped and compared for accuracy of waypoints. Figure 5 presents data collected around the Newcastle city centre area on this day. To create the maps presented here, data was extracted from QTravel and @TripPC software programmes and projected in ArcGIS version 9.3.

Figure 5 clearly shows the accuracy and sensitivity of the QStarz device is greater than the i-gotU. The QStarz waypoint tracks are aligned with visible walking routes whereas the i-gotU data appear to exhibit a greater degree of waypoint drift. Both devices lost satellite signal at some time points, a problem commonly associated with using GPS in built up areas.

Figure 5 Map showing data collected using the QStarz and i-gotU GPS devices in the Newcastle area (03/11/2010, AL)



1.3.3 Test three

A third test was conducted with the aim to test battery life, and data accuracy and sensitivity over a 4 day period. The participant (RG) carried both the QStarz and i-gotU GPS devices at all times between Thursday 25/11/2010 and Sunday 28/11/2010. The QStarz device was switched to 'LOG' at 7:00AM on Thursday 25/11/2010. As in test two, the schedule function of the i-gotU device was active, configured to log waypoints between 07:00AM and 11:00PM for the 4 day period only. The i-gotU was not scheduled to collect data during any other time periods or days. Table 5, Figure 6 and Figure 7 show the device setting and configuration for this test.

Table 5 Test three, device settings and results

	QStarz	I-gotU
Tester ID	RG	RG
Scheduled start date	25/11/2010 (manual)	25/11/2010 (auto)
Scheduled device on time (h:m)	n/a	07:00 – 23:00 daily
Epoch interval (s)	10	10
Memory full	Stop log	Circular log disabled
Power saving mode	Enabled	Enabled
Scheduled end date	n/a	28/11/2010
Scheduled end time (h:m:s)	n/a	23:00
Other	RG manually switched device to 'LOG' at start	Button control disabled
Actual start date	25/11/2010	25/11/2010
Actual start time	~14:30	07:00
First waypoint recorded (h:m:s)	14:40:36	12:43:37
Actual end date	01/12/10	25/11/2010
Actual end time (h:m:s)	12:45:03	17:55:17
Total waypoints	2608	461
Waypoints cleaned	856	215
No. tracks	6	1
Total running time (h:m)*	142:04	05:12
Total running time (d:h:m)*	5d 22h 4m	0d 5h 12m
Hours data recorded (h:m:s)**	07:12:06	01:18:02
Missing data (h:m:s)***	134:51:54 (95%)	03:53:58 (75%)

*total running time = end date/ time minus start date/ time

**hours data recorded = total waypoint recorded/ 6/ 60 (decimal time converted to h:m:s)

***missing data = total running time minus hours data recorded

Figure 6 Configuration of QStarz device for test three

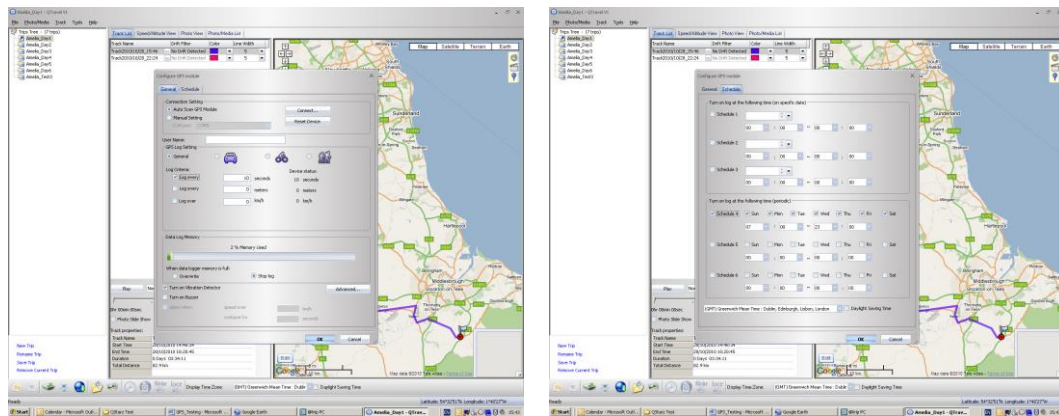


Figure 7 Configuration of i-gotU device for test three

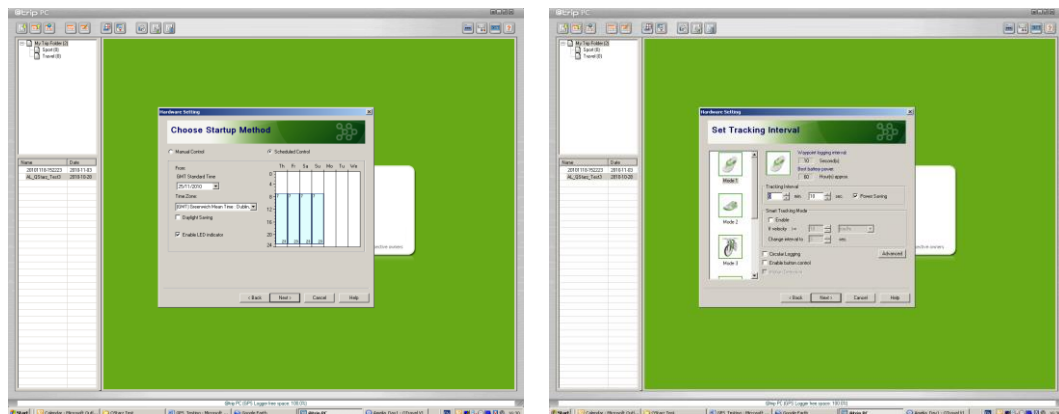


Table 6 Test three timing function results

Day	Day/date	Time	QStarz	i-gotU
1	25/11/2010 Thursday	First waypoint	14:40:36	12:43:37
		Last waypoint	18:06:21	17:55:17
2	26/11/2010 Friday	First waypoint	No data	Scheduled, no data
		Last waypoint		
3	27/11/2010 Saturday	First waypoint	13:50:36	Scheduled, no data
		Last waypoint	16:54:10	
4	28/11/2010 Sunday	First waypoint	10:30:06	Scheduled, no data
		Last waypoint	17:00:04	
5	29/11/2010 Monday	First waypoint	No data	Not scheduled
		Last waypoint		
6	30/11/2010 Tuesday	First waypoint	No data	Not scheduled
		Last waypoint		
7	01/12/2010 Wednesday	First waypoint	10:43:24	Not scheduled
		Last waypoint	12:45:03	

Human error is highlighted in this dataset with RG forgetting to power on the QStarz device on day 1, powering on at a later time than instructed. Data for any journeys taken prior to this time are therefore lost (

Figure 8). Having the QStarz powered on prior to starting the study or reminding the participant to power on the logger may prevent data being lost in this manner.

The i-gotU device automatically powered on at 07:00 on day 1 as programmed. The first waypoint was recorded upon satellite fix when the device was positioned outdoors. This function of the i-gotU is an advantage as participants have no responsibility for device operation.

The QStarz shows a greater battery life than the i-gotU device. In this test, the i-gotU only recorded waypoints on one of the study days. The 'wake-up' function may also provide an explanation; it is possible that the function is not as sensitive in the i-gotU as in the QStarz. The requirement is for participants to carry the GPS device with minimum effort (for example in a school bag). A device with greater sensitivity to movement is required in order to minimise data loss.

It appears that neither of the loggers was able to pick up journeys of very short distance. RG reported visiting a gym close to her home on study day 2. Neither device recorded any waypoints. It could be that the devices did not 'wake up' or were not outdoors and in view of satellites for long enough to secure a fix. The area is built up urban, and the walk was very short in terms of time and distance, both factors known to influence GPS logger performance. This shows the potential for GPS to miss vital information and therefore it is important use GPS data in conjunction with diaries and interview methods. The use of diaries is essential to provide contextual information to accompany the GPS data which used alone could be easily misinterpreted. For example, RG did not travel on study days 5 and 6 due to adverse weather conditions. No data was recorded by the GPS devices on these days due to lack of movement, not device failure as could be assumed without the contextual information. However, on day 7, the QStarz recorded waypoints suggesting that the battery life of this device had the potential to record data over 4 days when the power saving function is activated.

In addition to battery life, waypoint accuracy and sensitivity was assessed during this test. Data were extracted from the loggers using the relevant

software and projected in ArcGIS v9.3. Figure 9 and Figure 10 present comparable data from the QStarz and i-gotU devices collected on day 1.

Figure 8 Map depicting all data collected by QStarz and igot-U devices on day 1 (RG)

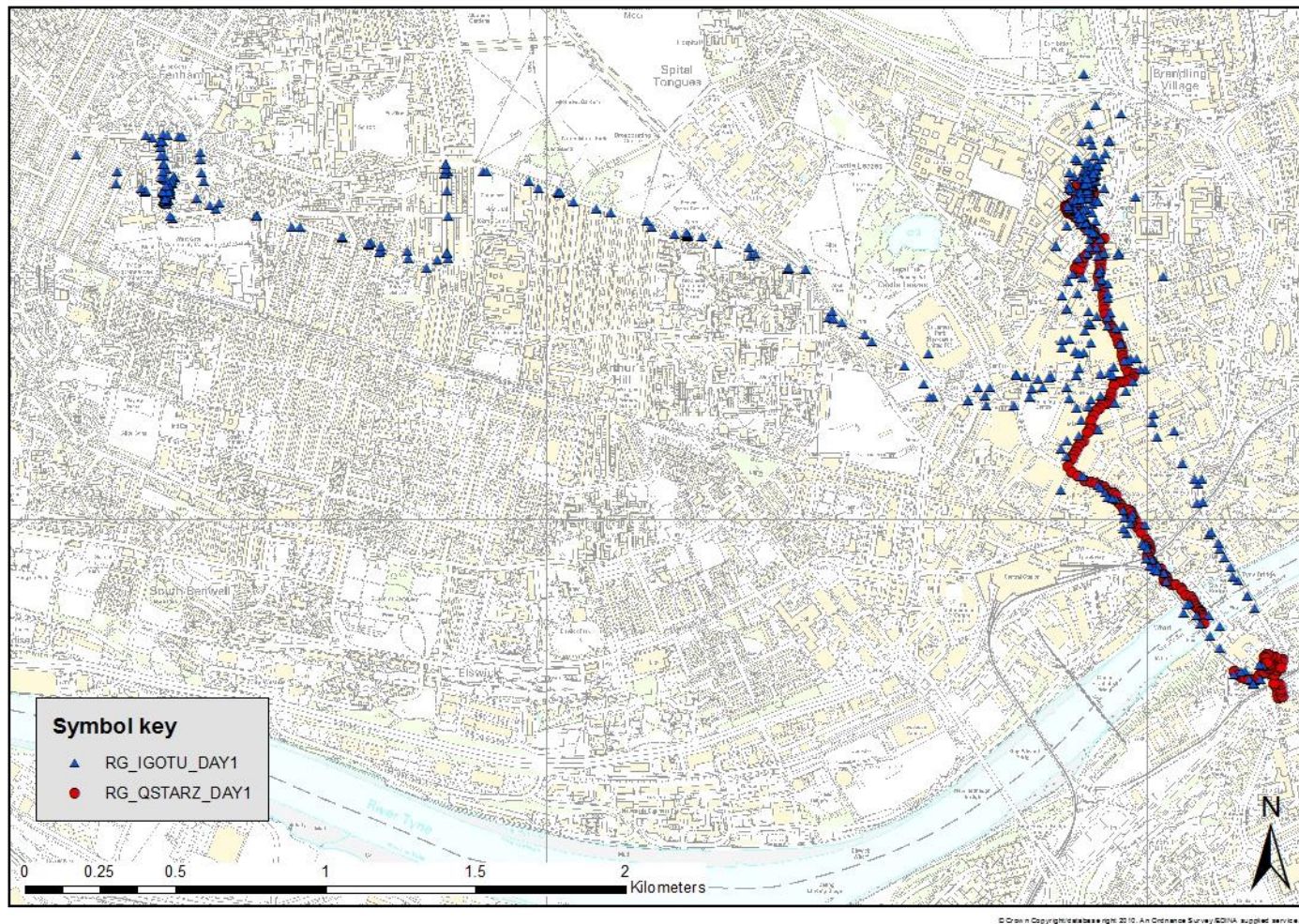


Figure 9 Comparison of data collected using QStarz and i-gotU GPS devices in Newcastle city centre, data is time matched for day 1 (RG)

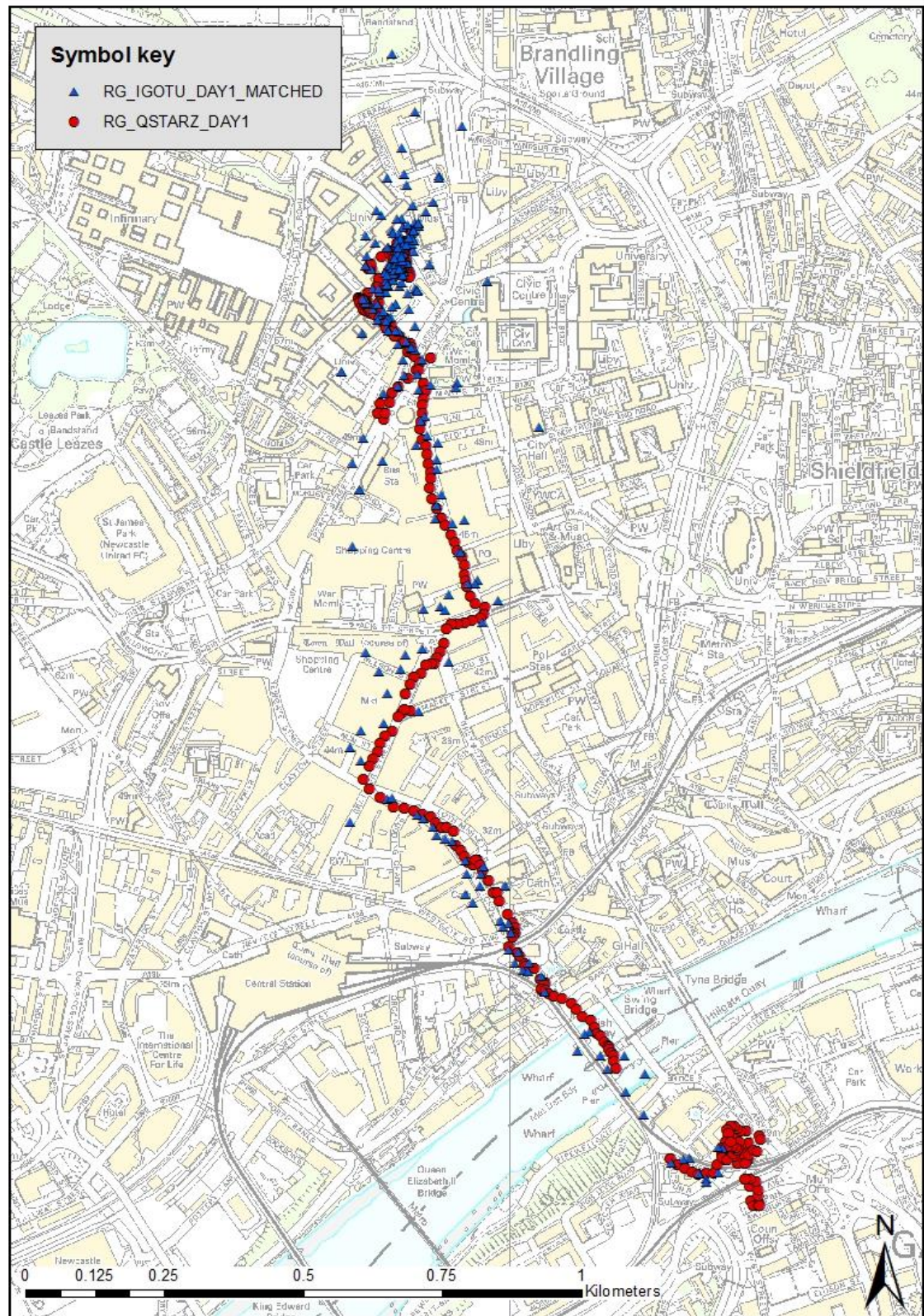
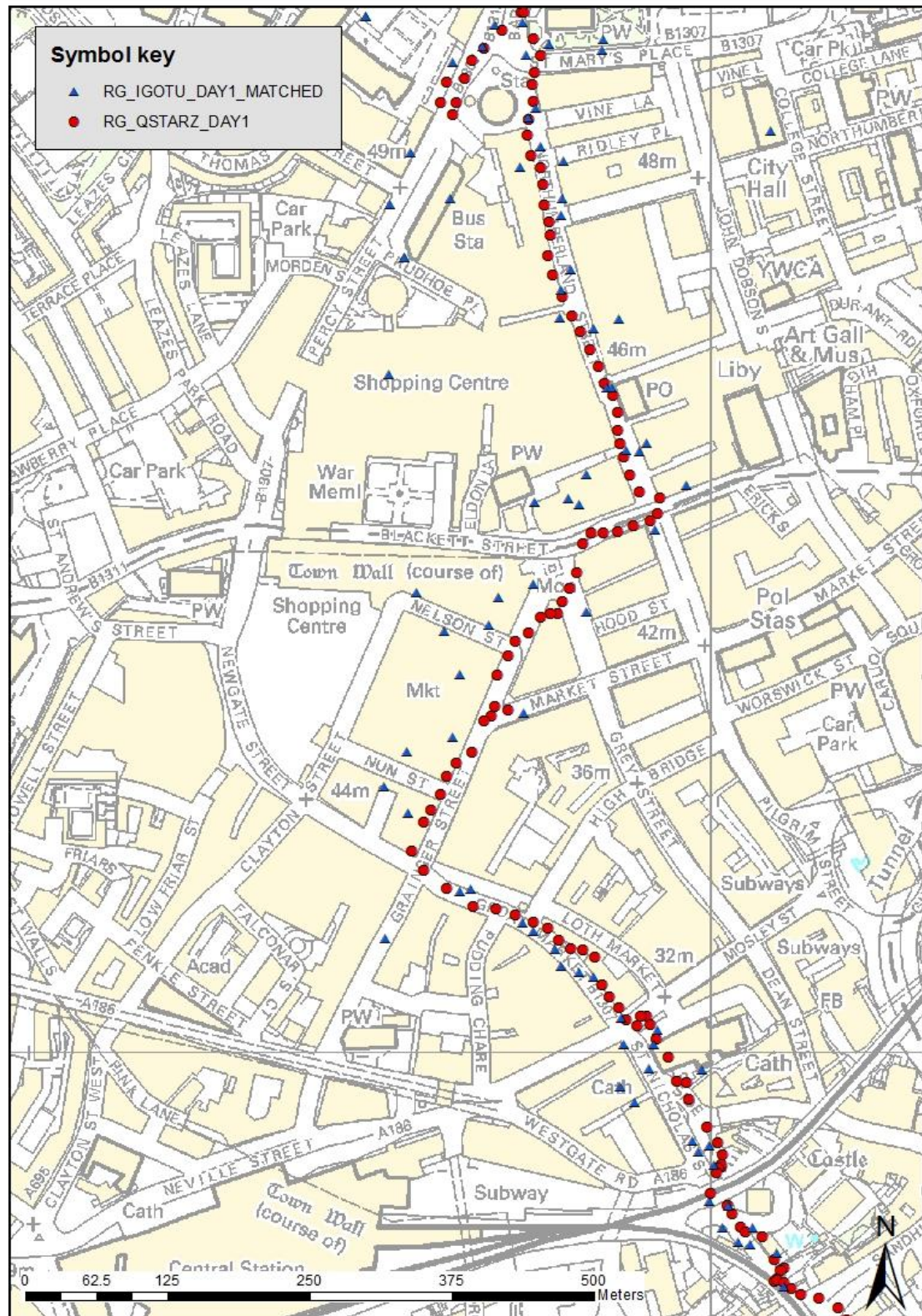


Figure 10 Map showing a zoomed area of data collected using the QStarz and i-gotU GPS devices in Newcastle city centre, data is time matched for day 1 (RG)



The QStarz appeared to have greater waypoint accuracy when recording walking routes. The i-gotU data was characterised by greater waypoint drift where points are not neatly aligned with walking routes. The figures demonstrate greater sensitivity and accuracy in waypoint recording by the QStarz device in the built up urban area of Newcastle upon Tyne city centre.

1.3.4 Test four

The aim of test four was to repeat the aims of test three and four with a free living subject (i.e. not a nutrition researcher). Battery life, ease of use by researcher and participant and waypoint accuracy are discussed here.

The participant (LG) was asked to carry the GPS devices in the outside pocket of a regularly used bag for 4-days between Friday 03/12/2010 and Monday 06/12/2010. LG was asked to switch the QStarz to 'LOG' at 07:00AM or upon waking on 03/12/2010 and leave the device running from that point forward. LG was instructed that the i-gotU device would automatically power on at 07:00AM on the 03/12/2010. Table 7 contains the device settings and results for test four.

Table 7 Test four, settings and results

	QStarz	I-gotU
Tester ID	LG	LG
Scheduled start date	03/12/2010 (manual)	03/12/2010 (auto)
Scheduled device on time (h:m)	n/a	07:00 – 23:00 daily
Epoch interval (s)	10	10
Memory full	Stop log	Circular log disabled
Power saving mode	Enabled	Enabled
Scheduled end date	n/a	06/12/2010
Scheduled end time (h:m:s)	n/a	23:00
Other	LG asked to manually switch device to 'log' upon waking.	Button control disabled
Actual start date	03/12/2010	03/12/2010
First waypoint recorded (h:m:s)	07:36:03	07:31:46
Actual end date	09/12/2010	09/12/2010
Actual end time (h:m:s)	14:41:12	14:07:06
Total waypoints	1011	789
No. tracks	10	1
Total running time (h:m)*	151:05	150:35
Total running time (d:h:m)*	6d 7h 5m	6d 6h 35m
Hours data recorded (h:m:s)**	02:47:59	02:12:06
Missing data (h:m:s)***	148:17 (98%)	148:23 (99%)

*total running time = end date/ time minus start date/ time

**hours data recorded = total waypoint recorded/ 6/ 60 (decimal time converted to h:m:s)

***missing data = total running time minus hours data recorded

Table 8 Test four timing function results

Day	Day/date	Time	QStarz	i-gotU
1	03/12/2010 Friday	First waypoint	07:36:03	07:31:46
		Last waypoint	12:05:46	11:58:39
2	04/12/2010 Saturday	First waypoint	No data	Scheduled, no data
		Last waypoint		
3	05/12/2010 Sunday	First waypoint	No data	Scheduled, no data
		Last waypoint		
4	06/12/2010 Monday	First waypoint	07:48:30	Scheduled, no data
		Last waypoint	17:37:17	
5	07/12/2010 Tuesday	First waypoint	08:07:35	Not scheduled
		Last waypoint	17:46:46	
6	08/12/2010 Wednesday	First waypoint	No data	Not scheduled
		Last waypoint		
7	09/12/2010 Thursday	First waypoint	11:54:55	11:19:18
		Last waypoint	14:41:12	14:07:06

Both devices logged the first waypoint shortly after 7:30 AM, confirmed by LG as the start of journey to the workplace. In this test, the i-gotU device acquired a first waypoint fix faster than the QStarz device.

The dates recorded by the i-gotU did not match up with those expected to be seen by the researcher. This is likely due to ‘human error’ in that the device was not configured, in terms of dates and times, as required. This highlights the need to develop a protocol for configuring GPS device settings to suit the study and to have a series of checks in place.

LG did not carry either of the GPS devices on days 2 and 3. The devices remained in the rucksack LG uses for work and this was not carried over the weekend days. This highlights a need to remind participants to carry the GPS devices as they would a purse or keys aiming to reduce the risk of the device being left in ‘school bags’ etc over the weekend. Capturing data on both week and weekend days is important as behaviours exhibited during these times may differ significantly.

As with the previous tests, the QStarz device recorded a greater number of waypoints than the i-gotU. LG carried both GPS devices on study days 4 and 5, however, only the QStarz device recorded any data on these days. It appears that short battery life was not the explanation on this occasion as the i-gotU recorded some data later on in the week. It could be that the i-gotU was not

configured to log data on these days or that the device failed to 'wake up' upon movement.

Data were mapped as in test three. In the example data shown in Figure 11 the i-gotU device (blue triangles) recorded a greater portion of the journey than the QStarz device (red circles). Both devices obtained a satellite fix when LG left his home around 07:30AM but the QStarz lost signal on his journey to work. The QStarz regained satellite fix during travel but the middle section of the journey is lost (Figure 12). Overall, the i-gotU device recorded a greater number of waypoints on Day 1 than the QStarz (523 and 425 respectively), this is possibly due to a failure to enter 'sleep mode' when static in the workplace. This is demonstrated by a greater density of igot-U waypoints clustered at the workplace exhibiting a high degree of waypoint drift (Figure 13). Overall, the QStarz data demonstrated greater accuracy in waypoint recording and less 'drift' when the devices were active in a built up environment such as Newcastle city centre (Figure 14).

Figure 11 Comparison of data collected by QStarz and i-gotU devices on day 1 (LG)

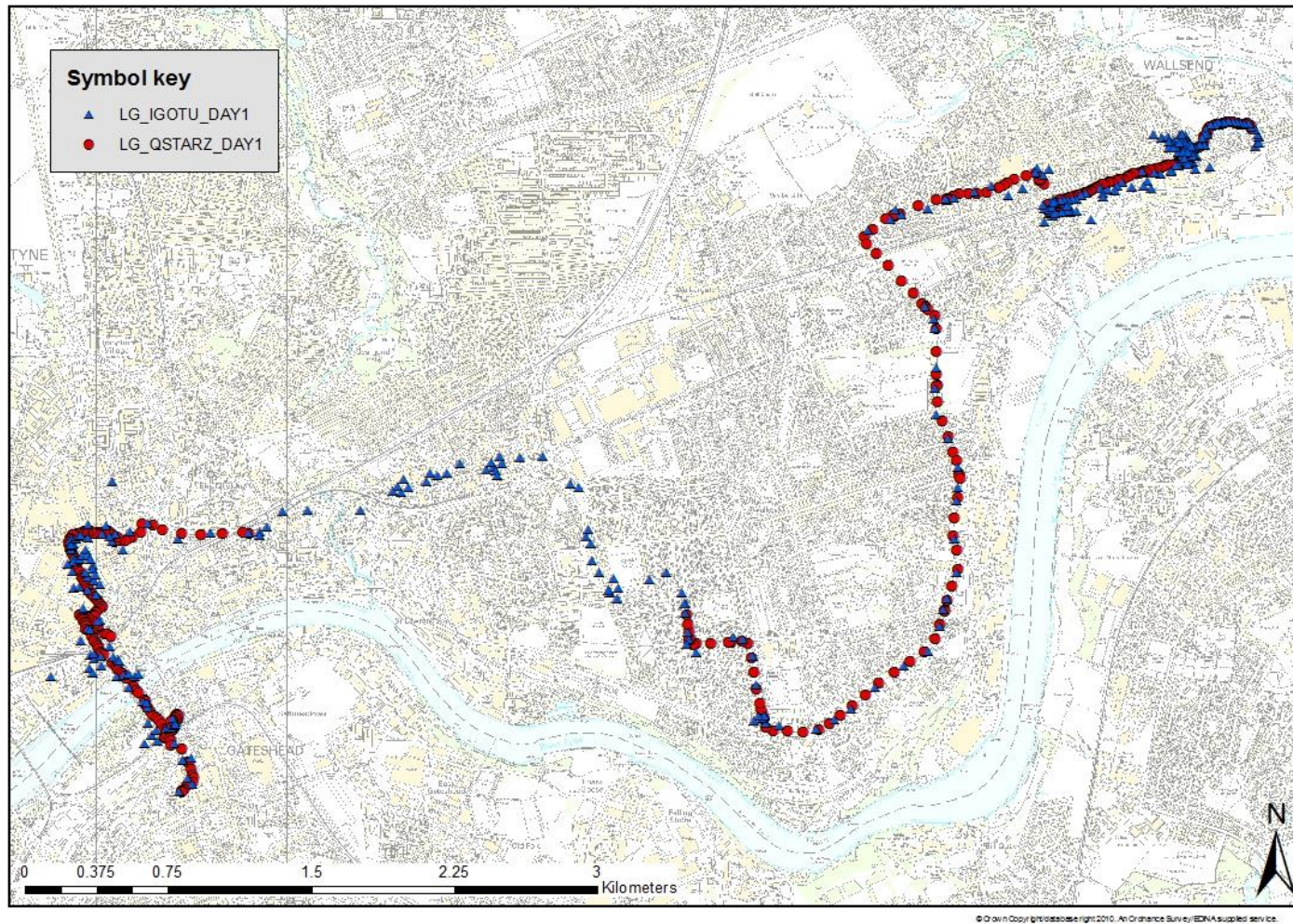


Figure 12 Map showing loss of satellite fix in Qstarz device, day 1 (LG)

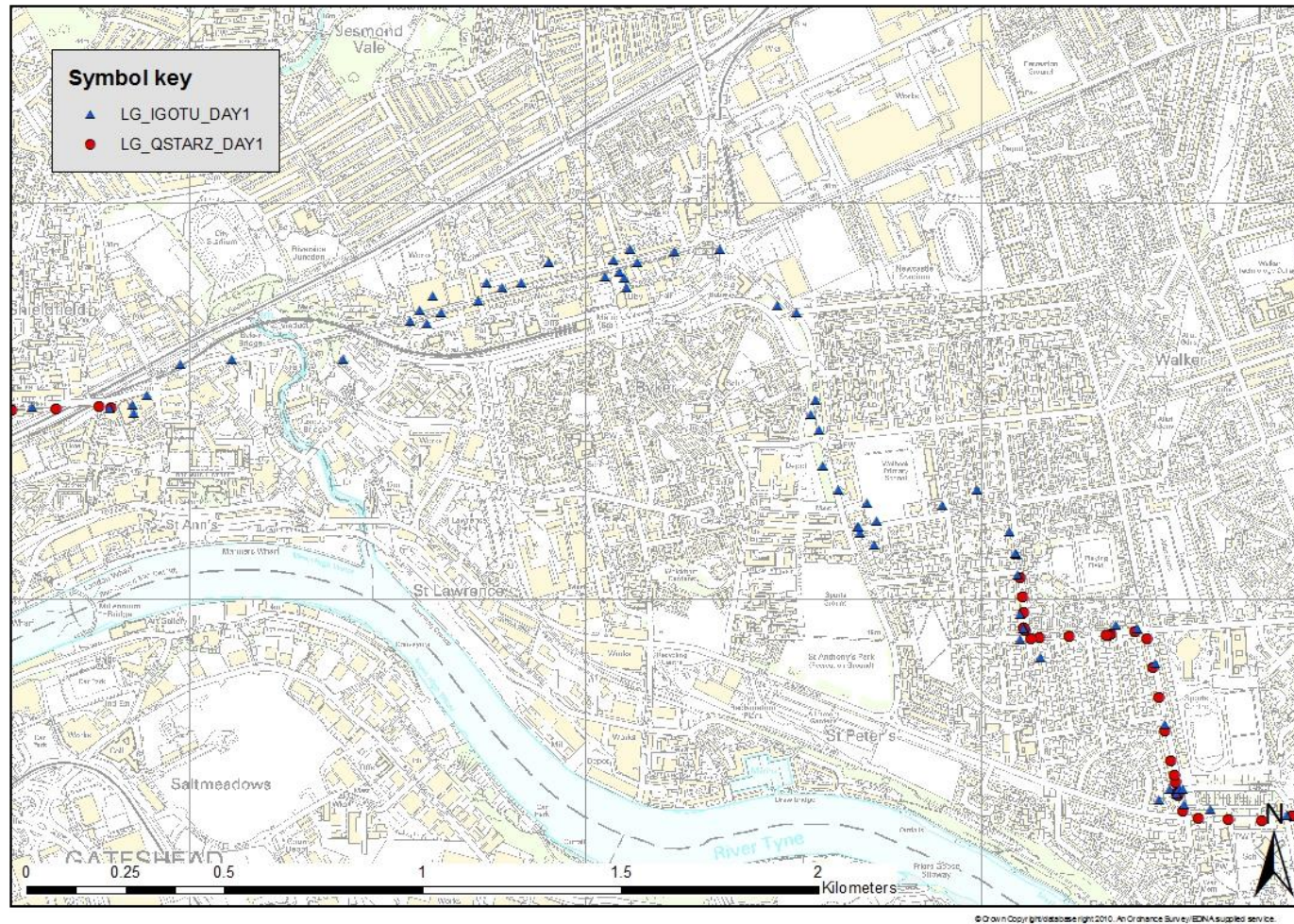


Figure 13 Map depicting waypoint clustering and drift in igot-U device, day 1 (LG)

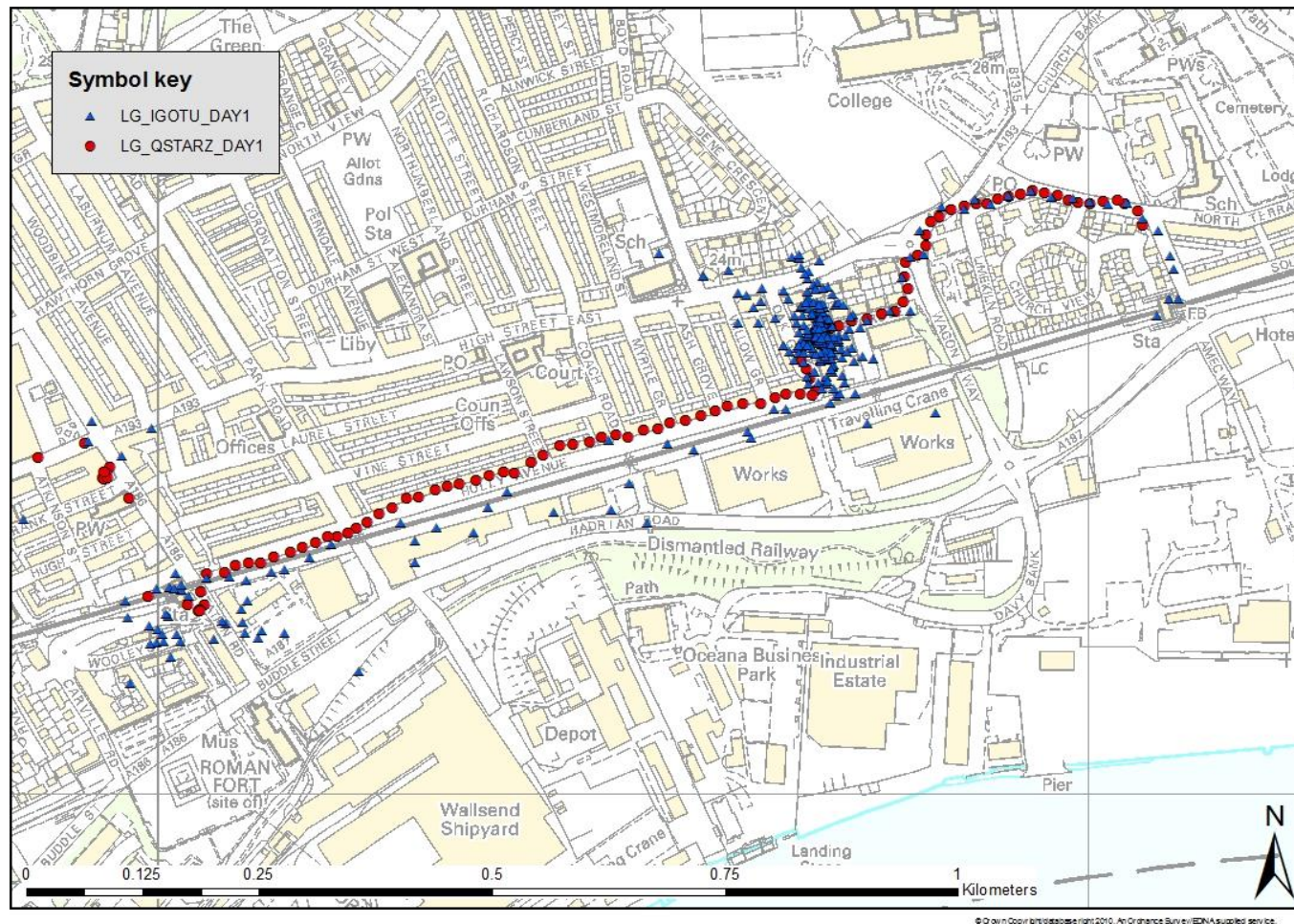
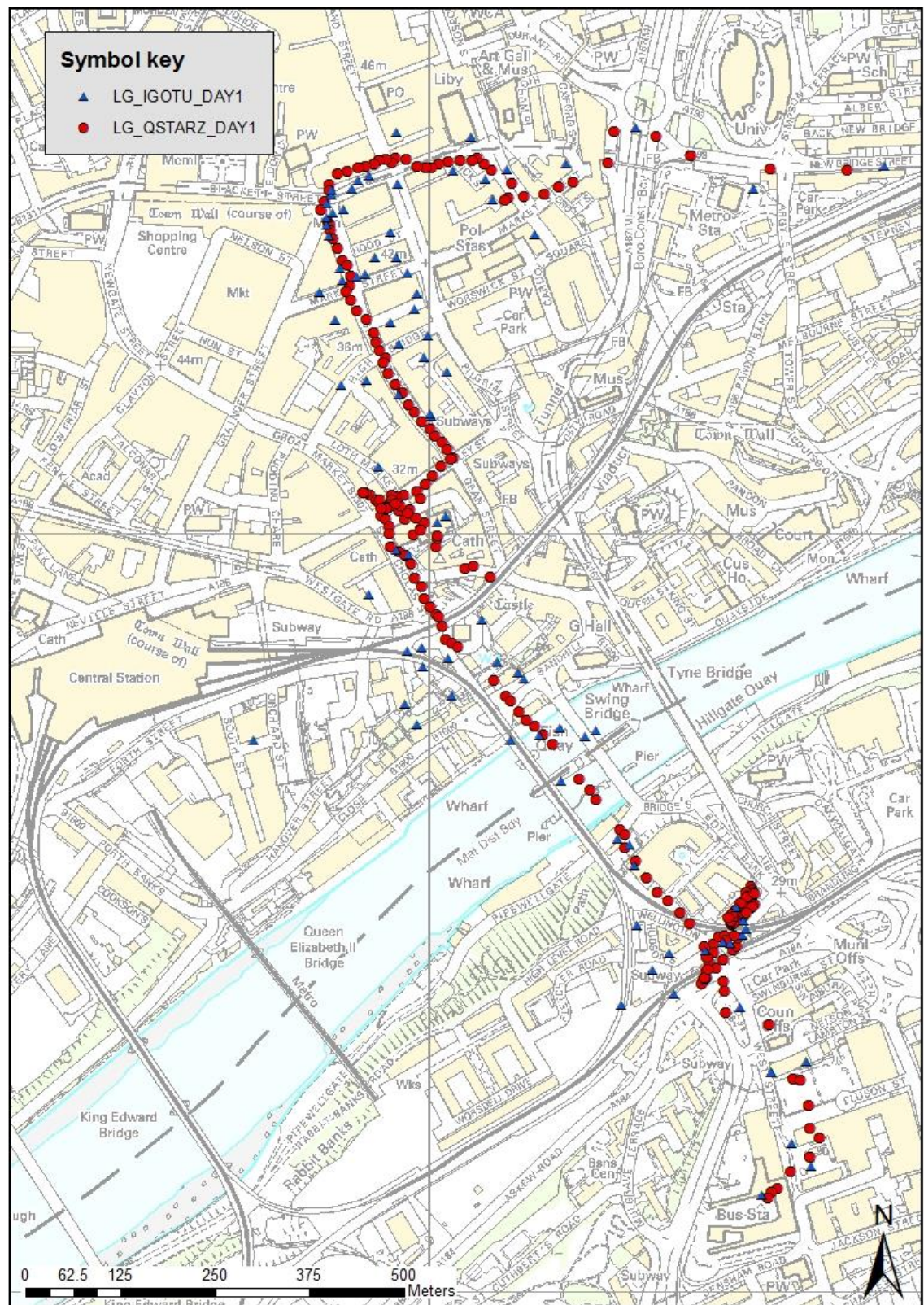


Figure 14 Map showing i-gotU waypoint 'drift' in Newcastle city centre area, day 1 (LG)



1.4 Conclusions and device selection

In this summary the results of the GPS device tests are considered and the strengths and limitations of the QStarz and i-gotU devices are discussed considering the seven factors outlined in the initial specifications (see section 1.1).

1.4.1 Accuracy and sensitivity

Latitude, longitude, time and date are the key data that need to be recorded at each epoch. Both devices do this in addition to other information such as speed and altitude. The output data should be of a high quality with regards to waypoint accuracy especially in built up urban areas such as Newcastle city centre. The QStarz device performed consistently better than the i-gotU in terms of clearly depicting the walking routes participants use. The i-gotU data was characterised by waypoint drift, particularly in the more densely built up areas.

The QStarz benefits from having 3 times the number of channels available for satellite fix than the i-gotU, increasing the likelihood of obtaining multiple satellite fixes when in view. The QStarz device also boasts a slightly more favourable sensitivity rating than the i-gotU device (see Table 1)

1.4.2 Battery life

Neither of the GPS devices advertised a battery life capable of recording waypoints for 4 days without the need to recharge the device. The QStarz and i-gotU devices both offered power saving functions which were utilised and tested for the battery longevity. The QStarz was found to consistently record a greater number of waypoints and recorded data on more consecutive days than the i-gotU device. The power saving function appeared to work more effectively in the QStarz device, the movement detector demonstrating a greater sensitivity in entering and exiting 'sleep mode' in comparison to the i-gotU device.

1.4.3 Fix time

The satellite fix times recorded in the test studies were much greater than those stated for cold starts in the manufacturers' specifications for both devices. This was due to testing the devices in a 'free living' manner, and not using an accurate test of fix time (as demonstrated in Kerr *et al* (2011)).

Participants will not be required to wait for a satellite fix when exiting buildings, avoiding any unnecessary influences on behaviour. The QStarz and i-gotU loggers performed similarly in this respect.

1.4.4 Data storage capacity

Both the devices tested have adequate data storage capacity for use in this study.

1.4.5 Ease of use

Ease of use is discussed in terms of participant involvement required and the ease of device configuration, data extraction, format and analysis for the researcher.

1.4.5.1 For the participant

The i-gotu device was the more user-friendly of the two devices from a participant perspective. The i-gotU could be configured by the researcher to automatically power on at a given date and time. Participant interaction with the device was therefore kept to a minimum.

In comparison, the QStarz device needed to be manually switched on in order to start recording process. However, this only needed to be done at the start of the study period as the 'sleep' function worked well to save battery power throughout the study.

Although manufacturer instructions indicated a need to 'shake' the device to reactivate following sleep mode, the QStarz was sensitive to movement and did in fact reactivate when moved in the 'free living' scenario. The i-gotU power saving function did not work to the same degree of sensitivity and

therefore this device would need to have additional participant instructions to wake the device at the start of journeys adding burden and the potential to influence behaviour.

1.4.5.2 For the researcher

The tests presented here highlighted the importance of the researcher to have a protocol for configuration and data extraction regardless of the logger chosen. A standard set of systems to be followed should be developed to ensure the same method is adopted for each dataset.

Both devices presented strengths and limitations. The ability to set the i-gotU device to power on/ off automatically was an advantage. This was essential in the power saving of this device as the 'sleep mode' did not appear to be as sensitive as that in the QStarz. In addition the facility to disable the power button on the i-gotU was a benefit to the researcher as it ensured that the device could not be accidentally or purposefully powered off thereby reducing the risk of data loss.

The @tripPC software provided with the i-gotU device proved difficult to use in terms of extracting data from the device following data collection. The data could only be downloaded once and therefore could easily be lost during the extraction process. The QStarz software was more user-friendly with the ability to extract data from the device multiple times. At the point of extraction, menu options for data manipulation in the form of automatic waypoint cleaning² etc. were clearly accessible.

It was difficult to determine when the i-gotU device lost satellite fix as the @TripPC software presented waypoints merged into a single track. In contrast, the QStarz software, a new 'track' indicated loss of satellite fix and/

² Automatic data cleaning includes the removal of extraneous data points recorded when GPS device is stationary, reducing waypoints recorded in clusters to a reduced geographical and the removal of drift points when data recorded in built up areas.

or entry and exit of the power saving mode. With this in mind, the data obtained from the QStarz device was favoured.

The software for both devices offered multiple data export formats, both required some manipulation of data prior to upload to ArcGIS. Again, both devices were easy to clear of data and recharge ready for use by the next participant.

1.4.6 Appearance

It is important for the GPS device to be attractive and acceptable to young people in order to encourage engagement with the method. Following preliminary workshop (see methods development chapter), it was clear that appearance is a key factor in the acceptance of the logger to the adolescent population with participants demonstrating reluctance to wear a watch style device. With this in mind, the device needed to have a modern appearance and ideally be able to be worn hidden from the view of others e.g. in a pocket or handbag. Both devices were able to obtain and maintain satellite fix in these hidden locations. Workshops conducted with 14-15 year olds in Durham UK found the QStarz and i-gotU GPS devices to be equally acceptable and attractive for the purpose of this research.

1.4.7 Affordability

A limit of £100 per unit was set, which included the provision of charging equipment, protective cases etc. Both the QStarz and i-gotU devices fall within this price range.

1.4.8 Summary

Of the seven factors discussed in this GPS testing appendix, the QStarz device performed consistently better than the i-gotU in two of the three prioritised factors; 1. battery life, and 2. sensitivity and accuracy. The two devices performed equally on the third factor of fix time. The QStarz was the more user-friendly device from the researcher perspective, although it required greater input from participants in its use than the i-gotU. Young

people showed no preference over the appearance of the two devices, both being equally acceptable. The QStarz device was therefore selected for use in the pilot study where the GPS protocol was further refined.

1.5 References

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Consent Form



Please tick all of the boxes that you agree with:

I confirm that I have read and understood the information sheet for the above study and have had the opportunity to ask questions.

☐

I understand that my participation is voluntary and that I am free to decide not to participate in any aspect of the study, without giving any reason, at any time.

☐

I confirm that I would like to take part in this study.

☐

Please complete this section if you would like to take part in the study

Your information will only be used for the purpose of this study and will not be passed onto any one else.

Surname:	
First Name:	
Date of birth	
Address:	
Postcode	
Telephone Number:	
Mobile Phone Number:	
Email Address:	

Please sign here: _____

Date: _____

If you do NOT want to take part in the study please tick this box:

☐

Please return form to Rachel Tyrrell: Human Nutrition Research Centre, Newcastle University, 1st floor Leech Building, Framlington Place, NE2 4HH

Phone: 0191 222 7648

Text: 07725724574

Email: food.environment@ncl.ac.uk

What next?

Following this you may be contacted and asked to meet with Rachel for a third time to have a confidential one-to-one interview about your food environment and discuss the data you collected in more detail. You can choose whether or not to take part in this, and the interview will be arranged at a time and place convenient to you.

What will happen to my information?

All your personal details will be kept confidential. The results will be written and published in scientific and medical journals and will be presented at meeting and conferences. **No one will be personally identified within the results.**

I want to take part!

Great news! Please complete the **consent form** and send it back to Rachel. Remember that you are under no obligation to take part and you can withdraw your participation at any point in the study without giving a reason.

Rachel will contact you to organise a time to meet to give you the food diary and GPS. Don't worry, she'll send you text messages to remind you of appointment times! If you have any other questions or queries in the meantime, give her a call or send a text or email (contact details on the back!).



For more information or if you have any questions contact:

Rachel Tyrrell

Phone: 0191 222 7648

Text: 07725724574

E-mail: food.environment@ncl.ac.uk



Find me on Facebook
facebook.com/food.environment

Supervisor contact details:
Prof Ashley Adamson
Phone: 0191 222 6994/5276
Email: a.j.adamson@ncl.ac.uk



Newcastle
University

Your Food Environment

What do you eat?



facebook.com/food.environment

food.environment@ncl.ac.uk

What is your food environment?

Interested in taking part in some research at Newcastle University? We are looking for volunteers aged 16-18 to take part in a project looking at food environments. The results of this study are important in helping researchers understand young people and their environments. If you take part, you will receive a **£10 Eldon Square voucher** to say thanks!

What will I have to do?

This study is designed to look at your food environment and find out what it is! We want to find out what you eat and drink, where you get your food from and who you eat it with. This leaflet describes everything we'll be asking you to do...

Food diary

For 4-days you will be asked write down

- Everything you eat & drink
- How much you eat & drink
- Where you get food from
- How much you spend on food



Receipts

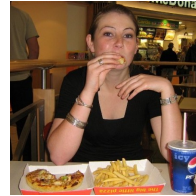


We would like you to collect till receipts for any food that you buy on the days you are filling out the food diary.

Photographs

We would like you to take photographs of:

- The food you eat
- The places you get food from
- Where you are eating the food



You can do this with your mobile phone if you like and send the picture to us. Or we can give you a digital camera to use for the 4-day study period.

Text messaging

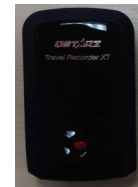
Over the 4-day study period you will be sent 1 text message per day. You will be asked to reply indicating:



- Where you are
- What you are doing
- What was the last thing you ate/drank

Global Positioning Systems (GPS)

In this study, GPS will help us to identify what shops and restaurants you have visited and travelled passed over the 4-day study period. We will not be able to



© Google maps 2011

see where you are in real-time, only look at maps of where you have been over the 4-day study period. All your data is confidential so we won't share it with anyone else.

Facebook

Are you on Facebook? So are we! Why don't you add us as a friend and find out more.



Facebook.com/food.environment

Questionnaires

You will be asked to fill out 3 computer based questionnaires containing questions about:

- The food you eat at home
- Your usual food choice habits
- Other lifestyle choices



Measurements

We would like to measure your height and weight and take your waist and hip measurements. Don't worry, this will be done in private and no one else will see your results.

Meet the researcher

If you are interested in taking part, Rachel will organise 2 meetings with you.

- 1) a 15-20 minute meeting to give you the food diary, GPS, camera (if required) and instructions, and answer any questions you might have.
- 2) 1 hour interview to collect the food diary, GPS and photographs. You will have time for you to fill in the questionnaires in this meeting and we'll take your height and weight measurements.

These meetings will be arranged for a time and place convenient to you.

If you are aged 16-18 & would like to take part contact:

Rachel Tyrrell

Phone: 0191 222 7648

Text: 07725724574

E-mail: food.environment@ncl.ac.uk

Institute of Health & Society

Newcastle University
Human Nutrition Research Centre
M1.151 William Leech Building
Medical School
Framlington Place
Newcastle upon Tyne
NE2 4HH United Kingdom

Dear Parent / Guardian

If you are receiving this letter, your child has volunteered to take part in the Measuring Food Environments Study being carried out at Newcastle University. The aim of this study is to look at what young people are eating, where they get their food from and the reasons behind their food choice behaviour. The study is supported by the Food Standards Agency and has been approved by Newcastle University's Research Ethics Committee.

What your child will be doing:

- Recording everything he/she eats and drinks for four days in a food diary and taking photographs of the food they eat and the places they get food from.
- Collecting any receipts for food purchases they make themselves away from the home.
- Carrying a Global Positioning Systems (GPS) logger for the same four days they are completing the food diary. This will record their movements over the four day period and allow us to see what food outlets, such as shops and restaurants, are potentially available to them day to day. The researcher will only look retrospectively at the information collected by the logger. They will not be able to locate your child in 'real-time'.
- One text message per day will be sent to your child's mobile phone asking them to reply with details of where they are, what they are doing and what they last ate/drank. Again, this information will be looked at retrospectively so the researcher will not know where your child is located at that time.
- Completing three computer-based questionnaires about the food available to them at home, their usual food choice habits and general lifestyle choices
- Your child will be measured for height, waist circumference, weight and body composition by the researcher (Rachel Tyrrell) working on the study. These measurements will be taken in private, on location at [REDACTED] and all the information collected will be confidential.

All information collected is confidential and will not be shared with anyone outside the research team at Newcastle University. Data will be anonymised in any reports and publications resulting from this study so your child and the school will not be identifiable.

Your child will receive a High Street Shopping Voucher to the value of £10 as a 'thank you' for participating in the study.

This study will take minimum time and effort and should not interfere with school work. Your child is free to leave the study at any time without the need to give any reason. If you have any queries or concerns about the study, please contact Rachel Tyrrell with the details below.

Yours sincerely,



Miss Rachel Tyrrell
PhD Student Researcher
Newcastle University
Tel: 0191 2227648
Text: 07725724574
Email: r.l.tyrrell@ncl.ac.uk or food.environment@ncl.ac.uk

Supervisor: Dr Susan Hodgson
Tel: 0191 222 3823
Email: susan.hodgson@ncl.ac.uk





Name: _____

Please complete this FOOD DIARY on the following days:

Day 1:	_____
Day 2:	_____
Day 3:	_____
Day 4:	_____

Please:

- ◆ Keep this booklet with you to record everything you eat and drink
- ◆ Write as much information as you can

If you have any questions about filling in the food diary or any other part of the study please contact me on:

Tel: 0191 222 7648

Text: 07725724574

Email: food.environment@ncl.ac.uk

Thank you very much, *Rachel Tyrrell*

ID number			
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Instructions for filling in the diary

Please read the following instructions and try to follow them as carefully as possible. To help, we have included an example of a completed day (on the following page)

1. Write down **everything** that you eat, no matter how small the amount, during the 4 days. **Do not include any leftovers.**
2. Use a new line for each new food item.
3. Give as much information as possible about the food and drink you have. Include:
 - a. Brand name and the flavour
 - b. Packet weight, for tinned or bottled foods and drinks
 - c. How you cooked the food e.g. fried, grilled, poached, raw, etc.
 - d. Estimate the size of the portion you have.
 - e. Where you got the food from
 - f. How much you spent on the food (if away from home)
 - g. Where the food was eaten
 - h. Who you ate the food with
 - i. How you travelled to get the food (if away from home)
4. If you are eating out, describe what was in the meal and estimate how much food you ate. Also write down the name and address of the restaurant where you ate the food.
5. For home recipe meals:
 - a. Write the name of the dish in the food description column.
 - b. Estimate the portion size you ate of what was cooked.
6. Write all the ingredients used in home recipes at the back of the booklet and **not** in the food diary.
7. Fill in any information about taking non-prescribed medicines or vitamin supplements i.e. multivitamins, at the bottom of the food diary sheets.
8. Please start each new day on a new page.
9. Please collect any till receipts for food you buy and put these into the envelope provided at the back of this food diary.

Remember:

Eat and drink as you would normally. All the information we collect about what you eat is private and there are no right or wrong answers.

I will visit you

On _____

At _____

to collect and discuss your completed food diary

Day & Date:			Start each day
Time	Food & Drink include: Brand name, flavour and weight <i>Enter each food item on a new line</i>	Amount eaten excluding leftovers. e.g. cup, slice, teaspoonful	Where did you get the food from just before it was eaten? Please include name and address if not home (e.g. name of shop, restaurant, takeaway, cafe etc.)
7.30 am	Kellogg's Frosties	1 bowl full	Home
	Tesco semi-skimmed milk	$\frac{1}{2}$ pint	"
10.35 am	Pringles - Cheese & Onion	$\frac{1}{2}$ 200g tube	College vending machine
	Can diet Coke	330 ml	"
12.30 pm	Chicken Mayo Sandwich Roll	1 Roll	Greggs - Nothumberland St
	Chocolate muffin	1 muffin	"
	Bottle water	500 ml	"
5.45 pm	Roast dinner		Toby Carvery - Kanton Bank
	Roast Chicken	4 slices	"
	Roast potatoes	3 small	"
	Yorkshire puddings	2 large	"
	Gravy	$\frac{1}{2}$ small jug	"
	Garden Peas	2 tablespoon	"
	Cauliflower	2 florets	"
	Coca-Cola	1 pint	"
10.00 pm	Cadbury's hot chocolate with water	1 mug	Home
	McVities Jaffa Cakes	4 biscuits	"
Have you taken any supplements or non-prescribed medication? E.g. Vitamin tablets, etc. Please specify: _____ _____ _____			

on a new sheet			Volunteer ID:							
How much did you spend?		WHERE was the food eaten? e.g. at home, in the park, college canteen etc	WHO did you eat the food with? e.g. on own, with family, with friends	How did you TRAVEL to get the food? E.g. car/bus/train/metro/walk/cycle/other	Portion size	Food Code				
£	p					Office use	Office use			
		Home	With family							
		"	"							
1	00	College	With friends	Bus to college						
	50	"	"							
1	95	In park	With friends	Walk to town						
	65	"	"	"						
	70	"	"	"						
7	99	Toby Carvery - Kenton Bank	Family	Car						
		"	"	"						
		"	"	"						
		"	"	"						
		"	"	"						
		"	"	"						
		"	"	"						
1	30	"	"							
		Home	On my own							
		"	"							

Day & Date:		Start each day	
Time	Food & Drink include: Brand name, flavour and weight <i>Enter each food item on a new line</i>	Amount eaten excluding leftovers. <i>e.g. cup, slice, teaspoonful</i>	Where did you get the food from just before it was eaten? <i>Please include name and address if not home (e.g. name of shop, restaurant, takeaway, cafe etc.)</i>
Have you taken any supplements or non-prescribed medication? E.g. Vitamin tablets, etc. Please specify: _____ _____			

on a new sheet

Volunteer ID:[illegible]

Day & Date:		Start each day	
Time	Food & Drink include: Brand name, flavour and weight <i>Enter each food item on a new line</i>	Amount eaten excluding leftovers. <i>e.g. cup, slice, teaspoonful</i>	Where did you get the food from just before it was eaten? <i>Please include name and address if not home (e.g. name of shop, restaurant, takeaway, cafe etc.)</i>
Have you taken any supplements or non-prescribed medication? E.g. Vitamin tablets, etc. Please specify: _____ _____			

on a new sheet

Volunteer ID:

[illegible]

Day & Date:			Start each day
Time	Food & Drink include: Brand name, flavour and weight <i>Enter each food item on a new line</i>	Amount eaten excluding leftovers. <i>e.g. cup, slice, teaspoonful</i>	Where did you get the food from just before it was eaten? <i>Please include name and address if not home (e.g. name of shop, restaurant, takeaway, cafe etc.)</i>
Have you taken any supplements or non-prescribed medication? E.g. Vitamin tablets, etc. Please specify: _____ _____			

on a new sheet

Volunteer ID:

[illegible]

Day & Date:		Start each day	
Time	Food & Drink include: Brand name, flavour and weight <i>Enter each food item on a new line</i>	Amount eaten excluding leftovers. <i>e.g. cup, slice, teaspoonful</i>	Where did you get the food from just before it was eaten? <i>Please include name and address if not home (e.g. name of shop, restaurant, takeaway, cafe etc.)</i>
Have you taken any supplements or non-prescribed medication? E.g. Vitamin tablets, etc. Please specify: _____ _____			

on a new sheet

Volunteer ID:

[illegible]

Day & Date:		Start each day	
Time	Food & Drink include: Brand name, flavour and weight <i>Enter each food item on a new line</i>	Amount eaten excluding leftovers. <i>e.g. cup, slice, teaspoonful</i>	Where did you get the food from just before it was eaten? <i>Please include name and address if not home (e.g. name of shop, restaurant, takeaway, cafe etc.)</i>
Have you taken any supplements or non-prescribed medication? E.g. Vitamin tablets, etc. Please specify: _____ _____			

on a new sheet

Volunteer ID:

[illegible]

Day & Date:		Start each day	
Time	Food & Drink include: Brand name, flavour and weight <i>Enter each food item on a new line</i>	Amount eaten excluding leftovers. <i>e.g. cup, slice, teaspoonful</i>	Where did you get the food from just before it was eaten? <i>Please include name and address if not home (e.g. name of shop, restaurant, takeaway, cafe etc.)</i>
Have you taken any supplements or non-prescribed medication? E.g. Vitamin tablets, etc. Please specify: _____ _____			

on a new sheet

Volunteer ID:

[illegible]

Day & Date:		Start each day	
Time	Food & Drink include: Brand name, flavour and weight <i>Enter each food item on a new line</i>	Amount eaten excluding leftovers. <i>e.g. cup, slice, teaspoonful</i>	Where did you get the food from just before it was eaten? <i>Please include name and address if not home (e.g. name of shop, restaurant, takeaway, cafe etc.)</i>
Have you taken any supplements or non-prescribed medication? E.g. Vitamin tablets, etc. Please specify: _____ _____			

on a new sheet

Volunteer ID:

[illegible]

Day & Date:		Start each day	
Time	Food & Drink include: Brand name, flavour and weight <i>Enter each food item on a new line</i>	Amount eaten excluding leftovers. <i>e.g. cup, slice, teaspoonful</i>	Where did you get the food from just before it was eaten? <i>Please include name and address if not home (e.g. name of shop, restaurant, takeaway, cafe etc.)</i>
Have you taken any supplements or non-prescribed medication? E.g. Vitamin tablets, etc. Please specify: _____ _____			

on a new sheet

Volunteer ID:

[illegible]

Recipe Section

Dish: <i>Spaghetti Bolognese</i>		Meal: breakfast / lunch / dinner / snack	
Day (delete as appropriate): 1/ 2 / 3 / 4		Serves: 4	
Ingredients	Amount	Cooking method	
<i>Butchers beef mince</i>	<i>500g</i>	<i>Fried</i>	
<i>Onions</i>	<i>1 large</i>	<i>Fried</i>	
<i>Asda tinned tomatoes</i>	<i>1 can</i>	<i>Boiled</i>	
<i>Mushrooms</i>	<i>8</i>	<i>Fried</i>	

[illegible][illegible]

Recipe Section

[illegible][illegible][illegible]

Recipe Section

[illegible][illegible][illegible]

Recipe Section

[illegible][illegible][illegible]

Recipe Section

[illegible][illegible][illegible]

Receipts Section

Please put receipts for any food you buy (where available) into the envelope below:

Food Diary: Any Comments?

Have you any comments about what you have eaten during the 4 days?

Do you think that you have eaten as you would usually do?

We appreciate your time and efforts in filling out such a detailed diary.

Thank you.

For office use

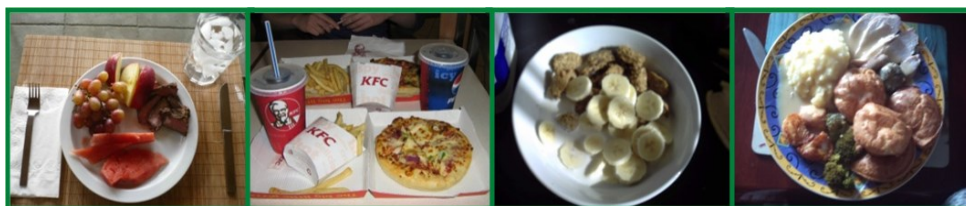
	Wt(kg)	Ht(cm)	Ws (cm)	Hp (cm)	W/H
1					
2					
3					
Av.					

Example Food Photo Diary



We would like you to take photographs of:

1. Everything you eat and drink over the four days of your food diary



2. Where you are eating (including at home/work)



3. The people you are eating with (friends, family, colleagues)



GPS Logger Instructions



Please turn your logger on when you wake up on the first day you start the MFE study.

You will be sent a text message reminder at 8 AM.
To turn the logger on, locate the switch on the side of the logger.



Switch the logger to LOG by moving the switch across to the left as far as it will go.

The logger will beep once and an orange light will appear.



The orange light will flash when the logger is receiving a satellite signal.

Don't worry if this doesn't happen straight away. If you are indoors or surrounded by high buildings the logger may not be able to get a signal.

Please do not turn the logger off once you have switched it on. Carry it with you at all times during the study period in a pocket or front pocket of a bag.

Please bring the logger with you when you have your food diary collection interview.

Thank you 😊

Participant Checklist



Name: _____

ID No:

Pre meeting 1

- ☐ Consent form
- ☐ Study pack (plastic wallet)
 - ☐ Information sheet
 - ☐ Food diary
 - ☐ Photograph example sheet
 - ☐ GPS unit
 - ☐ Pen
 - ☐ Digital camera and instruction sheet
- ☐ Laptop with questionnaires
- ☐ Directions to meeting place (if required)

Meeting 1

Place: _____

Date: // Time: :

- ☐ Information sheet given and instructions explained
- ☐ Participant questions answered
- ☐ Consent form completed and returned
- ☐ Study pack given to participant
- ☐ Lifestyle questionnaire complete
- ☐ Organise meeting 2 (fill out details below)

Study start date: //

Post meeting 1

- ☐ Set up text message campaign

Pre meeting 2

- | | |
|--|---|
| <input type="checkbox"/> Leicester height measure | <input type="checkbox"/> Spare batteries for digital camera (if required) |
| <input type="checkbox"/> Tanita scales | <input type="checkbox"/> Coloured pens |
| <input type="checkbox"/> Tape measure | <input type="checkbox"/> Eldon Square voucher |
| <input type="checkbox"/> Portion sizes atlas | <input type="checkbox"/> Voucher receipt |
| <input type="checkbox"/> Laptop with questionnaires | <input type="checkbox"/> Directions to meeting place (if required) |
| <input type="checkbox"/> SMS text message print out for individual | |

Meeting 2

Place: _____

Date: // Time: :

- ☐ Food diary
- ☐ 4 days completed
 - ☐ Check addresses of food outlets
 - ☐ Food portion sizes collected
 - ☐ Validate with SMS text message replies
 - ☐ Validate with food photographs
 - ☐ Receipts collected

☐ GPS logger returned:

☐ Any times not carried? _____

☐ Digital camera returned (if provided)

☐ Home food environment questionnaire complete

☐ Adolescent food habits checklist complete

☐ Body measurements taken

- ☐ Height
- ☐ Weight
- ☐ Waist circumference
- ☐ Hip circumference

☐ Consent for individual interview

☐ Eldon Square voucher given (collect receipt)

<u>Code</u>	<u>Type of outlet</u>	<u>Description</u>
1. Restaurant, Pub & Hotel Restaurant		
1.01	Traditional	Sit down restaurant
		Waiter/waitress takes your order
		Pay for meal after eating
1.02	Buffet	Sit down restaurant
		No waiter service
		May pay at the till after food has been selected from the buffet but before eating
		If 'all you can eat' at a fixed price may pay before or after consumption. Drinks may or may not be included in the price.
1.03	Restaurant with takeaway/delivery option	Primarily a restaurant but has the option to order for takeout
		Waitress/ waiter service or Food is ordered and paid for at the counter and eaten elsewhere
		Usually open after 5pm
		Examples include Chinese restaurants, Indian restaurants, pizza hut
1.04	Fast Casual (e.g. Nandos)	Order and pay for food at counter
		Waitress/ waiter delivers food to table
		Similar to fast food but offers a higher quality of food and atmosphere
		Usually sit down but may have takeaway option
1.05	Pub Sit down restaurant	Sells predominantly alcohol
		Sit down restaurant
		Waiter/waitress takes your order
		Pay for meal after eating
1.06	Pub Fast casual	Sells predominantly alcohol
		Order and pay for food at bar. Waitress/ waiter delivers food to table
		Similar to fast food but offers a higher quality of food and atmosphere
		Sit down only not takeaway
1.07	Pub with takeaway/delivery option	Primarily a pub but has the option to order for takeout
		Waitress/ waiter service or food is ordered and paid for at the counter and eaten elsewhere
1.08	Traditional Hotel	Restaurant with waiter service
		Light bar meals with/without waiter service
		Room service and banqueting rooms
		May have a buffet for selected meals (e.g. breakfast)

2. Pub no food		
2.01	Pub no food	Only alcoholic and non- alcoholic drinks served.
		May served crisps and nuts behind the bar
		Includes nightclubs

3. Sit In café/coffee, specialist and sandwich shop		
3.01	Traditional café	Predominantly coffee and hot beverages sold
		Informal seating area
		May have waiter service or order at the counter
		Pre-made/made to order sandwiches and confectionery available
3.02	Greasy spoon types cafe	Predominately less healthy fried foods
		Informal seating area
		May have waiter service or order at the counter
3.03	Specialist café	Includes milkshake/smoothie bars and ice cream shops
		Similar in style to cafes and coffee shops
		Informal seating area
		Fair trade cafes/coffee shops are included here
3.04	Café with delicatessen/bakery	Predominantly café with delicatessen/bakery counter enabling ready-to-eat foods to be taken away
		Informal seating area
3.05	Sit-in sandwich shop	Small seating area
		Order and pay at the counter
		Made to order sandwiches/salads etc. May sell drinks, branded snacks and homemade cakes
		No waiter service
		Sit down or takeaway

4. Takeaway café/coffee, specialist and sandwich shop		
4.01	Takeaway café	Predominantly coffee and hot beverages sold
		No seating - takeaway only
		Pre-made/made to order sandwiches and confectionery available
4.02	Greasy spoon types cafe	Predominately less healthy fried foods
		No seating - takeaway only
4.03	Specialist café	Includes milkshake/smoothie bars and ice cream shops
		Similar in style to cafes and coffee shops
		Takeaway only
		Fair trade cafes/coffee shops are included here
4.04	Traditional sandwich shop	Made to order sandwiches/salads etc.
		May sell drinks, branded snacks and homemade cakes
		No sit in option - takeaway only

5. Baker - Retail		
5.01	Baker - Retail	Freshly baked savouries/bread, pre-made sandwiches, baked sweet products and branded products
		Usually a chain e.g. Greggs, Milligan's, Bakers Oven but can be independent

6. Takeaway and Fast Food		
6.01	Traditional takeaway	Hot food ordered and paid for at the till
		Wait whilst food is prepared and cooked
		No sit down option to eat-in but may have a seated waiting area.
		Usually open after 5pm
6.02	Traditional takeaway + delivery/collection	As traditional plus: The option to telephone for delivery and/or collection
6.03	Traditional takeaway + delivery/collection	As traditional plus: Limited seating is available giving the option to eat-in
	With seating	May have the option to telephone for delivery and/or collection
6.04	Instant fast food	Food ordered and paid for at the till
		Available instantly as commonly cooked in bulk in advance and kept hot. Food that can be eaten without cutlery
		Sit down, takeaway and drive-thru facilities
		May be part of a chain or franchise

7. Supermarket		
7.01	Large multiple	Large, departmentalised, self-service food store selling food and household goods
		E.g. Tesco, Asda, Morrisons, Sainsburys
7.02	Discount	E.g. Kwiksave, Netto, Lidl, Aldi
7.03	Small multiple	Smaller, self-service food store selling a limited range of food and household goods for greater convenience
		E.g. Tesco metro/express, large Nisa/Premier

8. Convenience		
8.01	Traditional (corner shop)	Sells groceries, newspapers/magazines, snacks, drinks, lottery, tobacco products and sometimes pre-packed sandwiches
		Small and usually independently owned
		Usually have extended hours
		Usually found in more residential areas
8.02	Newsagents	Small in size
		Sells primarily newspapers, magazines, snacks, drinks and tobacco products
		In well-trafficked public places
8.03	Petrol Station Shop	Sells groceries, newspapers/magazines, snacks, drinks, lottery, tobacco products and sometimes pre-packed sandwiches
		Usually have extended hours
		May be a small multiple supermarket
8.04	Off-licence	Licensed to sell alcoholic beverages for consumption off the premises
		Also sells groceries, newspapers, magazines, snacks, drinks and tobacco products.

9. Specialist (Purchase to takeaway only)		
9.01	Organic food stores	
9.02	Health food stores	Health supplements
		No fresh foods
9.03	Fair Trade stores	
9.04	Seasonal/ farmers market	Includes farmers markets and seasonal markets such as Christmas fayres
9.05	Artisan Food Stores	Stores selling only locally produced goods
9.06	Delicatessen	Grocery type store.
		Sells fresh ready-to-eat foods (made to order sandwiches/salads, cooked meats and cheeses etc.)
9.07	Wine Merchant	E.g. Majestic, Oddbins
9.08	World food (All sizes)	E.g. Oriental, Indian and Continental shops and supermarkets
9.09	Candy/sweet/ chocolate shops	Shops that do not fall under the category of convenience or confectioners as sell only bought in sweets
9.10	Butcher	Fresh meat is prepared and sold in store
9.11	Baker	Bread and baked products prepared fresh and sold in store
		Usually independent bakeries
9.12	Fishmonger	Fresh fish is prepared and sold in store
9.13	Greengrocer	Sells fresh fruit and vegetables

10. Mobile food and market*		
10.01	Food provision	Food to take home
		Usually needs preparation before consumption
		e.g. meat stall at a farmers market
10.02	Takeaway food	Food to consume now
		Usually found at outdoor events e.g. music festivals, food matches, outside nightclubs
		Includes burger vans, noodle stands, breakfast bars etc.
10.03	Ice cream van	
10.04	Beverages	Includes coffee carts and smoothie stands

*Saturday/farmers markets. For static markets, individual stalls should be classified under 'specialist' categories.

11. Vending machines (Stand alone. Not a part of another food outlet)		
11.01	Hot beverages	Vending machine contains hot drinks.
11.02	Cold beverages	Vending machine contains cold drinks.
11.03	Food	Vending machine contains food e.g. confectionary, savoury snacks, sandwiches.

12. Non-food stores (Includes crisps and confectionery usually displayed around the till area common around Christmas, Easter, Halloween etc.)		
12.01	Clothes/accessory shops	
12.02	Gift shops	
12.03	Stationery shops (WH Smith)	
12.04	Furniture/catalogue shops	
12.05	Sports Shops	
12.06	Cosmetic/toiletry shops	
12.07	Pharmacy	Retail shop where medicine and other health and beauty items are sold.
		Snack foods and confectionery may be available
		Particular stores may have lunch meal deals (e.g. Boots)
12.08	Hardware store e.g. B&Q	
12.09	Post Office	
12.10	Department Stores	Large retail store organized into departments offering a variety of merchandise; commonly part of a retail chain
		Usually contain a restaurant/café selling hot and cold foods and/or a food hall.
12.11	Large Discount store (e.g. Wilkinsons, TJ Hughes)	Meet the requirements of a department store but have lower cost structures and typically sell at lower prices. Usually contain a restaurant/café selling hot and cold foods.
12.12	Small Discount store (e.g. Poundland)	Sell novelty items/clothing and low price branded food items (not fresh)

13. Entertainment (Primarily visit establishment for entertainment - food is secondary to this)		
13.01	DVD/Video/Games rental shop	Primarily snack foods and drinks. Some hot snacks occasionally sold (i.e. Blockbuster video)
13.02	Cinema	Primarily snack foods and drinks. Some hot snacks occasionally sold.
		Popcorn, ice cream, sweets - pre-packed and pick and mix, crisps, cold drinks, hot dogs etc.
13.03	Theatre	Primarily snack foods and drinks, alcohol sold.
		Sometimes includes a restaurant.
13.04	Casino	May include a sit down restaurant and/or provide bar snacks
		Licensed to sell alcohol
13.05	Comedy Clubs	May include sit-down restaurant or offer bar snacks
		Usually licenced
13.06	Music venues/music bars (Jazz Club)	May include sit-down restaurant or offer bar snacks. Usually licenced
13.07	Amusements	Snack foods and drinks. May have café and may be licensed.
		E.g. Noble
13.08	Ten-pin bowling	Snack foods and drinks. Usually licensed.
		Commonly a restaurant/diner selling meals
13.09	Snooker/Pool clubs	Hot/cold snacks may be available
		Usually licenced
13.10	Sports related (football match/golf club)	Hot/cold snack food and confectionery bought to takeaway. Usually licenced
13.11	Art Gallery	Primarily snack foods and drinks, alcohol sold. Sometimes includes a restaurant.

14. Health and Leisure		
14.01	Gyms	Equipped for sports or physical training
		May include vending machines or small café
14.02	Health Clubs	Usually has additional facilities to a gym.
		May include vending machines or small café/restaurant
14.03	Leisure Centre	Usually owned and run by the council - similar facilities to a health club
		May include vending machines or small café

15. Closed/Private food outlets (Not accessible to the public (e.g. offices and universities))		
15.01	Clubs and Associations	Usually snack food and drinks
		Working men's clubs, coffee mornings etc.
		May be licensed
15.02	Function rooms	A venue used for weddings, receptions & parties
		Usually licensed
15.03	Community centres	
15.04	Charitable organisations	
15.05	Hospitals	
15.06	Staff canteens	No waiter service
		Food is paid for at the till before consumption
		Usually hot meals and pre-packed/made to order sandwiches and salads
		May include vending machines
		Includes staff rooms
15.07	Education/Childcare/Care for elderly	No waiter service
		Food is paid for at a till before consumption or is paid in advance by parents/carers
		Usually hot meals and pre-packed sandwiches and salads
		May include vending machines
15.08	Wholesalers	
15.09	Suppliers	
15.10	Distribution	
15.11	Caterers	
15.12	Cash and carry	

PROMPT – When classifying multi-use outlets: 1. What does the outside of the outlet look like? 2. What is the dominant floor space usage?



User Guide

Contents

Introduction to the MFE tools.....	3
Completing and using the tool kit	3
MFE Shop Tool.....	4
Which outlets should the shop tool be used for?	4
Completing the MFE-S tool	4
Before you arrive.....	4
When you arrive	4
Basic information	4
Facilitators and supports to healthy eating.....	5
Barriers to healthy eating.....	7
Comparative pricing	7
Beverages	7
Food items.....	9
Scoring MFE-S.....	11
MFE Restaurant Tool.....	12
Which food outlets should the restaurant tool be used for?	12
Completing the MFE-R tool	12
Before you arrive.....	12
When you arrive	12
Basic information	12
Menu Options.....	14
Beverages	16
Facilitators and supports to healthy eating.....	18
Barriers to healthy eating.....	18
Comparative pricing	19
Scoring MFE-R	20
MFE Vending Tool	21
Completing the MFE-V tool	21
Before you arrive.....	21
When you arrive	21
Basic information	21
Hot beverages	22
Cold beverages	23
Food items.....	24
Scoring MFE-V	26

Introduction to the MFE tools

The Measuring Food Environment (MFE) tool kit has been designed to quantitatively assess the the out-of-home food environment. Three surveys have been developed to assess the healthiness of the Shop, Restaurant and Vending environments young people are exposed to. The tool kit consists of the following components:

- MFE Shop Tool
- MFE Restaurant Tool
- MFE Vending Tool
- Scoring sheets
- Food Outlet Classification System

The Shop, Restaurant and Vending tools should be completed by a minimum of two researchers to ensure inter-observer reliability.

Completing and using the tool kit

Complete and correct coding of the tools is essential to achieving accurate and high quality results. This user guide will help you understand how to use and what to look for when using these tools.

A number of different methods can be used to identify food outlets present within your chosen study area and you will have chosen the most suitable method to suit your research needs. Prior to using the MFE tools you will require a list of food outlets to be assessed.

Before you start using the tools ensure you have the following:

- Food outlet names and addresses
- Outlet ID (unique for each food outlet)
- Tools relevant to the food outlets you will be visiting
- Clip board
- Pen/Pencil
- Observer ID (Your initials)
- Photo ID (e.g. University Smartcard)
- Project letter to show managers (if required)
- A copy of this user guide and the appendices as a reference point when out in the field
- Directions to the food outlets you will be visiting
- GPS logger or geo-caching device

MFE Shop Tool

Which outlets should the shop tool be used for?

The MFE-Shop tool should be used in outlets such as supermarkets, newsagents, shop style market stalls (i.e. those which sell food requiring further preparation) as well as more specialist shops such as Greggs.

Completing the MFE-S tool

Before you arrive

Complete the following items prior to arriving at the shop:

- Observer ID
- Outlet ID
- Shop name, address and postcode

When you arrive

When you arrive at the shop, you may need to speak to the manager/owner of the shop in order to gain permission to complete the survey. It is advisable to carry photo ID and a letter from the university explaining the purpose of your visit with your supervisor contact details should the manager require more information. Some larger chain shops may have strict policies in place restricting surveys being conducted in their businesses. If this is the case, leave the shop immediately and contact the head office for permission to conduct the survey. Some shops may refuse to take part in the study and if this is the case, leave immediately and make a note of the situation in the 'additional comments' section.

Basic information

Date: Complete with the date the survey is completed

Arrival time: Record the time you arrive at the food outlet and start the MFE survey

Photograph: It is useful to take a photograph of the outside of the shop. This will help when identifying and mapping the food outlets back in the office. Tick 'yes' or 'no' as to whether you have taken a photograph or not.

Geo-tag: Geo-tagging the outlets for mapping can be done in one of two ways depending on what kind of GPS device you are using. If you are using a handheld geo-caching device, write down the latitude and longitude points onto the MFE survey sheet directly from the screen. If you are using a closed GPS logger without a screen, simply carry the device with you when out in the field. Later you will be able to manually match the GPS data with the time data recorded on the MFE survey and the time associated with any photographs taken. The latitude and longitude co-ordinates can then be completed on the MFE sheet in the office for completeness.

An example of how to complete the co-ordinate reading can be seen below. The figures should be given to 6 decimal places and North (N) or South (S) direction given for latitude, East (E) or West (W) for longitude.

Latitude:

5	4
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 .

9	7	6	2	8	8
---	---	---	---	---	---

N

 Longitude:

-	1
---	---

 .

6	1	5	4	8	6
---	---	---	---	---	---

W

Outlet classification and description: Use the food outlet classification system (Appendix A) to code the food outlet type (number). Include a written description

Opening times: State the shop opening times for all days. If the shop is closed for any whole days in the week, make this clear by writing 'CLOSED' across the time box. If the opening hours are not easily identifiable i.e. posted on the door/ window ask a member of staff where you can find them.

Number of tills: Record the total number of till machines in the shop and the total number of tills that are open and operating. This will give a measure of shop size.

Queue size: This is a measure of how busy the shop is at the time of assessment. Take an average queue size for the time you are there. If there is more than one till, take an average number across the tills open.

Facilitators and supports to healthy eating

Nutritional information stated on products: It is assumed that nutritional information will be stated on the majority of branded pre-packaged products. Therefore, the answers to this question are staged to give an idea of exactly how many products within the shop have nutritional information stated on them. Guidance below:

All – more than 90% products have nutrition labelling

Most – 51-90% of products have nutrition labelling

Few – 10-50% of products have nutrition labelling

None – less than 10% of products have nutrition labelling

Tick the box corresponding to the amount of nutrition labelling seen in the shop.

FSA Traffic Light labelling: This is to assess the proportion of products in the shop that have Food Standards Agency (FSA) Traffic Light Nutrition Labelling. As before, use the guidance to give an idea of what percentage of products within the shop has FSA Traffic Light Labelling. You may wish to note which brands use the labelling in the 'additional comments' section.

All – more than 90% products have nutrition labelling

Most – 51-90% of products have nutrition labelling

Few – 10-50% of products have nutrition labelling

None – less than 10% of products have nutrition labelling

Tick the box corresponding to the amount of nutrition labelling seen in the shop.

Note: If GDA (Guideline Daily Amount) nutrition labelling is used, do not include in this section but give a description of the types of products/brands these are found on in the 'additional comments' section. Information about the FSA signpost labelling can be found in Appendix B.

Promotions for 'more healthy' choices: Are 'more healthy' foods being promoted in the shop? For example; free fruit with a sandwich or bottles of water buy one get one free. Tick 'yes' or 'no'.

'More healthy' meal deals available: Are there any healthy meal deals available in the shop? For example; sandwich + fruit + bottle of water offered as a meal deal. Tick 'yes' or 'no'.

Are healthy choices arranged prominently: This measure is restricted to products placed within the till area. Are there more 'healthy' or 'unhealthy' choices in the till area?

Tick 'yes' if there are more than 50% of the products are healthy.

Tick 'no' if less than 50% of the products are healthy.

Barriers to healthy eating

Promotions for ‘less healthy’ choices: Are ‘less healthy’ foods being promoted in the shop? For example offers on large packets of crisps and chocolate, buy one get one free full sugar soft drinks. Tick ‘yes’ or ‘no’.

‘Less healthy’ meal deals available: Are there any ‘less healthy’ meal deals available in the shop? For example, sandwich + crisps + full sugar soft drink offered as a meal deal. Tick ‘yes’ or ‘no’.

Comparative pricing

Sum of individual items compared to combo meal deal: A combo meal deal is defined as a meal that combines several menu items that would otherwise be sold separately. This assesses the cost of a combo meal deal compared to purchasing the same items separately. For example; sandwich + chocolate bar + drink priced as a combo meal deal, versus the cost of sandwich + chocolate bar + drink at the prices as sold separately.

Price of combo meal deal < sum individual items = tick ‘more’

Price of combo meal deal > sum individual items = tick ‘less’

Price of combo meal deal = sum individual items = tick ‘same’

Combo meal deals are not available = tick ‘N/A’

Healthy options compared with regular ones: This assesses the cost of healthy alternative products compared to regular products. Examples of products that could be compared are; lasagne ready meal compared to low fat lasagne ready meal, or chocolate bar compared to a piece of fruit.

Price of ‘healthier’ option < standard option = tick ‘less’

Price of ‘healthier’ option > standard option = tick ‘more’

Price of ‘healthier’ option = standard option = tick ‘same’

‘Healthier’ options are not available = tick ‘N/A’

Note: Write down which products and prices you used for the comparison in the ‘additional comments’ section.

Beverages

For each of the beverage categories listed on the survey sheet you should state the following under the appropriate column headings:

- Whether a beverage(s) fitting the subheading is available – circle ‘Y’ or ‘N’

- The number of different varieties available - count up to 10, if over 10 different products mark as '10+'. This is only applicable if the availability section was answered 'Y'.
- The size of the container(s) - this may be a range i.e. 330ml can to 2 litre bottle
- The price range of products
- Any other information that may be relevant to the project can be noted in the 'additional comment' section

Worked example:

If 330ml cans of Coca Cola, Fanta and Sprite and 500ml bottles of Coca Cola and Pepsi are available in the shop then the table would be filled out as follows:

	Available?	No. of Varieties?	Size?	Price Range
Carbonated soft drinks, NOT DIET e.g. Coca Cola	<input checked="" type="radio"/> Y <input type="radio"/> N	4	330ml – 500ml	50 – 99p

Note: In this example Coca Cola is available in two different sizes. However, it is only counted as one item when assessing number of varieties as the product is the same, only the size of container changes.

Below is a table containing definitions and example products for each of the categories included in the beverage section:

<i>Item</i>	<i>Description</i>	<i>Example products</i>
<i>Carbonated soft drinks, NOT DIET</i>	Carbonated soft drinks with high sugar content	Coca Cola, Pepsi, Fanta, Tango, Sprite, and lemonade
<i>Carbonated soft drinks, DIET</i>	Sugar free or no added (low) sugar carbonated soft drinks	Diet Coke, Coca Cola Zero, Sprite Zero, Fanta Zero, Pepsi Max, Diet lemonade
<i>Fruit juice drink, added sugar</i>	Fruit juice drinks with water and added (high) sugar content.	Ribena, Oasis, 5Alive, cranberry juice drinks, tropical juice drinks
<i>Fruit juice drink, low or no added sugar</i>	Fruit juice drinks with water, low or no added sugar i.e. sugars content derived from fruit juice only	Examples include Ribena Extra Light and Oasis Light
<i>Fruit juice and fruit based smoothies</i>	Freshly squeezed, pure and from concentrate fruit juices and fruit and fruit juice based smoothies. Do not include any smoothies containing dairy ingredients.	Innocent strawberry and banana smoothie

Item	Description	Example products
<i>Milkshakes and dairy based smoothies</i>	Includes all types of milkshakes and dairy based smoothies. Do not include any smoothies that contain fruit here.	Frijj milkshakes, Yazoo and Innocent yogurt, vanilla bean and honey thickie
<i>Energy drinks, high sugar</i>	Includes all glucose based energy drinks	Lucozade original and Red Bull
<i>Energy drinks, low sugar</i>	Includes all energy drinks that contain less than 4.5g sugars per 100ml product	Lucozade Sport, HydroActive and Alert. PowerAde and sugar free Red Bull.
<i>Water</i>	Includes all types of bottled water, still, sparkling, plain and flavoured	

Food items

For each of the food item categories listed on the survey sheet you should state the following under the appropriate column headings:

- Whether a food item(s) fitting the subheading is available – circle ‘Y’ or ‘N’ (or ‘N/A’ where appropriate)
- The number of different varieties available - count up to 10, if over 10 different products mark as ‘10+’. This is only applicable if the availability section was answered ‘Y’.
- The size of the packet if information is accessible - this could be a quantity range e.g. 150-300g or a description of the portion size e.g. individual bar or share size
- The price range
- Any other information that may be relevant to the project can be noted in the ‘additional comment’ section

Worked example:

If 15 pre-pack sandwiches are available in the shop then the table should be filled out as follows:

	Available?	No. of Varieties?	Size?	Price Range
Sandwiches total number – pre-pack &/or made to order	<input checked="" type="radio"/> Y <input type="radio"/> N	10 +	N/A	£1.80 – 2.50

Note: For sandwiches and salad products it should be stated whether the products are pre-pack, made to order, or both, strikethrough any irrelevant words to indicate selection.

If the shop has a large variety of other products, as in a supermarket, give a brief description of what is available e.g. full range of household groceries, in the ‘additional comments’ section.

Below is a table containing definitions and example products for each of the categories included in the food item section:

<i>Item</i>	<i>Description</i>	<i>Example products</i>
<i>Crisps and other savoury snacks</i>	Includes all potato crisps, maize snacks and other savoury snack products.	Walkers crisps, McCoys crisps, Frazzles, Wotsits, pork scratching, Mini Cheddars
<i>Chocolate confectionery and sweets</i>	Includes all types and sizes of chocolate bars and sweets such as jellies, hard boiled and toffees.	Cadbury Dairy Milk, Galaxy, Mars, Snickers, Double Decker, Starburst, Polo's, Werther's Originals
<i>Cakes, muffins, sweet biscuits, cookies and flapjack</i>	Includes all sweet cakes and pastries	Muffins, doughnuts, vanilla slices, flapjack, choc chip cookies, gingerbread men, croissants
<i>Cereal bars</i>	Includes all cereal and 'health' bars	Kellogg's cereal and milk bars (e.g. Special K, Coco Pops, Frosties), Alpen bars, Nutri-grain and Eat Natural bars
<i>Pies and pasties</i>	Includes all savoury pastry products	Sausage rolls, pork pies, cheese and onion pasties, quiche
<i>Yoghurt</i>	Includes all yoghurt products with the exception of yoghurt based smoothies (see beverages section)	Muller light, Muller fruit corners, Shape
<i>Fruit</i>	Includes whole fresh fruit and prepared fruit salads and dried fruits	
<i>Sandwiches, total number</i>	Count all hot and cold, pre-packed and/or made to order sandwiches, rolls and wraps	Tuna mayonnaise roll.
<i>Sandwiches, without mayonnaise</i>	All hot and cold, pre-pack and/or made to order sandwiches, rolls and wraps what do not contain mayonnaise. Only applicable if sandwiches are available i.e. answer to availability section of 'sandwiches, total number' category is 'yes'.	Ham salad roll made without mayonnaise.
<i>Salad, total number</i>	Includes all pre-packed or made to order vegetable, pasta and rice type salads	Chicken Caesar salad

Item	Description	Example products
<i>Salad, without mayonnaise/dressing</i>	Includes pre-packed and /or made to order salad products without any mayonnaise or salad dressings. Products which contain a serving of dressing in a separate sachet, pot or compartment to the main salad can be counted here as they allow for individual control over how much, if any, dressing is used. Only applicable if salads are available i.e. answer to availability section of 'salad, total number' category is 'yes'	Chicken Caesar salad with dressing in a separate pouch

Finish time: When you have finished the survey, make a note of the finish time back on the front page.

Scoring MFE-S

A score for each shop can be devised using a points system based on the availability and variety of products and the facilitators/barriers to healthy eating and comparative pricing.

In the beverage and food item sections if the answer to the 'availability' section is 'yes' then the 'variety' section will need to be scored. If the answer to the 'availability' is 'no' then the 'variety' section becomes inapplicable.

MFE Score is a percentage and is calculated using the following formula

$$\text{MFE Score} = X/Y * 100$$

Where X = total points scored and Y= total points available adjusted for not applicable

A higher percentage score indicates a 'more healthy' food environment.

A full worked example of the scoring of the Shop tool can be found in appendix C to this user manual.

MFE Restaurant Tool

Which food outlets should the restaurant tool be used for?

The MFE-Restaurant tool should be used in traditional style, waiter service restaurants, fast casual and fast food outlets, pubs serving food, cafes, coffee shops and other 'eat on premises' type outlets and takeaways. The MFE-Restaurant tool can also be used when assessing sandwich shops.

Completing the MFE-R tool

Before you arrive

Complete the following items prior to arriving at the restaurant:

- Observer ID
- Outlet ID
- Restaurant name, address and postcode

When you arrive

When you arrive at the restaurant, you may need to speak to the manager/owner of the restaurant in order to gain permission to complete the survey. It is advisable to carry photo ID and a letter from the university explaining the purpose of your visit with your supervisor contact details should the manager require more information. Some larger chain restaurants may have strict policies in place restricting surveys being conducted in their businesses. If this is the case, leave the outlet immediately and contact the head office for permission to conduct the survey. Some restaurants may refuse to take part in the study and if this is the case, leave immediately and make a note of the situation in the 'additional comments' section.

Basic information

Date: complete with the date the survey is completed

Arrival time: record the time you arrive at the food outlet and start the MFE survey

Photograph: It is useful to take a photograph of the outside of the restaurant. This will help when identifying and mapping the food outlets back in the office. Tick 'yes' or 'no' as to whether you have taken a photograph or not.

Geo-tag: Geo-tagging the outlets for mapping can be done in one of two ways depending on what kind of GPS device you are using. If you are using a handheld geo-caching device, write down the latitude and longitude points onto the MFE survey sheet directly from the screen. If you are using a closed GPS logger without a screen, simply carry the device with you when out in the field. Later you

will be able to manually match the GPS data with the time data recorded on the MFE survey and the time associated with any photographs taken. The latitude and longitude co-ordinates can then be completed on the MFE sheet in the office for completeness.

An example of how to complete the co-ordinate reading can be seen below. The figures should be given to 6 decimal places and North (N) or South (S) direction given for latitude, East (E) or West (W) for longitude.

Latitude:

5	4
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9	7	6	2	8	8
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N

 Longitude:

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---	---

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6	1	5	4	8	6
---	---	---	---	---	---

W

Outlet classification: use the food outlet classification system (Appendix A) to code the food outlet type (number).

Outlet description & cuisine type: describe the type of outlets and identify the dominant cuisine type. Examples of cuisine type are listed below although this is not exhaustive. If none of these are suitable, insert your own definition and include some describe some of the dishes available if a copy of the menu cannot be obtained to takeaway.

Cuisine type definitions

British – e.g. Sunday roast, fish and chips, pies and puddings

Italian – pizza and pasta dishes

Chinese – rice and noodle dishes

American – burgers, hot dogs etc

Indian – curries

Mexican – fajitas, burritos, tacos, chilli con carne etc

Other – insert own definition

Opening times: State the restaurant opening times for all days. If the restaurant is closed for any whole days in the week, make this clear by writing 'CLOSED' across the time box. If the opening hours are not easily identifiable i.e. posted on the door/ window ask a member of staff where you can find them. Opening times are split for lunch and dinner as a lot of restaurants operate in this way. However, if the restaurant is open all day without an afternoon closure, write the opening time in the lunch section and closing time in the evening section. If the restaurant is open for breakfast, write the opening times in the 'additional comments' section.

Size of restaurant: State the approximate seating capacity OR number of tables in the establishment.

Takeaway menu: Is a menu for takeaway food available? If yes, obtain a copy and attach to completed survey sheet.

Note: Try to obtain a copy of the restaurant full service menu to take away for future reference and completeness.

Menu Options

For each of the menu option categories listed on the survey sheet you should state the following under the appropriate column headings:

- Whether a meal(s) fitting the menu option subheading is available – circle ‘Y’ or ‘N’ (or ‘N/A’ where appropriate)
- The number of different meal options available fitting the specified category - count up to 10, if over 10 different meals mark as ‘10+’. This is only applicable if the availability section was answered ‘Y’.
- The source of the information - website, menu, site visit or other
- Any other comments that may be relevant to the project can be made in the ‘additional comments’ sections

Note: If a section is greyed out then no answer is required for this category.

Worked example:

A café has a menu notation that states their entire range of sandwiches are available without mayonnaise. They have a list of 25 different sandwich fillings, 13 of which contain cheese.

	Available	No. of options available?	Data source (W/M/S/O)
Sandwiches and toasties - without mayonnaise/cheese	<input checked="" type="radio"/> Y <input type="radio"/> N	10 +	M

Make a note in the ‘additional comments’ section - All available without mayo, not all without cheese.

If the restaurant has a large variety of menu items not measured using this tool, give a brief description of what is available in the ‘additional comments’ sections.

A list of definitions including example meals for each of the menu item categories can be found in the table below:

Item	Description	Example
<i>Healthy options identified on the menu</i>	Are there any notations on the menu to suggest that some meal choices are healthier than others? Applicable for all outlets.	JD Wetherspoons (2008) have 'less than 5% fat' written on the menu next to a number of items.
<i>Boiled/jacket potatoes offered as an alternative to chips</i>	Are alternatives to fried chips available? Only applicable where chips are stated on the menu. If chips are not available, mark 'N/A'	
<i>Boiled rice as an alternative to fried rice</i>	Only answer 'yes' where it is clear that rice without any added fat is available. Only applicable where rice dishes appear on the menu. The variety section is not applicable for this category measure.	Examples of fried rice dishes include egg fried rice and pilau rice
<i>Pasta dishes with vegetable based sauces e.g. tomato (NOT creamy/cheese sauces)</i>	Sauce must be vegetable based (e.g. tomato) and not contain any cream or cheese. Category only applicable where pasta dishes appear on the menu.	Tomato and basil sauce, Arrabiata sauce.
<i>Burgers served without cheese, mayonnaise or sauce</i>	Are there any plain burgers i.e. served without cheese or condiments available? This can include burgers served with sauces on the side as the individual can control the amount used. Not applicable in restaurants that do not serve burgers.	
<i>Total main dish salads</i>	Are salads available as main meal? Applicable to all restaurants.	Chicken Caesar salad
<i>Main dish salads without creamy/oily dressing</i>	Only applicable if main dish salads are on the menu. How many of these are served without creamy/oily dressings (e.g. plain or with a low fat dressing)? Count if menu states that dressing are served on the side.	Chicken Caesar salad without creamy dressing
<i>Side salad and/or vegetables served with meals</i>	Applicable to all restaurants. Are side salads and/or vegetables served with main meals? If yes, how many main meals are served with salad/vegetables? Must be stated on menu to count. Vegetables included	

Item	Description	Example
<i>Oily fish e.g. salmon, fresh tuna</i>	Is oily fish available on the menu? Can be present within any type of main menu dish. If yes, how many options are available? Applicable to all restaurants.	Salmon, mackerel, sardines, fresh tuna (not tinned)
<i>Sandwiches/toasties without mayonnaise/cheese</i>	Only applicable if sandwiches and/or toasties are served (includes all types of sandwiches, panini's, wraps etc). Note the number of options (if any) available without mayonnaise and cheese.	Chicken salad sandwich without mayonnaise
<i>Healthier desserts e.g. fruit salad, sorbet, frozen yoghurt</i>	Only applicable in restaurants where a dessert menu is served. Are there any healthier options available? If yes, how many are available?	Fruit salad, sorbet, frozen yoghurt, low fat yogurt

Beverages

For each of the beverage categories listed on the survey sheet you should state the following under the appropriate column headings:

- Whether a beverage(s) fitting the subheading is available – circle 'Y' or 'N'
- The number of different varieties available - count up to 10, if over 10 different products mark as '10+'. This is only applicable if the availability section was answered 'Y'.
- The source of the information - website, menu, site visit or other
- Any other information that may be relevant to the project can be noted in the 'additional comment' section

Note: If a section is greyed out then no answer is required for this category.

Worked example:

You are surveying a major fast food chain outlet with a site visit and you can see 4 carbonated soft drink products – Coca Cola, Sprite, Diet Coke and Fanta. In this situation the table would be filled out as follows:

	Available?	No. of options Available?	Data Source (W/M/S/O)
Carbonated soft drinks, NOT DIET e.g. Coca Cola	<input checked="" type="radio"/> Y <input type="radio"/> N	3	S
Carbonated soft drinks, DIET e.g. Diet Coke	<input checked="" type="radio"/> Y <input type="radio"/> N	1	S

A list of definitions, example products and additional notes for each of the beverage categories can be found below.

Item	Description	Example products
<i>Carbonated soft drinks, NOT DIET</i>	Carbonated soft drinks with high sugar content	Coca Cola, Pepsi, Fanta, Tango, Sprite, and lemonade
<i>Carbonated soft drinks, DIET</i>	Sugar free or no added (low) sugar carbonated soft drinks	Diet Coke, Coca Cola Zero, Sprite Zero, Fanta Zero, Pepsi Max, Diet lemonade
<i>Fruit juice drink, added sugar</i>	Fruit juice drinks with water and added (high) sugar content.	Ribena, Oasis, 5Alive, cranberry juice drinks, tropical juice drinks
<i>Fruit juice drink, low or no added sugar</i>	Fruit juice drinks with water, low or no added sugar i.e. sugars content derived from fruit juice only	Examples include Ribena Extra Light and Oasis Light
<i>Fruit juice and fruit based smoothies</i>	Freshly squeezed, pure and from concentrate fruit juices and fruit and fruit juice based smoothies. Do not include any smoothies containing dairy ingredients.	Innocent strawberry and banana smoothie
<i>Milkshakes and dairy based smoothies</i>	Includes all types of milkshakes and dairy based smoothies. Do not include any smoothies that contain fruit here.	Frijj milkshakes, Yazoo and Innocent yogurt, vanilla bean and honey thickie
<i>Energy drinks, high sugar</i>	Includes all glucose based energy drinks	Lucozade original and Red Bull
<i>Semi-skimmed/skimmed milk available for hot drinks</i>	Where hot drinks are served is a reduced fat milk option available?	Skinny latte
<i>Low fat hot chocolate/ malt drinks</i>	Is a reduced fat/calorie hot chocolate option available?	Hot chocolate without whipped cream
<i>Alcohol</i>	Are alcoholic drinks available?	Beers, wine, spirits

Facilitators and supports to healthy eating

Healthy choices arranged prominently on menu: Only complete where healthy choices are identified on the menu, are they placed where they are easily seen and accessed? Tick 'Yes' or 'No', or 'N/A' if healthy options are not identified on the menu.

Nutritional information stated on menu: Is there any nutritional information about the meals on offer stated on the menu? Must state, at minimum, details of a calorie and total fat content to be counted. Tick 'Yes' or 'No'.

Nutritional information available through website: Is nutritional information for the meals on offer available through a company website? If yes, print a copy of the data if possible, and attach to the completed survey sheet. This section may be completed before or after the site visit. Tick 'Yes' or 'No'.

Reduced portion size offered: Are a range of portion sizes available? For example, in an Italian restaurant you may be able to have a starter size portion of pasta as a main meal, or a fast food restaurant may offer varying portion sizes of fries. Tick 'Yes' or 'No'.

Menu notations encouraging special requests: Do menu notations encourage healthy requests and indicate that it would make the selection a healthier choice? For example, menu says, "all our sandwiches are available without mayonnaise – just ask". Tick 'Yes' or 'No'.

Barriers to healthy eating

Large portion sizes encouraged: Does the restaurant promote large portion sizes on the menu e.g. super-size, extra large meal options or offers extras for small charges [e.g. add chips to meal for 60p]. Tick 'Yes' or 'No'.

Menu notations discouraging special requests: Are there notations on the menu discouraging special requests e.g. "no substitutions" or "extra charge for substitutions"? Tick 'Yes' or 'No'.

All you can eat: does the restaurant offer an all-you-can-eat or unlimited trips/refills menu? Main menu food only, does not include beverages or desserts. Tick 'Yes' or 'No'.

Special offers: Are there any unhealthy special offers? For example, "2 meals for £7" from a restricted menu not including any healthy options. Tick 'Yes' or 'No'.

Free refills on drinks offered: Does the restaurant offer unlimited free refills on drinks policy? Note in the comments section what beverages are included in this offer. Tick 'Yes' or 'No'.

Free refills on desserts offered: Does the restaurant offer unlimited refills on desserts e.g. ice cream? Tick 'Yes' or 'No'.

Charge for sharing single meal: Is there a cover charge for sharing a single meal? Tick 'Yes' or 'No'.

Comparative pricing

Sum of individual items compared to combo meal deal: Identify if combo meals cost more, the same, or less than purchasing individual items. A combo meal deal is defined as a meal that combines several menu items that would otherwise be sold separately. It is not an item with a side dish(es) but separate items with separate prices put together as a "combo". For example: burger + fries + drink as a combo, vs. burger + fries + drink purchased separately.

Price of combo meal deal < sum individual items = tick 'more'

Price of combo meal deal > sum individual items = tick 'less'

Price of combo meal deal = sum individual items = tick 'same'

Combo meal deals are not available = tick 'N/A'

Healthy options compared with regular ones: Identify if healthy meal options are more, the same price, or less than regular meal options. Make a note of which menu items are used for the comparison in the 'additional comments' section. E.g. salad main meals versus lasagne.

Price of 'healthier' option < standard option = tick 'less'

Price of 'healthier' option > standard option = tick 'more'

Price of 'healthier' option = standard option = tick 'same'

'Healthier' options are not available = tick 'N/A'

Smaller portion compared with regular one: Is a smaller portion more, the same price, or less than a regular portion?

Price of smaller portion < standard portion = tick 'less'

Price of smaller portion > standard portion = tick 'more'

Price of smaller portion = standard portion = tick 'same'

Smaller portions are not available = tick 'N/A'

Finish time: When you have finished the survey, make a note of the finish time back on the front page.

Scoring MFE-R

A score for each restaurant can be devised using a points system based on the availability and variety of meals and beverages on the menu and facilitators/barriers to healthy eating and comparative pricing.

In the menu options and beverage sections if the answer to the 'availability' section is 'yes' then the 'variety' section will need to be scored. If the answer to the 'availability' is 'no' then the 'variety' section becomes inapplicable. There are some cases where the question will not be applicable (N/A) and because of this the end score is adjusted for 'not applicable'.

MFE Score is a percentage and is calculated using the following formula

$$\text{MFE Score} = X/Y * 100$$

Where X = total points scored and Y= total points available adjusted for not applicable

A higher percentage score indicates a 'more healthy' food environment.

A full worked example of the scoring of the restaurant tool can be found in appendix D to this user manual.

MFE Vending Tool

Completing the MFE-V tool

Before you arrive

Complete the following items prior to arriving at the vending machine:

- Observer ID
- Outlet ID
- Location of the vending machine (building name, address and postcode)

When you arrive

Vending machines may be located in areas where you need to be granted access permissions for example, schools, hospitals, workplaces etc. In this case you may need to speak to someone at reception (or higher) order to gain permission to complete the survey. It is advisable to carry photo ID and a letter from the university explaining the purpose of your visit with your supervisor contact details should anyone require more information.

Basic information

Date: complete with the date the survey is completed

Arrival time: record the time you arrive at the food outlet and start the MFE survey

Photograph: It is useful to take a photograph of the vending machine. This will help when identifying and mapping the food outlets back in the office. Tick 'yes' or 'no' as to whether you have taken a photograph or not.

Geo-tag: Geo-tagging the outlets for mapping can be done in one of two ways depending on what kind of GPS device you are using. If you are using a handheld geo-caching device, write down the latitude and longitude points onto the MFE survey sheet directly from the screen. If you are using a closed GPS logger without a screen, simply carry the device with you when out in the field. Later you will be able to manually match the GPS data with the time data recorded on the MFE survey and the time associated with any photographs taken. The latitude and longitude co-ordinates can then be completed on the MFE sheet in the office for completeness.

An example of how to complete the co-ordinate reading can be seen below. The figures should be given to 6 decimal places and North (N) or South (S) direction given for latitude, East (E) or West (W) for longitude.

Latitude:

5	4
---	---

 .

9	7	6	2	8	8
---	---	---	---	---	---

N

 Longitude:

-	1
---	---

 .

6	1	5	4	8	6
---	---	---	---	---	---

W

Outlet classification and branding: use the food outlet classification system (Appendix A) to code the food outlet type (number). Make a note of the vending machine brand.

Number and type of vending machines: Note down the total number of vending machines in the area being studied. Do not complete the measures for each individual vending machine separately but what is available in the all vending machines in the area as a combined unit. Decide what types of foods are sold in the vending machine(s), remembering that more than one option may be ticked.

Queue size and surrounding area: State the approximate queue size and give the number of tables (if any) available in the surrounding area. Use the 'additional comments' section to note any relevant information about the location of the vending machine e.g. is the vending machine situated in a canteen area?

Hot beverages

Only fill this section in if you have ticked the 'hot beverages' option when describing the type of vending machine(s). If hot beverages are not offered, leave this section blank.

For each of the hot beverage categories listed on the survey sheet you should state the following under the appropriate column headings:

- Whether a beverage(s) fitting the subheading is available – circle 'Y' or 'N'
- The number of different varieties available - count up to 10, if over 10 different products mark as '10+'. This is only applicable if the availability section was answered 'Y'.
- The price range of products
- Any other information that may be relevant to the project can be noted in the 'additional comment' section

Worked example:

The following hot chocolate options are available in a hot beverages vending machine: Original, caramel and double chocolate. All options cost 75 pence. The survey table would be completed as follows:

	Available?	Varieties?	Price Range
Hot Chocolate	<input checked="" type="radio"/> Y <input type="radio"/> N	3	75p

Definitions and guidance on what types of products are to be included in each individual category can be found in the table below.

Item	Description
<i>Tea</i>	Includes options of tea with milk, without milk, fruit teas etc
<i>Coffee</i>	Includes all coffee vending options including white coffee, black coffee, latte, cappuccino, mocha etc
<i>Hot chocolate</i>	Includes options with milk, etc. Make a note in the 'additional comments' section if low calorie hot chocolate is available.
<i>Soup</i>	Examples include golden vegetable, chicken and tomato soups
<i>Sugar options</i>	Are there sugar options for the drinks e.g. tea with 1 sugar, tea with 2 sugars etc.

Cold beverages

Only fill this section in if you have ticked the 'cold beverages' option when describing the type of vending machine(s). If cold beverages are not offered, leave this section blank.

For each of the cold beverage categories listed on the survey sheet you should state the following under the appropriate column headings:

- Whether a beverage(s) fitting the subheading is available – circle 'Y' or 'N'
- The number of different varieties available - count up to 10, if over 10 different products mark as '10+'. This is only applicable if the availability section was answered 'Y'.
- The price range of products
- Any other information that may be relevant to the project can be noted in the 'additional comment' section

Worked example:

If a cold beverage vending machine stocked cans of Coca Cola, Fanta and Sprite priced at 80 pence each, the table would be filled out as follows:

	Available?	Varieties?	Price Range
Carbonated soft drinks, NOT DIET e.g. Coca Cola	<input checked="" type="radio"/> Y <input type="radio"/> N	3	80p

Definitions and guidance on what types of products are to be included in each individual category can be found in the table below:

Item	Description	Example products
<i>Carbonated soft drinks, NOT DIET</i>	Carbonated soft drinks with high sugar content	Coca Cola, Pepsi, Fanta, Tango, Sprite, and lemonade
<i>Carbonated soft drinks, DIET</i>	Sugar free or no added (low) sugar carbonated soft drinks	Diet Coke, Coca Cola Zero, Sprite Zero, Fanta Zero, Pepsi Max, Diet lemonade
<i>Fruit juice drink, added sugar</i>	Fruit juice drinks with water and added (high) sugar content.	Ribena, Oasis, 5Alive, cranberry juice drinks, tropical juice drinks
<i>Fruit juice drink, low or no added sugar</i>	Fruit juice drinks with water, low or no added sugar i.e. sugars content derived from fruit juice only	Examples include Ribena Extra Light and Oasis Light
<i>Fruit juice and fruit based smoothies</i>	Freshly squeezed, pure and from concentrate fruit juices and fruit and fruit juice based smoothies. Do not include any smoothies containing dairy ingredients.	Innocent strawberry and banana smoothie
<i>Milkshakes and dairy based smoothies</i>	Includes all types of milkshakes and dairy based smoothies. Do not include any smoothies that contain fruit here.	Frijj milkshakes, Yazoo and Innocent yogurt, vanilla bean and honey thickie
<i>Energy drinks, high sugar</i>	Includes all glucose based energy drinks	Lucozade original and Red Bull
<i>Energy drinks, low sugar</i>	Includes all energy drinks that contain less than 4.5g sugars per 100ml product	Lucozade Sport, HydroActive and Alert. PowerAde and sugar free Red Bull.
<i>Water</i>	Includes all types of bottled water, still, sparkling, plain and flavoured	

Food items

Only fill this section in if you have ticked one or more of following options when describing the type of vending machine(s):

- Confectionery
- Crisps
- Sandwich
- Other (if 'other' items are food)

If food items are not offered in the vending machine(s), leave this section blank.

For each of the food item categories listed on the survey sheet you should state the following under the appropriate column headings:

- Whether a food item(s) fitting the subheading is available – circle ‘Y’ or ‘N’
- The number of different varieties available - count up to 10, if over 10 different products mark as ‘10+’. This is only applicable if the availability section was answered ‘Y’.
- The price range of products
- Any other information that may be relevant to the project can be noted in the ‘additional comment’ section

Worked example:

If 2 flavours of Hula Hoops priced at 70 pence and 3 flavours of Walkers crisps priced at 60 pence were available in a vending machine, the ‘crisps and other savoury snacks’ section of the table would be completed as follows:

	Available?	Varieties?	Price Range
Crisps and other savoury snacks	<input checked="" type="radio"/> Y <input type="radio"/> N	5	60-70p

A list of definitions, including examples of products, for each of the food item categories can be found in the table below:

Item	Description	Example products
<i>Crisps and other savoury snacks</i>	Includes all potato crisps, maize snacks and other savoury snack products.	Walkers crisps, McCoys crisps, Frazzles, Wotsits, pork scratching, Mini Cheddars
<i>Chocolate confectionery</i>	Includes all types and sizes of chocolate bars.	Cadbury Dairy Milk, Galaxy, Mars, Snickers, Double Decker
<i>Cakes, muffins, sweet biscuits, cookies and flapjack</i>	Includes all sweet cakes and pastries	Muffins, doughnuts, vanilla slices, flapjack, choc chip cookies, gingerbread men, croissants
<i>Cereal bars</i>	Includes all cereal and ‘health’ bars	Kellogg’s cereal and milk bars (e.g. Special K, Coco Pops, Frosties), Alpen bars, Nutri-grain and Eat Natural bars
<i>Sweets</i>	Includes sweets such as jellies, hard boiled, toffees	Some branded examples are Starburst, Polo’s and Werther’s Originals.
<i>Savoury pies and pasties</i>	Includes all savoury pastry products	Sausage rolls, pork pies, cheese and onion pasties, quiche
<i>Fruit</i>	Includes whole fresh fruit and prepared fruit salads and dried fruits	
<i>Sandwiches</i>	Includes all sandwiches, rolls and wraps.	Tuna mayonnaise roll.

Finish time: When you have finished the survey, make a note of the finish time back on the front page.

Scoring MFE-V

A score for each vending machine area can be devised using a points system based on the availability and variety of food and beverage categories typically stocked in vending machines.

In the menu options and beverage sections if the answer to the 'availability' section is 'yes' then the 'variety' section will need to be scored. If the answer to the 'availability' is 'no' then the 'variety' section becomes inapplicable. If the box for the number of varieties is greyed out a number is not required for that question. The score is adjusted for 'not applicable' questions.

MFE Score is a percentage and is calculated using the following formula

$$\text{MFE Score} = X/Y * 100$$

Where X = total points scored and Y= total points available adjusted for not applicable

A higher percentage score indicates a 'more healthy' food environment.

A full worked example of the scoring of the vending tool can be found in appendix E to this user manual.

NOTE: Some examples included within this user guide have been taken directly from the NEMS training manual available online (Nutrition Environment Measures Study 2008)

References

JD Wetherspoons. (2008). "JD Wetherspoons Food Menu " Retrieved 09/03/03, from [http://www.jdwetherspoon.co.uk/resource/documents/food-and-drink/jdw-food-menu%20\(prices%20vary%20depending%20on%20pub%20visited\).pdf](http://www.jdwetherspoon.co.uk/resource/documents/food-and-drink/jdw-food-menu%20(prices%20vary%20depending%20on%20pub%20visited).pdf)

Nutrition Environments Measures Study. (2008). "Nutrition Environments Measures Study " Retrieved 17/03/08, from <http://www.sph.emory.edu/NEMS/Measures.htm>.

Appendix A

Food Outlet Classification Tool

This is provided as a separate document.

Lake, A. A., Burgoine, T., Greenhalgh, F., Stamp, E. & Tyrrell, R. (2010) 'The foodscape: Classification and field validation of secondary data sources', *Health & Place*, 16 (4), pp. 666-673.

Appendix B

Food Standards Agency Traffic Light Nutrition Labelling

Below are some examples of traffic light label designs used by different food companies (Food Standards Agency 2008). Although they may look different, the companies are all using the Food Standards Agency guidelines.

Asda



Boots



Co-op



Marks & Spencer



Sainsbury's



Waitrose



Food Standards Agency. (2008). "Eatwell: Traffic Light Nutrition Labelling " Retrieved 09/03/08, from <http://www.eatwell.gov.uk/foodlabels/trafficlights/>.

MFE: Shop



Complete the following prior to shop visit:

Observer ID:

Shop name and address:

Outlet ID:

Postcode:

Complete the following during shop visit:

Date visited:

Survey start time: :

Survey finish time: :

Photograph? Yes ☐ No ☐

Geotag? Yes ☐ No ☐

Latitude: . Longitude: .

Outlet classification: .

Outlet description: _____

Opening times:

Additional comments:

	Opening time	Closing time
<i>Monday</i>	:	:
<i>Tuesday</i>	:	:
<i>Wednesday</i>	:	:
<i>Thursday</i>	:	:
<i>Friday</i>	:	:
<i>Saturday</i>	:	:
<i>Sunday</i>	:	:

Total number of tills:

Number of tills open:

Queue Size: 0-3 4-6 7-10 +10

Facilitators and supports to healthy eating:

	All (>90%)	Most (51-90%)	Few (10-50%)	None (<10%)
Nutritional information stated on products				
FSA Traffic Light labelling present on products				

Facilitators and supports to healthy eating (continued):

	Yes	No
Promotions for 'more healthy' choices		
'More healthy' meal deals available (fruit/water/fruit juice)		
Are healthy choices arranged prominently? (restricted to till area)		

Barriers to healthy eating:

	Yes	No
Promotions for 'less healthy' choices		
'Less healthy' meal deals available (crisps/chocolate/soft drinks)		

Comparative pricing:

	More	Less	Same	N/A
Sum of individual items compared to combo meal deal				
Healthy options compared to regular options				

Beverages:

	Available?	No. of Varieties?	Size?	Price range
Carbonated soft drinks, NOT DIET e.g. Coca Cola	Y N			
Carbonated soft drinks, DIET e.g. Diet Coke	Y N			
Fruit juice drink, added sugar e.g. Oasis and Ribena	Y N			
Fruit juice drink, low or no added sugar e.g. Oasis Light	Y N			
Fruit juice and fruit based smoothies (including those from concentrate)	Y N			
Milkshakes and dairy based smoothies without fruit	Y N			
Energy drinks, high sugar e.g. Lucozade Energy and Red Bull	Y N			
Energy drinks, low sugar (less than 4.5g per 100ml) e.g. Lucozade sport	Y N			
Water (including flavoured water)	Y N			

Food items:

	Available?	No. of Varieties?	Size?	Price range
Crisps and other savoury snacks	Y N			
Chocolate confectionery and sweets	Y N			
Cakes, muffins, sweet biscuits, pastries, cookies, flapjack etc	Y N			
Cereal bars	Y N			
Savoury pies and pastries e.g. sausage rolls	Y N			
Yoghurt	Y N			
Fruit including fruit salad and dried fruit	Y N			
Sandwiches – total number Pre-pack &/or made to order	Y N			
Sandwiches - without mayo Pre-pack &/or made to order	Y N N/A			
Salads – total number Pre-pack &/or made to order	Y N			
Salads – without mayo/dressing Pre-pack &/or made to order	Y N N/A			

Additional comments:

MFE: Shop Score



Marker ID:

Outlet ID:

Date visited:

Instructions:

Circle the score that corresponds with the survey answer. In the 'beverage' and 'food item' sections, two scores apply: available and variety.

If the item is not available i.e. available = no, then variety is not scored.

If the item is available i.e. available = yes, then the variety item is also scored.

If the box is greyed out and no score is stated then the option is not scored.

The total score is adjusted for 'not applicable' questions and is presented as a percentage.

The total score (%) = $X/Y \times 100$

X = total points scored—sum of X values circled

Y = total points available—sum of Y values circled

A higher percentage score indicates a 'more healthy' food environment.

Facilitators and supports to healthy eating:

	All (>90%)	Most (51-90%)	Few (10-50%)	None (<10%)
Nutritional information stated on products	3/3	2/3	1/3	0/3
FSA Traffic Light labelling present on products	3/3	2/3	1/3	0/3
			Yes	No
Promotions for 'more healthy' choices			1/1	0/1
'More healthy' meal deals available (fruit/water/fruit juice)			1/1	0/1
Are healthy choices arranged prominently? (restricted to till area)			1/1	0/1

Barriers to healthy eating:

	Yes	No
Promotions for 'less healthy' choices	0/1	1/1
'Less healthy' meal deals available (crisps/chocolate/soft drinks)	0/1	1/1

Comparative pricing:

	More	Less	Same	N/A
Sum of individual items compared to combo meal deal	0/2	2/2	1/2	0/0
Healthy options compared to regular options	0/2	2/2	1/2	0/0

Beverages:

	Available?		No. of Varieties?		
	Yes	No	<5	5-10	>10
Carbonated soft drinks, NOT DIET e.g. Coca Cola	0/1	3/3	2/2	1/2	0/2
Carbonated soft drinks, DIET e.g. Diet Coke	1/1	0/3	0/2	1/2	2/2
Fruit juice drink, added sugar e.g. Oasis and Ribena	0/1	3/3	2/2	1/2	0/2
Fruit juice drink, low or no added sugar e.g. Oasis Light	1/1	0/3	0/2	1/2	2/2
Fruit juice and fruit based smoothies (including those from concentrate)	1/1	0/3	0/2	1/2	2/2
Milkshakes and dairy based smoothies without fruit	0/1	3/3	2/2	1/2	0/2
Energy drinks, high sugar e.g. Lucozade Energy and Red Bull	0/1	3/3	2/2	1/2	0/2
Energy drinks, low sugar (less than 4.5g per 100ml) e.g. Lucozade sport	1/1	0/3	0/2	1/2	2/2
Water (including flavoured water)	1/1	0/3	0/2	1/2	2/2

Food items:

	Available?			No. of Varieties?		
	Yes	No	N/A	<5	5-10	>10
Crisps and other savoury snacks	0/1	3/3		2/2	1/2	0/2
Chocolate confectionery and sweets	0/1	3/3		2/2	1/2	0/2
Cakes, muffins, sweet biscuits, pastries, cookies, flapjack etc	0/1	3/3		2/2	1/2	0/2
Cereal bars	0/1	3/3		2/2	1/2	0/2
Savoury pies and pastries e.g. sausage rolls	0/1	3/3		2/2	1/2	0/2
Yoghurt	1/1	0/3		0/2	1/2	2/2
Fruit including fruit salad and dried fruit	1/1	0/3		0/2	1/2	2/2
Sandwiches – total number Pre-pack &/or made to order	1/1	0/3		0/2	1/2	2/2
Sandwiches - without mayo Pre-pack &/or made to order	1/1	0/3	0/0	0/2	1/2	2/2
Salads – total number Pre-pack &/or made to order	1/1	0/3		0/2	1/2	2/2
Salads – without mayo/dressing Pre-pack &/or made to order	1/1	0/3	0/0	0/2	1/2	2/2

Total score:Total points scored (X) = Total score (%) = $X/Y * 100 =$. Total points available (Y) =

A higher percentage score indicates a 'more healthy' food environment.

MFE: Restaurant



Complete the following prior to restaurant visit:

Observer ID:

Restaurant name and address:

Outlet ID:

Postcode:

Complete the following during restaurant visit:

Date visited:

Survey start time: :

Survey finish time: :

Photograph? Yes ☐ No ☐

Geotag? Yes ☐ No ☐

Latitude: . Longitude: .

Outlet classification: .

Outlet description & cuisine type: _____

Opening times:

	Opening time (Lunch)	Closing time (Lunch)	Opening time (Evening)	Closing time (Evening)
<i>Monday</i>	:	:	:	:
<i>Tuesday</i>	:	:	:	:
<i>Wednesday</i>	:	:	:	:
<i>Thursday</i>	:	:	:	:
<i>Friday</i>	:	:	:	:
<i>Saturday</i>	:	:	:	:
<i>Sunday</i>	:	:	:	:

Size of restaurant: Seating Capacity OR Number of Tables

Takeaway menu available? Yes ☐ No ☐

Copy of menu obtained on premises? Yes ☐ No ☐

Additional comments:

Menu options:

	Available?	No. of options available?	Data source* (W/M/S/O)
Healthy options identified on the menu	Y N		
Boiled/ jacket potatoes offered as an alternative to chips	Y N N/A		
Boiled rice as an alternative to fried rice (e.g. egg fried rice, pilau rice)	Y N N/A		
Pasta dishes with vegetable based sauces e.g. tomato (NOT creamy/cheese sauces)	Y N N/A		
Burgers served without cheese mayonnaise or sauce	Y N N/A		
Total main dish salads	Y N		
Main dish salad without creamy/oily dressing	Y N N/A		
Side salad and/or vegetables served with meals	Y N		
Oily fish e.g. salmon, fresh tuna	Y N		
Sandwiches and toasties without mayonnaise/cheese	Y N N/A		
Healthier desserts e.g. fruit salad, sorbet, frozen yoghurt	Y N N/A		

Beverages:

	Available?	No. of options available?	Data Source* (W/M/S/O)
Carbonated soft drinks, NOT DIET e.g. Coca Cola	Y N		
Carbonated soft drinks, DIET e.g. Diet Coke	Y N		
Fruit juice drink, added sugar e.g. Oasis and Ribena	Y N		
Fruit juice drink, low or no added sugar e.g. Oasis Light	Y N		
Fruit juice and fruit based smoothies (including those from concentrate)	Y N		
Milkshakes and dairy based smoothies without fruit	Y N		
Energy drinks, high sugar e.g. Lucozade Energy and Red Bull	Y N		
Semi-skimmed/skimmed milk available for hot drinks e.g. coffee, tea	Y N		
Low fat hot chocolate/ malt drinks	Y N		
Alcohol	Y N		

*Data source: W = Website M = Menu S = Site O = Other (please state)

Facilitators and supports to healthy eating:

	Yes	No	N/A
Healthy choices arranged prominently on menu			
Nutritional information stated on menu			
Nutritional information available through website			
Reduced portion size offered			
Menu notations encouraging special requests			

Barriers to healthy eating:

	Yes	No
Large portion sizes encouraged		
Menu notations discouraging special requests		
All you can eat		
Special offers e.g. 2 meals for £7		
Free refills on drinks offered		
Free refills on desserts offered		
Charge for sharing single meal		

Comparative pricing:

	More	Less	Same	N/A
Sum of individual items compared to combo meal deal				
Healthy options compared to regular options				
Smaller portion compared to regular portion				

Additional comments:

MFE: Restaurant Score

Marker ID: Outlet ID: Date visited:

Instructions:

Circle the score that corresponds with the survey answer. In the 'menu options' and 'beverage' sections, two scores apply: available and number of options available.

If the item is not available i.e. available = no, then number of options is not scored.

If the item is available i.e. available = yes, then the number of options is also scored (although not in all cases).

If the box is greyed out and no score is stated then the option is not scored.

The total score is adjusted for 'not applicable' questions and is presented as a percentage.

The total score (%) = $X/Y * 100$

X = total points scored—sum of X values circled

A higher percentage score indicates a 'more healthy' food environment.

Menu options

	Available?			No. of options available?		
	Yes	No	N/A	<5	5-10	>10
Healthy options identified on the menu	1/1	0/3		0/2	1/2	2/2
Boiled/ jacket potatoes offered as an alternative to chips	1/1	0/1	0/0			
Boiled rice as an alternative to fried rice (e.g. egg fried rice, pilau rice)	1/1	0/1	0/0			
Pasta dishes with vegetable based sauces e.g. tomato (NOT creamy/cheese sauces)	1/1	0/3	0/0	0/2	1/2	2/2
Burgers served without cheese mayonnaise or sauce	1/1	0/3	0/0	0/2	1/2	2/2
Total main dish salads	1/1	0/3		0/2	1/2	2/2
Main dish salad without creamy/oily dressing	1/1	0/3	0/0	0/2	1/2	2/2
Side salad and/or vegetables served with meals	1/1	0/3		0/2	1/2	2/2
Oily fish e.g. salmon, fresh tuna	1/1	0/3		0/2	1/2	2/2
Sandwiches and toasties without mayonnaise/cheese	1/1	0/3	0/0	0/2	1/2	2/2
Healthier desserts e.g. fruit salad, sorbet, frozen yoghurt	1/1	0/3	0/0	0/2	1/2	2/2

Beverages:

	Available?		No. of options available?		
	Yes	No	<5	5-10	>10
Carbonated soft drinks, NOT DIET e.g. Coca Cola	0/1	3/3	2/2	1/2	0/2
Carbonated soft drinks, DIET e.g. Diet Coke	1/1	0/3	0/2	1/2	2/2
Fruit juice drink, added sugar e.g. Oasis and Ribena	0/1	3/3	2/2	1/2	0/2
Fruit juice drink, low or no added sugar e.g. Oasis Light	1/1	0/3	0/2	1/2	2/2
Fruit juice and fruit based smoothies (including those from concentrate)	1/1	0/3	0/2	1/2	2/2
Milkshakes and dairy based smoothies without fruit	0/1	3/3	2/2	1/2	0/2
Energy drinks, high sugar e.g. Lucozade Energy and Red Bull	0/1	3/3	2/2	1/2	0/2
Semi-skimmed/skimmed milk available for hot drinks e.g. coffee, tea	1/1	0/1			
Low fat hot chocolate/ malt drinks	1/1	0/1			
Alcohol	0/1	1/1			

Facilitators and supports to healthy eating:

	Yes	No	N/A
Healthy choices arranged prominently on menu	1/1	0/1	0/0
Nutritional information stated on menu	1/1	0/1	
Nutritional information available through website			
Reduced portion size offered	1/1	0/1	
Menu notations encouraging special requests	1/1	0/1	

Barriers to healthy eating:

	Yes	No
Large portion sizes encouraged	0/1	1/1
Menu notations discouraging special requests	0/1	1/1
All you can eat	0/1	1/1
Special offers e.g. 2 meals for £7	0/1	1/1
Free refills on drinks offered	0/1	1/1
Free refills on desserts offered	0/1	1/1
Charge for sharing single meal	0/1	1/1

Comparative pricing:

	More	Less	Same	N/A
Sum of individual items compared to combo meal deal	0/2	2/2	1/2	0/0
Healthy options compared to regular options	0/2	2/2	1/2	0/0
Smaller portion compared to regular portion	0/2	2/2	1/2	0/0

Total score:Total points scored (X) = Total score (%) = $X/Y * 100 =$. Total points available (Y) =

A higher percentage score indicates a 'more healthy' food environment.

MFE: Vending



Complete the following prior to vending machine visit:

Observer ID:

Location of vending machine:

Outlet ID:

Postcode:

Complete the following during vending machine visit:

Complete one form per vending machine area NOT one form per vending machine.

Date visited:

Survey start time: :

Survey finish time: :

Photograph? Yes ☐ No ☐

Geotag? Yes ☐ No ☐

Latitude: . Longitude: .

Outlet classification: . Vending machine brand: _____

Number of vending machines in area:

Type of vending machine:

Hot beverages ☐

Cold beverages ☐

Confectionery ☐

Crisps ☐

Sandwich ☐

Other (Please specify) _____

Queue Size: 0-3 ☐ 4-6 ☐ 7-10 ☐ +10 ☐

Tables in surrounding area? Yes ☐ No ☐

If yes, how many?

Additional comments:

Hot beverages:

Section only to be completed if hot drinks are present in the vending machine area being surveyed.

	Available?	Varieties?	Price range
Tea	Y N		
Coffee	Y N		
Hot chocolate	Y N		
Soup	Y N		
Sugar options	Y N		

Cold beverages:

Section only to be completed if cold drinks are present in the vending machine area being surveyed.

	Available?	Varieties?	Price range
Carbonated soft drinks, NOT DIET e.g. Coca Cola	Y N		
Carbonated soft drinks, DIET e.g. Diet Coke	Y N		
Fruit juice drink, added sugar e.g. Oasis and Ribena	Y N		
Fruit juice drink, low or no added sugar e.g. Oasis Light	Y N		
Fruit juice and fruit based smoothies (including those from concentrate)	Y N		
Milkshakes and dairy based smoothies without fruit	Y N		
Energy drinks, high sugar e.g. Lucozade Energy and Red Bull	Y N		
Energy drinks, low sugar (less than 4.5g per 100ml) e.g. Lucozade sport	Y N		
Water (including flavoured water)	Y N		

Food items:

Section only to be completed if food items are present in the vending machine area being surveyed.

	Available?	Varieties?	Price range
Crisps and other savoury snacks	Y N		
Chocolate confectionery	Y N		
Cakes, muffins, sweet biscuits, pastries, cookies, flapjack etc	Y N		
Cereal bars	Y N		
Sweets	Y N		
Savoury pies and pastries e.g. sausage rolls	Y N		
Fruit including fruit salad and dried fruit	Y N		
Sandwiches	Y N		

MFE: Vending Score



Marker ID: Outlet ID: Date visited:

Instructions:

Circle the score that corresponds with the survey answer. In the 'beverage' and 'food item' sections, two scores apply: available and variety.

If the item is not available i.e. available = no, then variety is not scored.

If the item is available i.e. available = yes, then the variety item is also scored.

If the box is greyed out and no score is stated then the option is not scored.

The total score is adjusted for 'not applicable' questions and is presented as a percentage.

The total score (%) = $X/Y * 100$

X = total points scored—sum of X values circled

Y = total points available—sum of Y values circled

A higher percentage score indicates a 'more healthy' food environment.

Hot beverages:

Only scored if hot drinks section of MFE survey completed for machine area.

	Available?		No. of Varieties?		
	Yes	No	<5	5-10	>10
Tea					
Coffee					
Hot chocolate	0/1	3/3	2/2	1/2	0/2
Soup	0/1	3/3	2/2	1/2	0/2
Sugar options	0/3	3/3			

Cold beverages:

Only scored if cold drinks section of MFE survey completed for machine area.

	Available?		No. of Varieties?		
	Yes	No	<5	5-10	>10
Carbonated soft drinks, NOT DIET e.g. Coca Cola	0/1	3/3	2/2	1/2	0/2
Carbonated soft drinks, DIET e.g. Diet Coke	1/1	0/3	0/2	1/2	2/2
Fruit juice drink, added sugar e.g. Oasis and Ribena	0/1	3/3	2/2	1/2	0/2
Fruit juice drink, low or no added sugar e.g. Oasis Light	1/1	0/3	0/2	1/2	2/2
Fruit juice and fruit based smoothies (including those from concentrate)	1/1	0/3	0/2	1/2	2/2
Milkshakes and dairy based smoothies without fruit	0/1	3/3	2/2	1/2	0/2
Energy drinks, high sugar e.g. Lucozade Energy and Red Bull	0/1	3/3	2/2	1/2	0/2
Energy drinks, low sugar (less than 4.5g per 100ml) e.g. Lucozade sport	1/1	0/3	0/2	1/2	2/2
Water (including flavoured water)	1/1	0/3	0/2	1/2	2/2

Food items:

Only scored if the food items section of MFE survey completed for machine area.

	Available?		No. of Varieties?		
	Yes	No	<5	5-10	>10
Crisps and other savoury snacks	0/1	3/3	2/2	1/2	0/2
Chocolate confectionery	0/1	3/3	2/2	1/2	0/2
Cakes, muffins, sweet biscuits, pastries, cookies, flapjack etc	0/1	3/3	2/2	1/2	0/2
Cereal bars	0/1	3/3	2/2	1/2	0/2
Sweets	0/1	3/3	2/2	1/2	0/2
Savoury pies and pastries e.g. sausage rolls	0/1	3/3	2/2	1/2	0/2
Fruit including fruit salad and dried fruit	1/1	0/3	0/2	1/2	2/2
Sandwiches	1/1	0/3	0/2	1/2	2/2

Total score:

Total points scored (X) =

Total score (%) = $X/Y * 100$ = .

Total points available (Y) =

A higher percentage score indicates a 'more healthy' food environment.

Interview Topic Guide

Resources checklist – specific to individual being interviewed

- ☐ GPS output maps
- ☐ Food diary
- ☐ Photographs
- ☐ Visited food environment list
- ☐ Exposure food environment list

BEFORE INTERVIEW

Thank you for agreeing to take part in this interview. As you already know, in this study we are interested in looking at what you eat and where you get food from and this interview is designed to find out in more detail about the foods you eat and the shops and restaurants you visit.

The interview will last about an hour but it depends on how much you have to say. There are no right or wrong answers – you're the expert – I just want to hear what you have to say!

Everything you tell me in this interview is confidential; I won't tell anyone what you've said. When I've listened to the tape, I'll give you a pseudonym so that no one else will know your real name. I'll also change the names and details of anyone else you talk about in the interview so they can't be identified.

I would like to record this interview so that I don't need to write anything down now. Is that ok? The interview will be transcribed but anything identifying you to the interview will be changed to preserve confidentiality.

If you want me to stop the tape, or you feel uncomfortable talking about something, just say 'I want to stop now' and we'll stop the interview.

*****TURN ON VOICE RECORDER *****

INTERVIEW QUESTIONS/ PROMPTS

FOLLOW UP ANY LEADS TO DO WITH REASONS THEY EAT WHAT THEY EAT AND REASONS THEY VISIT THE FOOD OUTLETS THEY DO. PROBE FULLY ALL EXPLANATIONS.

Using food diary, GPS maps, photographs etc and discuss if this was typical day/behaviour.

Ask them to talk through a typical **WEEK DAY** (SCHOOL/ COLLEGE/ WORK/ HOLIDAY/ UNEMPLOYED) and integrate questions about weekends into this. Let the conversation flow naturally.

Note: we will have at least 2 days food diary data for week day and data for at least 1 weekend day for each participant

*Be careful not to give labels to meals unless the participant does so.

The following structure is a guide only.

Talk through food diary with participant.

Start with **breakfast** on a weekday

- Is _____ what you eat every morning?
- Is this what you normally do? Refer to place and time recorded in food diary.
- Do you eat different things in the morning?
- What time do you normally eat in the morning?
- How do you decide what to eat?
- Are there any times that this is different? E.g. weekend?
- Do you eat anything different for breakfast at weekend than weekday? If so, what is different?

Explore in detail:

- **What** did they have to eat?
- **Where** did they eat the food?
- What were the **factors influencing** this?

Morning snacks

*Be careful not to label 'snacks'

- I see you had _____ to eat/drink in the morning. Is this something you normally have?

Explore in detail:

- **What** did they have to eat?
- **Where** did they eat the food?
- What were the **factors influencing** this?

Lunch

- I see from your food diary that you went to Greggs, is that where you normally go? Who are you usually with when you go to Greggs? Are you always with Katie? No? What about when you're with your boyfriend/mum/etc? Where else do you get food during school/college? The chippy, when you're with your work mates. Anywhere else? How do you decide whether to go to Greggs or the chippy? What else helps you decide? [you don't need all this on topic guide, but I'm just highlighting how the conversation/probing should proceed]
- Where do they get food from for lunch? Different for weekend?
- If home, do they prepare the food themselves? Probe all who prepare food
- If out of home, where do they go and what kinds of food do they usually buy?
- Where do they eat lunch? Different to where they get food from?
- If at school/college etc – how long do you get for lunch? Are you allowed out of the school to get lunch (open/closed gate policies) ; what about work – how long do you get etc
- How do you pay for lunch if out of school – allowance, free school meals, parents, part time job?
- Any rules about where allowed to eat at school?

Explore in detail:

- **What** did they have to eat?
- **Where** did they eat the food?
- What were the **factors influencing** this?

Afternoon snack

*Be careful not to label 'snacks'

- I see you had _____ to eat/drink in the afternoon. Is this something you normally have?

Explore in detail:

- **What** did they have to eat?
- **Where** did they eat the food?
- What were the **factors influencing** this?

Dinner (tea)

- Where do you usually eat dinner?
- Home? Who prepares dinner usually? Are there any times in the week where this changes? What affects this? [go through the week for more details]
- Where is food from? Home cooked? Takeaway? REFER TO FOOD DIARY
- After you've eaten your evening meal, do you have anything else to eat?
- Who do you eat dinner with and where? Family/friends? At table/ in front of TV?
- Do you get to choose what you eat for dinner or does someone else decide?

Explore in detail:

- **What** did they have to eat?
- **Where** did they eat the food?
- What were the **factors influencing** this?

Supper

- Do you eat anything after dinner?
- Before you go to bed?
- From food diary – if been out clubbing etc – do you usually buy any food on way home e.g. chips or eat anything when get home?

General

- Who shops for food at home? Probe: all i.e. at supermarket
- How often do you have takeaways that you eat at home?
- When would you have these kinds of meals?
- Who pays for them? What do you order?
- ***REMEMBER TO ASK ABOUT DRINKS***

GPS maps – additional information

- Were there any time where you didn't take the GPS logger with you?
- When were these times?
- Do the maps accurately reflect how you spend your time on a week/weekend day? If not, what would usually be different?
- How do you get to x? (e.g. school) walk/car/cycle?

END OF INTERVIEW

Thank participant for time and input.

Answer any questions from the participant and allow them to add any information they feel is missing.

Tell participant what will happen now/to the information (e.g. will be analysed, anonymously and added to my overall PhD report and in presentations/papers I prepare).

Reassure confidentiality and anonymity.

Reimburse any travel expenses (if applicable) and give participant £10 gift voucher.

Individual Interviews: Topic Guide Additions

Additional questions were added to the interview topic guide following completion of the second interview in line with the ground theory approach to analysis.

Tried and tested favourites

1. How do you find your favourites?
2. Do you work your way through the whole menu? Copy friends?
3. How do you narrow your favourites down – how quickly?
4. How do you feel when a friend suggests you try a new restaurant or somewhere you've never been before?
5. Are the foods you eat when you eat out with friends different to those you would choose when with your family?

Family takeaway

1. Round the corner? 'local'

Human Nutrition Research Centre

M1.151 Leech Building
Medical School, Framlington Place
Newcastle upon Tyne, NE2 4HH

Dear:

Further to my email sent [date], please find enclosed two posters and 10 leaflets containing further information about the Measuring Food Environments (MFE) study. This is a study currently being conducted within the Human Nutrition Research Centre at Newcastle University and aims to identify the eating habits and sources of food for young people. The purpose of MFE is to better understand the food choices available to young people in Newcastle. We would like to invite your school participate in this research; we are looking to recruit a small number (5-10) of young people aged 16-18 years from your school.

What the young people will be asked to do:

- Complete a consent form
- Complete a Food Diary for 4 consecutive days
- Carry a GPS logger for the same 4 days
- Reply to one text message per day about the food they are eating
- Take photographs of the food they eat and where they eat it using their mobile phone (a digital camera will be provided if requested)
- Complete three short questionnaires
- Complete an hour long interview with a member of the Newcastle University research team at the end of diary completion
- Have their height, weight, waist and hip measurements taken by two members of the Newcastle University research team

This research can be conducted on school premises or arranged individually with volunteers visiting the university. If possible, we would like to give a short oral presentation about MFE to potential volunteers at [school/college name]. Please distribute the enclosed leaflets to students you feel would be interested in taking part.

Please note the time burden of completing the study is low and we envisage limited disruption to school work. All University research staff having any contact with young people holds enhanced CRB clearance.

All volunteers completing the study will receive a £10 Eldon Square voucher to thank them for their efforts. It is hoped that students will enjoy taking part in the study.

I look forward discussing your further involvement in the MFE study.

Yours sincerely,

Rachel Tyrrell
PhD Student, Newcastle University
R.L.Tyrrell@ncl.ac.uk
Telephone: 07725724574 or 0191 222 7648

Supervisor: Ashley Adamson
Professor of Public Health Nutrition
A.J.Adamson@ncl.ac.uk
Telephone: 0191 222 5276

WANTED! ARE YOU 16-18 YRS OLD? WE NEED YOU!



Newcastle University Researchers need volunteers to understand young people's food environments and contribute to health research.



We want to know:

- WHAT you eat and drink
- WHERE you get food

If you are interested in taking part you will be asked to complete a food diary, keep food receipts, take photographs of your food, carry a GPS logger and complete questionnaires. All information is private and confidential.

If you take part you will receive a **£10 Eldon Square Voucher** to say thanks!

If you are interested in taking part in this important research and would like more information please contact:

Rachel Tyrrell

Phone: 0191 222 7648

Text: 07725 724574

E-mail: food.environment@ncl.ac.uk



Newcastle
University

Contact Rachel:
food.environment@ncl.ac.uk

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Contact Rachel:
food.environment@ncl.ac.uk

Researcher: _____ Date: ____/____/____

Time GPS on: ____:____

Location GPS on: _____ (mark on fieldwork map)

Participant ID: _____ Diary day: _____

Area: _____

[illegible]

[illegible]

Food Outlet Classification Coding Rules

Food outlet	Classification decision
Outlets within the Metro Centre	Individual outlets counted once only regardless of number of floors occupied/ number of entrances
Outlets containing own brand café	Classify as 12.10 department store
Outlets containing other 'branded' café	e.g. Costa coffee within WH Smiths List and classify each outlet separately
Fenwick	Treat as shopping centre not department store List and classify individual branded outlets within Fenwick
Millies cookies	4.03 specialist takeaway
Pretzel stands	4.03 specialist takeaway
Chocolatier	E.g. Thorntons and Hotel Chocolat Classify as 9.09 candy/ sweet shop/ chocolate shop
Combination post office/ newsagent	Classify dependent on dominant signage outside of the outlet
Vending machines	Include in database as vending machine areas or 'shopping opportunities' and use level 1 classification (11). List and classify each individual vending machine present in the area in the notes section. Workplace vending machines to be classified as 15.06
Cake shops and cupcake stands	9.11 Bakers (specialist)
Subway and other sandwich brands	Classify as either 3.05 or 4.04 depending on seating arrangements
Canteen style cafes	1.2 buffet restaurant Except when located within department store (12.10)or staff canteen (15.06)
Hotel restaurants	Classify as traditional hotel (1.08) if only available to hotel guest and/or for functions e.g. need to visit hotel in order to visit restaurant. Hotel and restaurant share the same name. Other classifications may be used for food outlets associated with hotels. For example, a number of bars and restaurants located on Osborne Road are below/ associated with hotels, however, the clientele is mainly made up of general public not hotel guests. E.g. Osbornes bar would be classified as 1.06 pub fast casual.
Traditional type fish & chip shop	6.04 fast food
Churches	15.03 community centre Only included for visited food environment, churches not recorded in exposure food environment database
Art galleries	e.g. Laing, Newcastle Arts Centre 13.11 Art gallery
Cinema with branded food outlets	Classified as cinema with food outlet (13.02) Branded food outlets within cinema foyer listed and classified separately (e.g. Ben & Jerry's and costa)
Yo! Sushi	Classified as 1.04 fast casual restaurant
Bingo halls	e.g. gala bingo 13.07 amusements
Spud U Like	3.03 specialist café – fast food jacket potatoes

Food Outlet Geo-Coding Rules

Food outlet	Geo-coding decision
Metro centre	Use postcode centroid for outlets housed within metro centre building.
The Gate	Use entrance geo-tag for all outlets housed in The Gate.
Eldon Square	Use address postcode centroid for Eldon Square outlets.
Fenwick	Geo-code as Fenwick main entrance (Northumberland Street)
Vending Machines	Geo-code as 'vending machine areas'.
St James Park	Geo-code as postcode centroid – takes into account multiple entrances
Newgate Centre	Food outlets geo-coded individually.