Exploring the relationship between prevalence of overweight and obesity in 10-11 year olds and the outdoor physical environment in North East England

Rachel Gill Gallo

MA, BSc Hons

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School of Architecture Planning and Landscape

Newcastle University

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Abstract

Childhood overweight and obesity have been at the forefront of the public health agenda for a decade. Within this time a paradigm shift within medical and social sciences has altered the focus on personal determinants of obesity towards environmental and societal level influences. The neighbourhood environment is implicated in health, encompassing all aspects of the energy balance equation (i.e. physical activity (PA), diet and weight). Relatively little is known about neighbourhood-level health associations in young people, particularly within the UK. At the heart of this thesis is the Children's Neighbourhood Environment Study (CNES) which aimed to identify physical environment correlates and mediating factors of PA and dietary intake behaviours and resultant weight outcomes in young people (10–11 years) within the North East of England.

In response to persistent recommendations in obesogenic environment literature CNES applied a cross-disciplinary mixed-methods approach to research. This comprised: focus groups, participant-reported PA and dietary behaviours, participant and parent reported neighbourhood enviorment perceptions, objective (utilizing a GIS-based approach) and subjective neighbourhood environment measurement and appraisal.

Youth PA showed statistically significant *positive* association with park and green space access, total street length and total road length but *inverse* association with mixed land use; associations with other neighbourhood features did not reach statistical significance. Dietary intake showed *no* statistically significant association with the neighbourhood environment. Elevated weight status showed statistically significant *positive* association with mixed land use and the absence of cycling facilities; associations with other neighbourhood features did not reach statistical significance.

CNES adopted a robust and comprehensive cross-disciplinary approach, the first study of its kind in the UK. It implicates the neighbourhood environment in enabling and disabling PA behaviours and weight outcomes in young people. CNES has successfully identified strategic areas to target public health intervention and inform urban planning to facilitate health.

Dedication

This thesis is dedicated to John Carr. A man who instilled in me a love of learning. A man who believed in education.

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This thesis is only possible thanks to the participation of an incredible group of young people. Thank you for your diligence, enthusiasm and honesty. Your results have made for an interesting piece of work!

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Publications and Conferences

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Child and Teen Consumption Conference, Edinburgh University, 9th–11th April 2014, ‘Exploring the links between outdoor food and drink advertising, food and drink intakes and the BMI status of children in the North East of England’.

Table of Contents

Abstract i
Dedication iii
Acknowledgements iv
Publications and Conferences v
Table of Contents vi
List of Tables xv
List of Figures xix
List of Abbreviations xxiv
Chapter 1: Introduction 1
Chapter 2: Literature Review 3
Literature Overview 5
2.1 Physical Activity and the Environment 7
2.1.1 Parks 7
2.1.2 Recreation Facilities 9
2.1.3 Neighbourhood Land Use Mix 10
2.1.4 Road Safety 11
2.1.5 Neighbourhood Safety 11
2.1.6 Streets 12
2.1.7 Activity Environment Literature Conclusions 13
2.2 Dietary Intake and the Environment 13
2.2.1 Food Outlet Access 14
2.2.2 Food Outlet Proximity 16
2.2.3 Fast Food Outlets 16
2.2.4 Convenience Outlets 17
2.2.5 Grocers 17
2.2.6 Food Advertising 18
2.2.7 Food Environment Literature Conclusions 18
2.3 Literature Overview Summary 19
Systematic Literature Review 20
2.4 Literature Search 21

2.4.1 Key word searching 21
2.4.2 Hand searching 22
2.4.3 Integrity Check 23
2.5 Inclusion Criteria 23
2.6 Screening 24
2.7 Quality Assessment 25
2.8 Data Extraction 26
2.9 Narrative Synthesis 29
2.9.1 Theory 29
2.9.2 Synthesis 29
2.9.3 Interpretation 33
2.10 Review Strengths and Weaknesses 36
Literature Review Implications for Research 37
Chapter 3: Methodology and Methods 38
3.1 Methodology 38
3.1.1 Mixed Methods 38
3.2 Ethical Approval 39
3.3 Research Process Overview 39
3.4 Statistical Analysis 41
Case Study Site Selection and Participant Recruitment 42
3.5 School Selection 42
3.5.1 Urbanicity 43
3.5.2 Socio-Economic Status 44
3.5.3 Obesity Prevalence Rates 46
3.6 Participant Recruitment 47
3.6.1 Comprehension Testing 47
3.6.2 Activity and Dietary Intake Diary Feasibility and Validity Testing and Focus Group 47
3.6.3 Activity and Dietary Intake Diary Validity Testing and Pilot Study (pCNES) 48
3.6.4 Main Study (CNES) 48
Focus Group 50
Methods Development 52

3.7 Attitude, Perception and Behaviour Survey Comprehension Testing 52
3.8 Activity and Dietary Intake Diary 53
3.8.1 Young Person Expert Opinion 54
3.8.2 Field Professional Expert Opinion 54
3.8.3 Comprehension Testing 56
3.8.4 Feasibility and Validity Testing 58
3.8.5 Validity Testing 61
3.9 Outdoor Food and Drink Advertising Audit 62
3.9.1 Field Professional Expert Opinion 64
3.9.2 Feasibility Testing 64
3.9.3 Validity Testing 64
Pilot and Main Study 66
3.10 Self-Reported Activity Behaviour 67
3.10.1 Activity Instance 68
3.10.2 Activity Type and Coding 69
3.10.3 Activity Intensity 69
3.10.4 Activity Location 69
3.10.5 Activity Companion 71
3.10.6 Self-Report Activity Amendments 71
3.11 Self-Reported Dietary Intake 72
3.11.1 Eating Occasion 73
3.11.2 Dietary Composition and Coding 73
3.11.3 Food Sourcing Location 77
3.11.4 Eating Location 77
3.11.5 Eating Companion 77
3.11.6 Self-Report Dietary Intake Amendments 78
3.12 Photography 78
3.13 Participant Attitude, Perception and Behaviour Survey 79
3.14 Anthropometric Measurement 80
3.14.1 Measurement Protocol 81
3.15 Parent/ Guardian Attitude, Perception and Behavioural Survey 81
3.15.1 Neighbourhood Environment 82
3.15.2 Physical Activity 84

3.15.3 Home Food Environment 85
3.16 Neighbourhood Environment 86
3.16.1 Parks and Green Spaces 87
3.16.2 Sports Facilities 90
3.16.3 Non-Food Shops and Services 93
3.16.4 Food Outlets 94
3.16.5 Outdoor Food and Drink Advertising 97
3.16.6 Roads 100
3.16.7 Streets 104
3.16.8 Cyclability 106
Detailed Case Study 107
3.17 PA Case Study 108
3.18 Dietary Intake Case Study 109
3.19 BMI Case Study 110
Chapter 4: Results 111
Focus Group 112
4.1 Neighbourhood Environment 112
4.2 Neighbourhood Physical Activity 112
4.3 Dietary Intake 113
4.4 Neighbourhood Food Environment 114
4.5 Food and Drink Advertising 114
Pilot Study 116
4.6 Physical Activity 117
4.6.1 Activity Intensity 117
4.6.2 Activity Location 118
4.6.3 Activity Companion 120
4.7 Dietary Intake 120
4.7.1 Food Item Intake 121
4.7.2 Sourcing and Eating Location 123
4.7.3 Eating Companion 123
4.8 Physical Environment 123
4.9 Discussion and Amendments 123
CNES Participants 126

4.10 Participant Demographics and Anthropometrics 127
4.11 Self-Reported Diary Amendments 128
4.12 Photographic Data 128
4.13 Activity Behaviour 129
4.13.1 Activity Type 130
4.13.2 Activity Intensity 130
4.13.3 Activity Location 131
4.13.4 Activity Companion 133
4.14 Dietary Intake 135
4.14.1 Food Items 135
4.14.2 Dietary Composition 136
4.14.3 Sourcing Location 138
4.14.4 Eating Location 138
4.14.5 Eating Companion 139
4.15 Attitude, Perception and Behavioural Survey 141
4.15.1 IMD and BMI 142
4.15.2 Neighbourhood Active Travel and Physical Activity 143
4.15.3 Dietary Intake 143
Parent/ Guardian Perception, Attitude and Behavioural Survey 145
4.16 BMI and IMD 146
4.17 Child's Neighbourhood Activity and Active Travel 147
4.18 Child's Physical Activity 147
4.19 Child's Dietary Intake 147
Neighbourhood Environment 149
4.20 Parks and Green Spaces 149
4.20.1 Proximity 149
4.20.2 Environment and Quality Assessment 150
4.20.3 Participant Perceptions 151
4.20.4 Parent Perceptions 152
4.21 Sports Facilities 153
4.21.1 Participant Perceptions 154
4.21.2 Parent Perceptions 154
4.22 Non-Food Shops and Services 155

4.22.1 Proximity 155
4.22.2 Participant Perceptions 155
4.22.3 Parent Perceptions 156
4.23 Food Outlets 158
4.23.1 Proximity 159
4.23.2 Healthfulness 159
4.23.3 Participant Perceptions 161
4.23.4 Parental Perceptions 161
4.24 Outdoor Food and Drink Advertising 162
4.24.1 Proximity 163
4.24.2 Branding 163
4.24.3 Unique Selling Point 163
4.24.4 Target Audience 164
4.24.5 Location 165
4.25 Roads 166
4.25.1 Road Safety 167
4.25.2 Participant Perceptions 167
4.25.3 Parent Perceptions 168
4.26 Streets 169
4.26.1 Street Quality 169
4.26.2 Participant Perceptions 170
4.26.3 Parent Perceptions 170
4.27 Cycling Facilities 171
4.27.1 Parent Perceptions 171
Neighbourhood Environmental Influence on Physical Activity 173
4.28 Activity Case Overview 175
4.29 High Activity Reporter Case Pair 176
4.29.1 Physical Environment 180
4.29.2 Case Perceptions 182
4.29.3 Parent Perceptions 183
4.29.4 Case Behaviour 183
4.30 Low Activity Reporter Case Pair 186
4.30.1 Physical Environment 186

4.30.2 Case Perceptions....190
4.30.3 Parent Perceptions....191
4.30.4 Case Behaviour....192
Neighbourhood Environmental Influence on Dietary Intake....195
4.31 Dietary Intake Cases....197
Neighbourhood Environmental Influence on BMI....198
4.32 Male BMI Case Overview....199
4.33 Male Under and Healthy Weight Case Pair....200
4.33.1 Physical Environment....204
4.33.2 Case Perceptions....206
4.33.3 Parent Perceptions....207
4.33.4 Case Behaviour....208
4.34 Male Overweight and Obese Case Pair....211
4.34.1 Physical Environment....212
4.34.2 Case Perceptions....218
4.34.3 Parent Perceptions....219
4.34.4 Case Behaviour....219
4.35 Female BMI Case Overview....222
4.36 Female Under and Healthy Weight Case Pair....223
4.36.1 Physical Environment....223
4.36.2 Case Perceptions....229
4.36.3 Parent Perceptions....230
4.36.4 Case Behaviour....231
4.37 Female Overweight and Obese Case Pair....235
4.37.1 Physical Environment....235
4.37.2 Case Perceptions....240
4.37.3 Parent Perceptions....242
4.37.4 Case Behaviour....242
Chapter 5: Discussion and Conclusion....246
CNES Population Characteristics....247
5.1 Physical Activity....247
5.1.1 Active Time....247
5.1.2 Sedentary Time....248

5.2 Dietary Intake 249
5.2.1 Carbohydrate 250
5.2.2 Fruit and Vegetables 250
5.2.3 Protein 250
5.2.4 Foods and Drinks High in Fat and/ or Sugar 251
5.3 BMI 251
Neighbourhood Environment Influences on Physical Activity, Dietary Intake and BMI253
5.4 The Neighbourhood 253
5.5 Parks and GSs 255
5.5.1 Physical Activity 256
5.5.2 Dietary Intake 259
5.5.3 BMI 261
5.6 Sports Facilities 263
5.6.1 Physical Activity 264
5.6.2 Dietary Intake 267
5.6.3 BMI 268
5.7 Land Use Mix 270
5.7.1 Physical Activity 270
5.7.2 Dietary Intake 275
5.7.3 BMI 279
5.8 Outdoor Food and Drink Advertising 282
5.8.1 Dietary Intake 284
5.9 Walkability 286
5.9.1 Physical Activity 287
5.9.2 Dietary Intake 293
5.9.3 BMI 294
5.10 Cyclability 297
5.10.1 Physical Activity 298
5.10.2 BMI 300
Strengths and Limitations 303
5.11 Approach 303
5.12 Sample 304

5.13 Methods ... 305
5.13.1 Objective Exposure Measurement ... 305
5.13.2 Perceived Exposure Measurement ... 309
5.13.3 Objective Outcome Measurement ... 309
5.13.4 Subjective Outcome Measurement ... 310
5.14 Analysis ... 311
Overarching Conclusions ... 313
5.15 Research Contribution and Future Research Implications ... 313
5.15.1 Gender ... 313
5.15.2 Parks and GSs ... 315
5.15.3 Land Use Mix ... 315
5.15.4 Outdoor Food and Drink Advertising ... 316
5.15.5 Walkability ... 316
5.15.6 Cyclability ... 317
5.15.7 Neighbourhood Definition ... 317
5.15.8 Cross-Disciplinary Research ... 318
5.16 Recommendations to Academia ... 319
5.17 Recommendations to Government and Policy ... 321
5.18 Overall Conclusions ... 322
5.18.1 Environmental Correlates of Energy Expenditure ... 323
5.18.2 Environmental Correlates of Energy Intake ... 324
5.18.3 Environmental Correlates of Energy Balance ... 324
5.18.4 Personal Correlates ... 324
5.18.5 Concluding Remarks ... 325
Appendices ... 327
References ... 343

List of Tables

Table 1: Characteristics of papers included in the physical activity and the environment overview 8
Table 2: Characteristics of papers included in the dietary intake and the environment overview 15
Table 3: Literature search inclusion criteria 23
Table 4: Screened exclusion groupings 25
Table 5: Data extraction table (part 1 of 2) 27
Table 6: Overview of methods stages 40
Table 7: IMD quintiles for England, North East and North East Schools 45
Table 8: Obesity prevalence rate quintiles for England, North East and North East Schools 47
Table 9: School count per affluent and deprived IMD quintile and highest and lowest obesity (OB) prevalence rate quintile for England, North East, North East Schools 49
Table 10: Overview of activity and dietary intake diary method development and testing stages 53
Table 11: Cognitive interviewing questions, comments and diary amendments (n=5) 57
Table 12: PCERT scores for activity types and model answer (n=5) 58
Table 13: Activity and Dietary Intake Diary completion agreement between participant and researcher 59
Table 14: Eating occasion reporting agreement between diary and 24 hour recall (n=7) 62
Table 15: Overview of Outdoor Food and Drink Advertising Audit Tool method development and testing stage 63
Table 16: Validation results for Outdoor Food and Drink Advertisement Audit Tool 65
Table 17: Parent/ Guardian Survey: neighbourhood 83
Table 18: Parent/ Guardian Survey: physical activity 84

Table 19: Parent/Guardian Survey: dietary intake and food 85
Table 20: Park and Green Space grouping, sub-type and definition......................89
Table 21: Points of Interest Positional Accuracy, taken from Ordnance Survey (2010b) 91
Table 22: Sports Facility grouping, type and sub-type, taken from Ordnance Survey (2010a) 92
Table 23: Non-food shops and services grouping, type and definition...................95
Table 24: Food outlet groupings, types and sub-types 96
Table 25: Outdoor Food and Drink Advertising Audit Tool categories and definitions 99
Table 26: Road type and definition, taken from Ordnance Survey (2013a) 101
Table 27: Road Safety groupings and variables, taken from Millington et al. (2009) 104
Table 28: Street Quality groupings and variables, taken from Millington et al. (2009) 105
Table 29: Activity intensity MET classification...109
Table 30: Mean (SD) age, IMD score, height, weight and BMI and counts per BMI and ethnic groupings for total (n=12) and completing (n=7) pCNES samples 116
Table 31: Activity intensity PCERT and MET classification.................................118
Table 32: Daily mean, SD and range of food items by food group type (n=7)......122
Table 33: Location of food and drink sourcing and eating (count (%)) (n=7)........122
Table 34: Recruitment and CNES completion counts (%) by gender (n=118) 126
Table 35: Mean (SD) age, IMD score, height, weight and BMI score and counts per BMI and ethnic groupings by gender for CNES sample (n=108) 127
Table 36: Total and mean (SD) photo counts by gender (n=106)........................129
Table 37: Total, mean (SD) and range of participant self-reported activity instances and activity time (in minutes) by gender (n=108) 129
Table 38: Activity type by activity intensity category 130
Table 39: Four day total and daily mean (SD) food item counts per eating occasion by gender (n=108) 136
Table 40: Daily mean, SD and range of food items by food group type (n=108)..136
Table 41: Participant perception, attitude and behaviour survey response by response category and associations with BMI and IMD (H (p)) (n=107).............142

Table 42: Mean (SD) IMD and BMI scores and counts per ethnic, relationship to child and academic achievement groupings by gender for CNES parent population (n=67) 145
Table 43: Total count (N) (neighbourhood count (NC)), mean, SD and range of GS provision and proximity (in meters) in all participant neighbourhoods (n=108) 149
Table 44: Total count (N), neighbourhood count (NC), mean, SD and range of sports facility provision and proximity (in meters) in all participant neighbourhoods and in those with at least one target facility (n=108) 153
Table 45: Count (n) and percentage total (%), neighbourhood count (NC), mean, SD and range of non-food shops and services in all participant neighbourhoods by grouping and type (n=108) 156
Table 46: Mean, SD and range of proximity (in meters) of all non-food shops and service by grouping in all participant neighbourhoods and in those with at least one (>1) target shop or service (neighbourhood count (NC)) (n=108) 156
Table 47: Total count (N), neighbourhood count (NC), percentage contribution to total food outlets (%), mean, SD and range by outlet grouping and type (n=108) 158
Table 48: Food outlet proximity (in metres) mean, SD and range by neighbourhood count (NC) in all participant neighbourhoods and those with at least one target food outlet by grouping (n=108) 159
Table 49: Total count (N), percentage (%) contribution to total food outlets, percentage contribution by outlet type, and basis for not auditing by grouping 160
Table 50: Count (N), percentage food outlet type (%), mean healthfulness score (higher score indicates health), SD and range of scores by food outlet grouping and type (n=108) 160
Table 51: Count (N), neighbourhood count (NC), percentage total (%), mean, SD and range of full food and drink adverts in all participant neighbourhoods (n=108) 162
Table 52: Full food and drink advert proximity (in meters) mean, SD and range by neighbourhood count (NC) in all participant neighbourhoods and in those with at least one target advertising media (n=108) 163
Table 53: Total, mean, SD and range of road and street lengths (in meters) by type in all participant neighbourhoods and only those containing at least some target road or street type (neighbourhood count (NC)) (n=108) 166

Table 54: Mean, SD and range of safety enhancing facilities per neighbourhood and street segment 167
Table 55: All and A road length, intersection density, road safety score, all street length and quality associations with parent perceptions of the neighbourhood environment (H or F and (p values)) (n=67) 168
Table 56: Mean (%), SD and range of street quality variables 170
Table 57: Binary logistic regression model of neighbourhood environment on PA (n=108) 174
Table 58: High activity reporter case pair neighbourhood environment variable count (N), percentage (%), and proximity (in metres) 179
Table 59: Low activity reporter case pair neighbourhood environment variable count (N), percentage (%), and proximity in metres 189
Table 60: Binary logistic regression model of neighbourhood environment on dietary intake (n=108) 196
Table 61: Binary logistic regression model of neighbourhood environment influence on BMI (n=108) 199
Table 62: Under and healthy weight male case pair neighbourhood environment variable count (N), percentage (%), and proximity (in metres) 203
Table 63: Overweight and obese male case pair neighbourhood environment variable count (N), percentage (%), and proximity (in metres) 215
Table 64: Under and healthy weight female case pair neighbourhood environment variable count (N), percentage (%), and proximity (in metres) 226
Table 65: Overweight and obese female case pair neighbourhood environment variable count (N), percentage (%), and proximity (in metres) 238
Table 66: Summary of neighbourhood environment amenities and health outcome associations 254
Table 67: Summary of key research contributions (significant associations only) 314
Table 68: CNES height and weight measurement protocol (informed by and consistent with NCMP protocol (Department of Health Obesity Team and Department for Education, 2011)) 340

List of Figures

Figure 1: Trend of number of obesogenic environment publications found on Medline (Ovid), Embase (Ovid) and Scopus 4

Figure 2: Systematic review process overview 21

Figure 3: Systematic review overview 24

Figure 4: Ecological Model depicting the four domains of active living taken from Sallis et al. (2006) 30

Figure 5: Ecological framework depicting the influences on what people eat taken from Story et al. (2008) 31

Figure 6: Purposeful school selection by socioeconomic status and obesity prevalence rate 43

Figure 7: Urban/ rural classification of North East primary schools by MSOA 45

Figure 8: Children's Neighbourhood Environment Study process 67

Figure 9: Participant #439 school day afternoon and evening activity 70

Figure 10: Pictorial Children's Effort Rating Table taken from (Yelling et al., 2002) 71

Figure 11: Participant #414 weekend day morning dietary intake 74

Figure 12: Participant #402 school day lunch 76

Figure 13: Participant #402 weekend evening meal part 1 76

Figure 14: Participant #402 weekend evening meal part 2 76

Figure 15: Participant Attitude, Perception and Behaviour Survey 80

Figure 16: Park and GS proximity to home postcode for participant #418 90

Figure 17: Road intersection and street segment with aligning road and street ... 102

Figure 18: Ten percent street segment selection 102

Figure 19: Cross tabulation and case selection process for BMI 'observed' and 'predicted' categories (under/ healthy weight (UHW) and overweight/ obese (OWOB)) 108

Figure 20: Mean activity time (minutes) per day by activity intensity (n=7) 119

Figure 21: Percentage of reported time per activity intensity by location (n=7) 119

Figure 22: Percentage of reported time with companion type per activity intensity (n=7) 120
Figure 23: Mean daily food item count per eating occasion by gender for school (SD) and weekend (WE) days (n=7) 121
Figure 24: Recommended and observed mean dietary intake (by serving and food item count) 122
Figure 25: Mean activity time per day by activity intensity and gender (n=108)...131
Figure 26: Percentage of reported time per activity intensity by location for male participants (n=45) 132
Figure 27: Percentage of reported time per activity intensity by location for female participants (n=63) 132
Figure 28: Percentage reported time per activity intensity by companion grouping for male participants (n=45) 133
Figure 29: Percentage reported time per activity intensity by companion grouping for female participants (n=63) 134
Figure 30: Mean daily food item count per eating occasion by gender for school (SD) and weekend (WE) days (n=108) 135
Figure 31: Observed dietary intake (food item count) comparative to Eatwell recommended intake (servings)...137
Figure 32: Proportion of total diet and drink consumption per food and drink type by gender (n=108) 137
Figure 33: Proportion of total eating occasions by eating location by BMI category (n=108) 139
Figure 34: Proportion of total eating occasions by food sourcing location by IMD quintile (IMD quintile 1 most affluent, IMD quintile 5 most deprived) (n=108) 140
Figure 35: Participant perception, attitude and behaviour (involvement) survey response by response category and gender (n=107) 142
Figure 36: Parent perception (yellow), frequency (red) and permissiveness (purple) survey responses by response category (n=67) 146
Figure 37: Amenity GS playground and safety facilities.......................................150
Figure 38: Semi-natural GS facility 150
Figure 39: Amenity and Semi-Natural GS facility counts by type in all participant neighbourhoods and only those containing at least one target facility (>1)..........151

Figure 40: Food and drink adverts USP price and promotion 164
Figure 41: Food and drink adverts targeted at ‘general public’ and ‘children and teenagers’ 164
Figure 42: Food and drink advert count by type and location 165
Figure 43: On-road cycle lanes..172
Figure 44: Mean neighbourhood environment variable counts per observed/ predicted PA grouping with overlying cases 176
Figure 45: High activity reporter typical case James (participant #437) neighbourhood environment (from postcode centroid)...177
Figure 46: High activity reporter deviant case Ella (participant #450) neighbourhood environment (from postcode centroid) 178
Figure 47: James’s neighbourhood Amenity GSs (GS #3008 and #3022)...........180
Figure 48: Ella’s neighbourhood Semi-Natural GS (GS #4249)...........................181
Figure 49: Ella’s neighbourhood street segments sample 182
Figure 50: James’s neighbourhood street segments sample...............................182
Figure 51: Ella playing in Amenity GS (GS #4195) 184
Figure 52: Low activity reporter typical case Chloe (participant #403) neighbourhood environment (from postcode centroid)...187
Figure 53: Low activity reporter deviant case Ben (participant #515) neighbourhood environment (from postcode centroid) 188
Figure 54: Ben’s neighbourhood street segments sample 191
Figure 55: Chloe’s neighbourhood street segments sample 191
Figure 56: Mean neighbourhood environment variable counts per observed/ predicted BMI grouping with overlying cases for male participants......................200
Figure 57: Under and healthy weight typical male case Tom (participant #511) neighbourhood environment (from postcode centroid)...201
Figure 58: Under and healthy weight deviant male case Chris (participant #507) neighbourhood environment (from postcode centroid)...202
Figure 59: Chris’s neighbourhood Amenity GSs (GSs #8001, #8127, #8156 and #8343)...204
Figure 60: Tom’s neighbourhood Amenity GS (GS #8455)..................................205
Figure 61: Tom’s neighbourhood street segments sample 207
Figure 62: Chris’s neighbourhood street segments sample 207

Figure 63: Josh’s neighbourhood Amenity GSs (GSs #8145 and #8148)............212
Figure 64: Overweight and obese typical male case Josh (participant #514) neighbourhood environment (from postcode centroid)...213
Figure 65: Overweight and obese deviant male case Luke (participant #401) neighbourhood environment (from postcode centroid)...214
Figure 66: Sample of Grocers in Josh’s neighbourhood 216
Figure 67: Sample of Sit-down eateries in Josh’s neighbourhood 216
Figure 68: Sample of Sit-down eateries in Luke’s neighbourhood 216
Figure 69: Josh’s neighbourhood street segments sample..................................218
Figure 70: Luke’s neighbourhood street segments sample..................................218
Figure 71: Luke’s garden 220
Figure 72: Mean neighbourhood environment variable counts per observed/ predicted BMI grouping with overlying cases for female participants...................223
Figure 73: Healthy weight typical female case Lucy (participant #448) neighbourhood environment (from postcode centroid)...224
Figure 74: Healthy weight deviant female case Sara (participant #491) neighbourhood environment (from postcode centroid)...225
Figure 75: Lucy’s neighbourhood Amenity GS (GS #4122) 228
Figure 76: Sara’s neighbourhood Amenity GSs (GS #7224 and #7228).............228
Figure 77: Lucy’s neighbourhood street segments sample..................................230
Figure 78: Sara’s neighbourhood street segments sample..................................230
Figure 79: Sample of Sara’s school trip sports facility images 232
Figure 80: Overweight and obese typical female case Ruth (participant #405) neighbourhood environment (from postcode centroid)...236
Figure 81: Overweight and obese deviant female case Freya (participant #432) neighbourhood environment (from postcode centroid)...237
Figure 82: Sample of Takeaway eateries in Ruth’s neighbourhood.....................239
Figure 83: Sample of Takeaway eateries in Freya’s neighbourhood 239
Figure 84: Ruth’s neighbourhood street segments sample..................................241
Figure 85: Freya’s neighbourhood street segments sample 241
Figure 86: Freya’s garden...243
Figure 87: BMI category prevalence rates for CNES, National and Regional NCMP, by gender...252

Figure 88: Ethical approval final draft (part 1 of 10) 328
Figure 89: Exert from four day Activity and Dietary Intake Diary (part 1 of 2) 338
Figure 90: Outdoor Food and Drink Advertising Tool...341
Figure 91: Parent/ Guardian Attitude, Perception and Behavioural Survey 342

List of Abbreviations

BMI	Body Mass Index
CNES	Children’s Neighbourhood Environment Study
GIS	Geographic Information System
GPS	Global Positioning System
GS	Green space
HA	High activity
HFS	High fat and/ or sugar
HFSS	High fat, salt and/ or sugar
HSE	Health Survey for England
IMD	Indices of Multiple Deprivation
KG	Kilogram(s)
LA	Low activity
LFS	Low fat and/ or sugar
M	Metre(s)
MSOA	Medium super output area
NPPF	National Planning Policy Framework
NCMP	National Child Measurement Programme
OFDAAT	Outdoor Food and Drink Advertising Audit Tool
OPAT	Observational Park Audit Tool
OB	Obese/ obesity
OWOB	Overweight and Obese
PA	Physical activity
PCERT	Pictorial Children’s Effort Rating Table

POI	Points of Interest
pCNES	Pilot Children’s Neighbourhood Environment Study
SD	Standard Deviation
UHW	Under and Healthy weight
USP	Unique selling point

Statistical Test Abbreviations:

df	Degrees of freedom
F	ANOVA
H	Kruskal Wallis
p	p value
r	Pearson's R
rs	Spearmans r
χ2	Chi squared
Z	Mann-Whitney U
T	Wilcoxon Signed Ranks Test
t	T-test

Chapter 1: Introduction

This research was funded by the Economic and Social Research Council in association with the North East Public Health Observatory. The aim of this thesis was to implement a cross-disciplinary approach to the examination of the obesogenic environment, with the critical purpose of exposing physical and built environment influences on health behaviours and outcomes, within a case study neighbourhood locale.

Obesogenic environment literature is well established within the US and Australia and there is compelling evidence associating neighbourhood environmental influence and health behaviours and outcomes (Beaulac *et al.*, 2009; Feng *et al.*, 2010; Mackenbach *et al.*, 2014). On the contrary, there is relatively little research within a UK context; consequently understanding of *national* applicability of *international* findings remains unclear (Lake and Townshend, 2006; Townshend and Lake, 2009). This is especially true of research on young people within this context therefore this was the population group of interest (Davison and Lawson, 2006; Ding *et al.*, 2011; Caspi *et al.*, 2012).

The thesis is structured as follows:

Chapter 2: Literature Review

This chapter is divided into three sections. Firstly, the Literature Overview outlines established knowledge in the field of obesogenic environment research contextualising this thesis. To ensure succinctness of the overview review and commentary papers were favoured. Secondly the Systematic Literature Review and corresponding narrative synthesis are presented. Thirdly Literature Review Implications for Research are briefly discoursed and Research Objectives outlined.

Chapter 3: Methodology and Methods

This chapter outlines the mixed methods approach adopted in this research; methods development and testing; and final research methods employed. Methods development and testing contributed a significant proportion of time within this research process, accordingly this chapter is comprehensive. Each method and protocol is described, and the use of that method justified.

Chapter 4: Results

This chapter is divided into eight distinct, but interconnected sub-sections. Firstly, the exploratory Focus Group results are presented thematically. Secondly preliminary results from the pilot study are outlined and methods and protocol amendments are detailed. Thirdly and fourthly characteristics of the main study sample and parents (of the main study sample) are outlined. Fifthly neighbourhood physical, built and food environments variables are outlined descriptively then discussed in relation to participant and parent perceptions. Finally, neighbourhood environment influences on physical activity (PA), dietary intake and BMI are explored using binary logistic regression and detailed case study interrogation.

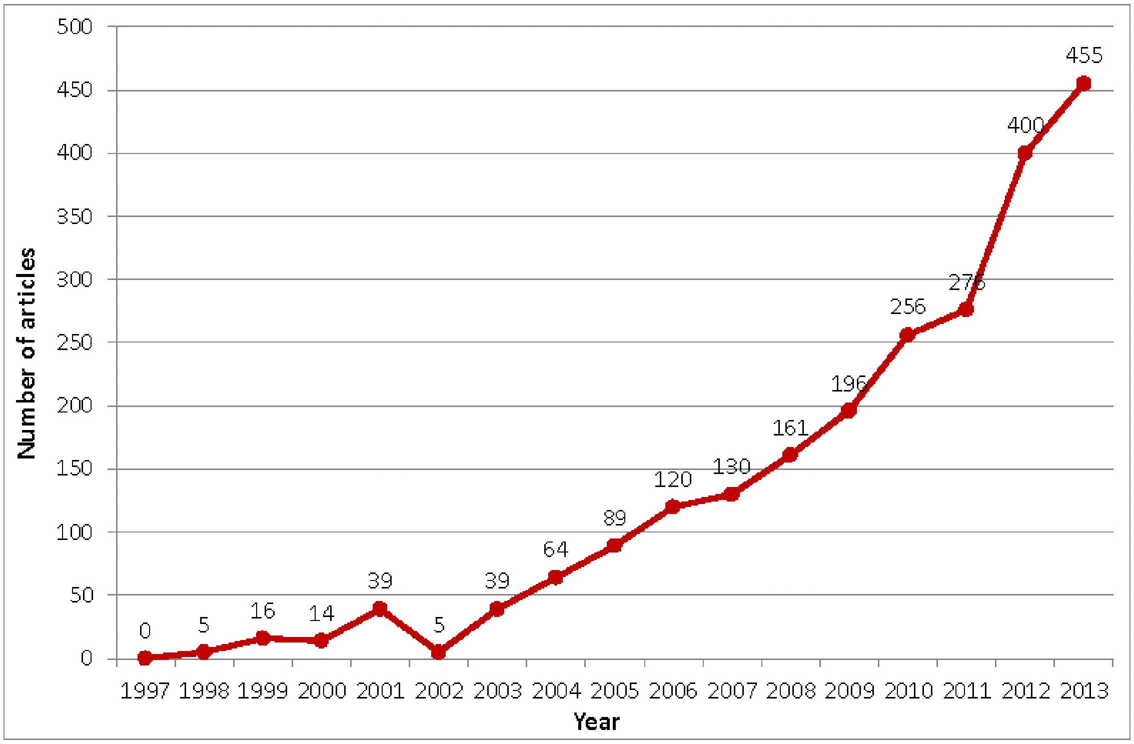
Chapter 5: Discussion and Conclusion

Research findings are discussed in relation to wider literature with resultant conclusions drawn within the Discussion and Conclusions chapter. The chapter is divided into four sections: firstly population characteristics comprising active and sedentary time, dietary intake and BMI are discussed in relation to published studies. Secondly, neighbourhood environment influences on PA, dietary intake and BMI according to binary logistic regression associations are discoursed. This section is further sub-divided according to distinct neighbourhood amenity types and their influences on health behaviours (PA and dietary intake) and outcome (BMI) are discussed in turn. Thirdly strengths and limitations of the research approach, sampling, methods application and analysis are discussed. Finally overarching conclusions comprising: research contribution, research implications for future research and policy; and closing remarks addressing research objectives are presented.

Chapter 2: Literature Review

There was a multi-pronged approach to reviewing the literature in this thesis; see Table 6 which outlines research structure. During the initial phases of problem exploration and objective formation (2009–2010), and throughout methods formulation and testing the approach to literature searching was both targeted (by key word and named author database searching and email alerts) and iterative using snowball reference list searching. The literature which guided these phases and the broader contextualisation of research is embedded and discussed within relevant chapters.

This Literature Review Chapter comprises a Literature Overview which highlights key findings from literature reviews and commentaries. This section will act to contextualise this thesis. As an extension to the Literature Overview, a Systematic Literature Review was conducted. This targeted and organised approach to literature searching was conducted within the year of thesis submission (2014). Though unusual to complete a comprehensive literature search and review at the end of the thesis, this was deemed the most appropriate time-point taking into consideration the exponential growth of obesogenic environment literature within the past decade, and particularly the past five years. See Figure 1 for a graphic illustration of this trend, figure created by author for illustrative purposes. The Systematic Review offers the reader a robust overview of timely and study population generation-specific research. Finally the implications of the Literature Review chapter as a whole are discussed and thesis Research Objectives are outlined.



Source: Medline (Ovid), Embase (Ovid) and Scopus search terms: "childhood overweight", "childhood obesity" and environment, June 2014

Figure 1: Trend of number of obesogenic environment publications found on Medline (Ovid), Embase (Ovid) and Scopus

Literature Overview

This section outlines established knowledge in the field of obesogenic environment research drawing on conclusions from key review and commentary papers.

Overweight and obesity (onwardly referred to as obesity) have been at the forefront of the public health agenda for the last decade. In the UK current obesity prevalence rates sit at 33.3 and 22.2 per cent for young people aged 10–11 and 4–5 years, respectively (Public Health England *et al.*, 2013). Childhood obesity represents significant concern for health both in the short and long term (Avenell *et al.*, 2004; Lobstein *et al.*, 2004; World Health Organization, 2009; Reilly and Kelly, 2010). Paediatric obesity is strongly associated with obesity in adulthood (Craigie *et al.*, 2009; The *et al.*, 2010; Brisbois *et al.*, 2012); similarly body mass index (BMI), dietary patterns and habits, physical activity and inactivity behaviours are shown to track into adulthood (van der Horst *et al.*, 2007; Monasta *et al.*, 2010; Craigie *et al.*, 2011; Pearson *et al.*, 2011). Once developed, obesity is difficult to treat; consequently prevention programmes aimed at children are considered a high priority (Waters *et al.*, 2011).

It is widely accepted that individual level changes in genes, biology, and psychology cannot explain the exponential rise in obesity in the past 10 years due to the pace at which the rise was observed, i.e. insufficient time for significant gene pool change (Hill and Peters, 1998; Koplan and Dietz, 1999; Kumanyika, 2007). Explanation therefore, must be sought amidst the broader environmental, societal and political changes.

In response to worldwide rising obesity rates and the ensuing rise in noncommunicable disease rates the World Health Organization (2004) launched a Global Strategy on Diet, Physical Activity and Health which highlighted the need to recognize *"the complex interactions between personal choices, social norms and economic and environmental factors"* (p. 5). Here, the 'complete' environment was seen to be positioned as both *causative of* and viably *preventative to* the obesity epidemic. The UK response to this call was the 2007 Foresight Report which outlined the multi-level influences on obesity comprising: biology, individual psychology, societal influence, food production, food consumption, individual activity and the activity environment. These influences were graphically depicted on an Obesity System Map the centre of which comprised three interlocking loops representative of: biological control of weight maintenance; potential for physical and social environments to override biological control; and cognitive ability to override biological, physical and social factors (Butland *et al.*, 2007). These international and national health agency reports initiated a paradigm shift in medical and social sciences focus from personal biological and psychological determinants of obesity towards environmental and societal level influences.

The central concept resultant from this shift was the study of the *obesogenic environment*. In their seminal paper Swinburn *et al.* (1999) defined the obesogenic environment as the *"the sum of influences that the surroundings, opportunities, or conditions of life have on promoting obesity in individuals or populations"* (p. 564). Authors described elements of the environment as either barriers or enablers to healthy weight status. These barriers and enablers align to the two aspects of the energy balance equation: energy intake and expenditure.

Obesogenic environment literature is extensive and growing exponentially (see Figure 1). This section of the thesis will be deliberately streamlined in an effort to provide a succinct topic overview; there is consequently a focus on review and commentary papers. This section is divided into two sub-sections: energy expenditure (physical activity) and energy intake (dietary intake) environments, so aligning to common literature distinctions. With the focus of this thesis being young people (10–11 years), only research on and with this population group is preferenced.

2.1 Physical Activity and the Environment

Physical activity (PA) environments are places where people can be physically active and engage in daily activities. Notable environments where young people spend most of their time therefore comprise: home, neighbourhoods, childcare settings, schools and recreation sites.

To provide a comprehensive synopsis of physical environment influences on young people's PA, and more broadly obesity, reviews and commentaries were identified from the following sources:

- On Scopus using key words: physical activity, physical environment, neighbourhood environment, review, systematic review, commentary, young and child/ children;
- Papers identified by Scopus search pertaining to dietary intake and the environment, see section 2.2 (page 13);
- Papers identified during the course of the thesis, see section 2.4.1 (page 21) for full details; and
- Papers acquired as part of the Systematic Review process see section 2.4 (page 21).

Table 1 outlines the principal characteristics of the review and commentary papers included in this overview. This sub-section is further sub-divided thematically, drawing out and discussing key environments identified in literature and their influence on PA in young people: Parks, Recreation Facilities, Neighbourhood Land Use, Road Safety, Neighbourhood Safety and Streets. The section culminates in an overview of activity environment research conclusions (section 2.1.7).

2.1.1 Parks

Neighbourhood parks were measured in literature according to proximity (or closeness from a given locale i.e. home postcode) and access/ availability (or enumeration/ facility count); for the purpose of this overview the terminology access shall be used.

Paper	Paper type	Age range/ search term	Publication years	Paper n=	Proportion US studies	Theme
Aziz & Said (2012)	Review	Children	1985–2010	30	Not reported	Children's use of the outdoors
Casey *et al.* (2014)	Review	Children & adolescents	≤2014	25	19 (76%)	Built environment & BMI
Carter & Dubois (2010)	Review	2–18 years	≤2009	27	16 (59%)	Physical & social neighbourhood environments & adiposity
Davison & Lawson (2006)	Review	Child, youth & adolescent	Not specified	33	12 (36%)	Environmental attributes & PA in children
Ding *et al.* (2011)	Review	3–18 years*	2002–2010	103	68 (66%)	Environmental attributes & PA in youth
Ferreira *et al.* (2007)	Review	3–18 years*	1980–2004	150	106 (71%)	Environmental factors & PA in youth
Limstrand (2008)	Review	3–19 years	≤2006	43	28 (65%)	Sports facility influence on PA in young people
McCormack *et al.* (2010)	Review	All	≤2009	21	11 (52%)	Qualitative exploration of association between urban parks & PA
Pate *et al.* (2013)	Review	5–18 years	1990–2011	61	Not reported	Factors predicting the development of excessive fatness in young people
Pont *et al.* (2009)	Review	5–18 years	1985–2008	38	17 (44%)	Environmental correlates of active transportation
Sallis *et al.* (2000)	Review	3–18 years*	1970–1988	108	86 (80%)	Correlates of youth PA
de Vet *et al.* (2011)	Review of reviews	3–18 years*	≤2009	671 (18 reviews)	Not reported	Environmental influences on weight related behaviours in young people
Saelens & Handy (2008)	Review of reviews	All	Reviews 2002–2006, papers 2005–2006	29 (& 13 reviews)	Not reported	Built environment & walking
Sallis & Glanz (2006)	Commentary	Children, youth & adolescents	Not specified	N/A	N/A	Built environment influence on PA & obesity in children
Ward Thompson (2013)	Commentary	All	Not specified	N/A	N/A	Outdoor environment & PA

** Child 3–12 years, adolescent 13–18 years*

Table 1: Characteristics of papers included in the physical activity and the environment overview

Park *access* was cited by de Vet *et al.* (2011), Sallis and Glanz (2006) and Limstrand (2008) to be positively associated with PA in young people. Park access was also reported to be positively associated with park use (McCormack *et al.*, 2010); neighbourhood active travel (Pont *et al.*, 2009) and generally inversely associated with BMI (Carter and Dubois, 2010; Pate *et al.*, 2013; Casey *et al.*, 2014). Davison and Lawson (2006) reported less conclusive findings but a slant towards positive association. Authors reported consistent positive association between PA and park access in studies employing self-reported PA measures but no association in studies employing objective accelerometer measured PA. This result wasn't mirrored in findings from Ding *et al.* (2011); here authors reported a summative trend towards null association across both objective and reported PA measurement. In children aged 3–12 years positive association was marginally more consistently positive in studies employing objective rather than reported PA measurement, the reverse was true for adolescents aged 13–18 years. Ding *et al.* despite concluding that inconsistent findings precluded assertion of positive association, found no studies that reported negative association.

Aziz and Said (2012) and McCormack *et al.* (2010) emphasize the importance of physically challenging play equipment as a key contributor towards young people's PA within parks and the function of this feature as an attractor to these spaces. Other facilities are also discussed as facilitators of park use, comprising but not limited to: open space, natural trails, and general amenities (e.g. paving, seating and toilets) (McCormack *et al.*, 2010; Ward Thompson, 2013). Sallis and Glanz (2006) link neighbourhood PA with recreational facility attractiveness; correspondingly McCormack *et al.* (2010) reported poor park maintenance as a usage deterrent.

2.1.2 Recreation Facilities

Recreational facilities are broadly defined in literature as commercial leisure facilities and PA programmes[1]. de Vet *et al.* (2011), Ding *et al.* (2011), Limstrand (2008), Davison and Lawson (2006), Sallis and Glanz (2006) and Sallis *et al.* (2000) all cited neighbourhood access to recreational facilities as being positively related to PA in young people. Pate *et al.* (2013) further reported an inverse association between access to recreational facilities and BMI. Notably three papers

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[1] Leisure facility examples: leisure centres, climbing walls and dance schools. PA programme examples: sports/ dance teams/ clubs or one-off sporting events.

reported stronger association in girls than boys which may indicate a higher dependency on formalised recreation in girls than boys (Davison and Lawson, 2006; Sallis and Glanz, 2006; Pate *et al.*, 2013).

Conversely Ferreira *et al.* (2007) concluded that there was a null association between proximity to recreational facilities and access to recreational programmes. Papers included in this review investigated *access to* recreational programmes more frequently than *proximity*. Notwithstanding the null conclusion, recreational programme access showed greater positive association with adolescents than children which may indicate higher reliance on formalised PA with increasing age.

2.1.3 Neighbourhood Land Use Mix

Mixed land use refers to the composite of residential, commercial, cultural, institutional, or industrial uses within a given area or environment. Ding *et al.* (2011) consistently reported mixed or commercial neighbourhood land-use as a positive correlate of PA in children and adolescents. Furthermore Pont *et al.* (2009) cited distance to a destination as inversely associated with active travel. In the review by Davison and Lawson (2006), neighbourhood retail destinations were consistently positively associated with PA in adolescent males, findings from adolescent females however were less conclusive.

de Vet *et al.* (2011), Limstrand (2008) and Davison and Lawson (2006) reported negative association between *distance* to neighbourhood parks, recreation facilities and schools and PA in young people. Correspondingly Pont *et al.* (2009) and Sallis and Glanz (2006) reported positive association between active travel and close proximity to parks and recreation facilities. Saelens and Handy (2008) and Davison and Lawson (2006) reported consistent inverse association with increasing distance to school and active travel. Though not inherently a discussion on mixed land use these results emphasise the importance of neighbourhood amenity proximity, a feature of mixed land use, on PA in young people.

2.1.4 Road Safety

Road safety broadly comprises measurement of: traffic speed and density, number of roads to cross, presence of road barriers and overarching pedestrian and cyclist safety. Neighbourhood active travel and PA are consistently shown in literature to be inversely associated with traffic/ poor road safety (Davison and Lawson, 2006; Sallis and Glanz, 2006; Limstrand, 2008; Saelens and Handy, 2008; Pont *et al.*, 2009; Ding *et al.*, 2011; Aziz and Said, 2012). Ding *et al.* (2011) reported stronger association in younger children compared to adolescents.

In their review of reviews de Vet *et al.* (2011) concluded neighbourhood traffic safety was unrelated to PA. This counter-intuitive result likely stems from the high proportion of non-significant associations observed in literature. This is potentially a consequence of inconsistency between perceived and objective measurement of PA and road safety and the resultant associations. Alternately it may be the product of inconsistent measurement of road safety features.

2.1.5 Neighbourhood Safety

In literature neighbourhood safety comprises objectively measured factors for example crime incidence, disorder and area deprivation, as well as perception of these factors from children, adolescents and parents. Reviews consistently report null association between neighbourhood safety, PA and active travel (Davison and Lawson, 2006; Ferreira *et al.*, 2007; Limstrand, 2008; Pont *et al.*, 2009; de Vet *et al.*, 2011; Ding *et al.*, 2011). Furthermore Carter and Dubois (2010) also reported null association with neighbourhood safety and adiposity. This null association is surprising taken in conjunction with the widely accepted contemporary culture belief that parents limit time spent outdoor by children due to safety concerns and stranger danger (Martin, 2008; Carter, 2014). A number of explanations were proposed for this null result: lack of measurement consistency ensuing to challenging collective summation; greater importance of the social environment as a measure of neighbourhood safety; and high levels of PA being performed outside the neighbourhood environment. Generally a ‘more evidence is required’ statement was concluded.

Broadly positive association was cited between neighbourhood safety and neighbourhood sports facility usage by Davison and Lawson (2006), Limstrand (2008) and McCormack *et al.* (2010).

2.1.6 Streets

Pavements are consistently shown in literature to be enabling of both active travel and PA (Davison and Lawson, 2006; Sallis and Glanz, 2006; Limstrand, 2008; Saelens and Handy, 2008; Ding *et al.*, 2011). Likewise Pont *et al.* (2009) reported broadly positive association between pavements and active travel though only half of the included studies reported significant association.

Street *crossing safety aids* (e.g. zebra and pelican crossings) were highlighted by Sallis and Glanz (2006) as being enabling of active travel, as was low road crossing frequency necessity. Ding *et al.* (2011) reported broadly positive association between pedestrian safety features (undefined) and PA.

Counter-intuitively Davison and Lawson (2006) reported presence of *cycle lanes* were inversely associated with cycling; this result was however deemed spurious due to insensitive research methods. Conversely Limstrand (2008) observed association with cycle lanes and cycling in the expected direction.

It is generally concluded that low *street connectivity*[2] is enabling of neighbourhood PA in young people, but disabling in adolescents (Ding *et al.*, 2011; Aziz and Said, 2012). Neighbourhoods with low street connectivity are characterised by having a predominance of cul-de-sacs or low-traffic areas that provide locations for children's safe outdoor play. Such low connectivity is seen as a barrier to neighbourhood active travel due to necessary protracted walking distances. Carter and Dubois (2010) reported inconsistent findings between connectivity and

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[2] Street connectivity is broadly defined as street intersection density. For example street designs with high levels of cul-de-sacs have low connectivity (or low intersection density) whereas grid designs have high connectivity (or high intersection density).

childhood adiposity; young people likely use the neighbourhood environment for both active transport and leisure-time PA, this mixed usage may be the cause of observed inconsistent findings. Davison and Lawson (2006) further drew attention to the disparity between perceived and objectively measured findings concluding that *“it is possible that individuals are not able to accurately recall and report the level of street connectivity in their neighbourhood”* (p. 11).

2.1.7 Activity Environment Literature Conclusions

Invariably review papers called for rigour and consistency in measurement of both the environment and PA and the establishment of a trans-disciplinary approach. Furthermore there was an acknowledgement of the erroneous nature of self-report and perception measurements.

There was general agreement that parents played a key role in children’s PA and therefore onward research on and with young people should include/ involve their parents. Finally there was agreement that there is a need for non-US studies to better understand international generalizability of findings and further explore domain and context specific environmental influences.

2.2 Dietary Intake and the Environment

It is commonly acknowledged that modern environments contain multiple cues for easily accessible, energy dense, highly satiating foods that are liable to result in energy intake, plausibly functioning to predispose over-consumption (Larson and Story, 2009). Glanz *et al.* (2005) conceptual model defined four nutrition/ food environment types: the *community environment* referring to places where food can be sourced/ obtained (e.g. shops and restaurants); the *consumer environment* which pertains to what a consumer encounters within and around food sources (e.g. availability, price and promotion); *organisational micro-environments* which are open to defined/ limited groups of people (e.g. homes and schools); and the *information environment* comprising data from public health, media and advertising agencies. This section shall focus predominately on the community and consumer environments.

To provide a comprehensive synopsis of food environment influences on young people's dietary intake, and broadly speaking obesity rates, reviews and commentaries were identified from the following sources:

- On Scopus using key words: diet, dietary intake, food, food choice, BMI, physical environment, neighbourhood environment, review, food environment, systematic review, commentary, young and child/ children;
- Papers identified by Scopus search pertaining to PA and the environment, see section 2.1 (page 7);
- Papers identified during the course of the thesis, see section 2.4.1 (page 21); and
- Papers acquired as part of the Systematic Review process see section 2.4 (page 21).

Table 2 outlines the principal characteristics of the review and commentary papers included in this overview. This sub-section is further sub-divided thematically drawing out and discussing key aspects of the food environment from literature and their influence on dietary intake in young people. Food outlet *access* and *proximity* are broadly discussed then a detailed interrogation of influence by food outlet type is given. Food advertising is briefly discussed before the section is concluded with an overview of food environment research conclusions (section 2.2.7).

2.2.1 Food Outlet Access

Food outlet access is defined as the presence of total food outlets within a given parameter. Carter and Dubois (2010) reported mixed findings on food retail access and association with obesity: one study reported null association, two negative and two positive associations. Engler-Stringer *et al.* (2014) broadly reported null association with total food outlet access and diet quality in studies employing both objective and subjective access measures.

Both Casey *et al.* (2014) and Williams *et al.* (2014) reported broadly positive association between food outlet access within the peripheral school environment and elevated body weight in young people. Williams *et al.* (2014) reported less conclusive and predominately non-significant association between school food environment food outlet access and food consumption.

Paper	**Paper type**	**Age range/ search term**	**Publication years**	**Paper n=**	**Proportion US studies**	**Theme**
Casey *et al.* (2014)	Review	Children & adolescents	≤2014	25	19 (76%)	Built environment & BMI
Carter & Dubois (2010)	Review	2–18 years	≤2009	27	16 (59%)	Physical & social neighbourhood environments & adiposity
Engler-Stringer *et al.* (2014)	Review	≤18 years	1995–2013	26	13 (50%)	Community & consumer food environment influences on children's diets
Fleischhacker *et al.* (2011)	Review	All	1998–2008	40	25 (63%)	Fast food access & health outcomes
Osei-Assibey *et al.* (2012)	Review	≤8 years	≤2011	35	23 (66%)	Environmental influences on dietary determinants of obesity in young children
Pate *et al.* (2013)	Review	5–18 years	1990–2011	61	Not reported	Factors predicting the development of excessive fatness in children & adolescents
Williams *et al.* (2014)	Review	5–18 years	≤2013	30	14 (47%)	External school food environment influence on dietary intake, weight & food purchasing behaviour in children
Larson & Story (2009)	Commentary	All	1998–2008	N/A	N/A	Environmental influences on food choice
Story *et al.* (2002)	Commentary	Adolescents	Not specified	N/A	N/A	Factors that influence adolescent eating behaviours & food choices

Table 2: Characteristics of papers included in the dietary intake and the environment overview

2.2.2 Food Outlet Proximity

Food outlet proximity is defined as closeness or distance to total food outlets from a given location. Engler-Stringer *et al.* (2014) reported broadly null associations between total food outlet proximity and overall diet quality.

2.2.3 Fast Food Outlets

Food consumed from fast food outlets is characterised as being high in fat, saturated fat and sodium and low in fibre (Story *et al.*, 2002). Both Larson and Story (2009) and Engler-Stringer *et al.* (2014) reported positive association between frequency of eating in fast-food outlets and less healthful, higher-calorie dietary patterns in young people. Engler-Stringer *et al.* (2014) also broadly reported inverse association between fast food outlet access and proximity, dietary intake of fruit and vegetables and total diet quality. In light of the inverse associations between diet quality and fast food it is perhaps unsurprising that Osei-Assibey *et al.* (2012) reported positive association between fast food consumption and BMI in young people.

Across reviews there was broadly inconsistent, inconclusive or null results pertaining to neighbourhood fast food outlet access and both weight status and dietary intake of foods from these outlets (Larson and Story, 2009; Carter and Dubois, 2010; Fleischhacker *et al.*, 2011; Casey *et al.*, 2014). Only Engler-Stringer *et al.* (2014) reported broadly positive association between fast food outlet access and food purchasing from these outlets.

More consistent associations were reported for neighbourhood fast food outlet proximity. Positive association was reported between fast food outlet proximity and weight status (Osei-Assibey *et al.*, 2012; Casey *et al.*, 2014) and food purchase from these outlets (Engler-Stringer *et al.*, 2014).

Four reviews reported on the peripheral school food environment. Williams *et al.* (2014) reported positive associations between access to fast food outlets, BMI and obesity. Williams *et al.* (2014), Engler-Stringer *et al.* (2014) and Story *et al.* (2002)

all reported positive association between school food environment fast food outlet access and increased purchasing from these outlets. All reviews reporting on the school food environment reported a broadly inverse association between healthful diet and proximity to fast food outlets (Fleischhacker *et al.*, 2011; Engler-Stringer *et al.*, 2014; Williams *et al.*, 2014).

2.2.4 Convenience Outlets

Soft drinks are the most commonly purchased item from convenience outlets, after that candy or gum, salty snacks and bakery items (Story *et al.*, 2002); nutrient profiles of these foodstuffs are far from healthful. Engler-Stringer *et al.* (2014) broadly reported inverse association between neighbourhood convenience outlet access and proximity (objective and subjective) and healthy dietary intake[3].

Both Casey *et al.* (2014) and Pate *et al.* (2013) reported null association between convenience store proximity and weight status in young people. Engler-Stringer *et al.* (2014) reported on one study which found neighbourhood convenience store access increased the likelihood of purchasing from these food locations.

Four review papers reported on convenience outlets within the peripheral school food environments. Story *et al.* (2002) indicated that having a high density of convenience stores surrounding schools makes them convenient and accessible food sources for young people. Casey *et al.* (2014) and Williams *et al.* (2014) positively associated school food environment convenience outlet access, adiposity and prevalence of overweight in school children. Engler-Stringer *et al.* (2014) however, reported mixed and inconclusive associations outlet access, proximity and dietary quality.

2.2.5 Grocers

Grocers, interchangeably supermarkets, are characterised as being large food outlets selling a wide range of everyday food and homeware. Engler-Stringer *et al.*

[3] Measured dietary intakes included the following foodstuffs: fruit and vegetables, soft drinks, potato chips, chocolate, white bread and ‘junk’ food.

(2014) reported broadly positive associations between neighbourhood proximity to grocers and healthful dietary intake. Fruit and vegetable intake was generally inversely associated with proximity to grocery stores but positively associated with access to these outlets. Casey *et al.* (2014) and Carter and Dubois (2010) broadly inversely associated neighbourhood grocer access, BMI and obesity.

2.2.6 Food Advertising

Story *et al.* (2002) highlight advertising and promotion as central to the marketing of the national food supply in the US. Reported US food industry spend is $11 billion annually with fast food restaurants (e.g. McDonalds and Burger King) and high fat salt and sugar products (e.g. Coca-Cola, M&Ms and Lays potato chips) being substantial spenders in this arena. Advertising present within the neighbourhood environment comprise: billboards and advertising in and around food outlets and stores, with evidence suggested this is particularly the case in outlets those surrounding schools. Neither of these advertising types however, is as dominant or well-studied as television advertising which ensues to a lack of reviews and commentaries on this subject area.

2.2.7 Food Environment Literature Conclusions

Authors generally concluded that more research is required to reach convincing conclusions; especially investigation of food advertising effects on diet and obesity. Many reviewers called for greater consistency in research methods and environment definitions which would aid cross-study comparison. Concurrent objective (preferentially employing geographic information system methods) and subjective measurement of the food environment is cited as important for onward research to further uncover the relationship and disparities between perceived and actual environments.

There was general acknowledgement that studies outside the US are needed to further explore cultural and climate differences. As it cannot be assumed that environmental factors will similarly impact population groups or all individuals within a given group, there is also requirement for studies to focus on distinct groups based upon differing levels of independence and mobility, age and social situation. Finally there is a need to progress from cross-sectional research designs to prospective and longitudinal designs which enable detection of correlation.

2.3 Literature Overview Summary

The most supported environmental correlates with young people’s PA were: presence of pavements, pedestrian and road safety features and perceptions, mixed neighbourhood land-use, presence and proximity to neighbourhood parks and recreation facilities. Inconsistent evidence exists for neighbourhood connectivity and safety.

Food environment associations with weight status and dietary intake in young people are poorly understood in literature. Broadly, fast food and convenience outlets are inversely associated, and grocers positively associated, with weight status and healthful dietary intakes in young people. These associations however, are far from consistently observed.

Across activity and food environment literature there is a requisite for increased rigor and consistency in quantitative and qualitative measurement of both the environment and health behaviours. Additionally to progress understanding from association to correlation there is a requirement for prospective and longitudinal research designs in defined age groups and geographic contexts, especially those outside the US.

Systematic Literature Review

This section comprises the Systematic Literature Review and Narrative Synthesis of findings.

The number of reviews and commentaries on obesogenic environments is sizeable, and growing, but to my knowledge no existing reviews address environmental influence on *both* PA and diet concurrently in young people which justifies the need for this systematic review. The objective of this systematic literature review was to provide a thorough exploration and reporting of obesogenic environment literature relating to *physical* (pertaining to natural features within the landscape e.g. green space and air quality) and *neighbourhood* (pertaining to built land mix, access to facilities and aesthetic design features) environment influences on *both* PA and dietary behaviours and outcomes in young people aged 7–12 years.

Both quantitative and qualitative study types were included in this review. Spanning the paradigm divide was imperative for this review as both the subject of this thesis and obesogenic environment research spans this divide. It is worthy of note that in recent years there has been a shift in medical sciences best practise to include previously considered ‘lower hierarchies of evidence’ – case studies, cross-sectional, case-control and cohort studies – in conjunction with eligibility criteria and evidence quality rating to ‘retain review integrity’ (Reeves *et al.*, 2011). The rationale chimes with social sciences which have historically contested that the richer *meaning* and *process* learnings from qualitative data are imperative (Petticrew and Roberts, 2006). Both Primary Research and Review papers were captured in the literature search.

Conventional systematic review methods were adopted as outlined in Figure 2. Methods are reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Alessandro *et al.*, 2009) and Guidance on the conduct of narrative synthesis in systematic reviews (Popay *et al.*, 2006; Rodgers *et al.*, 2009). This was in accordance with systematic reviewing best practice and ensured a robust approach was adhered to according to pre-defined explicit criteria (The Cochrane Collaboration, 2013).

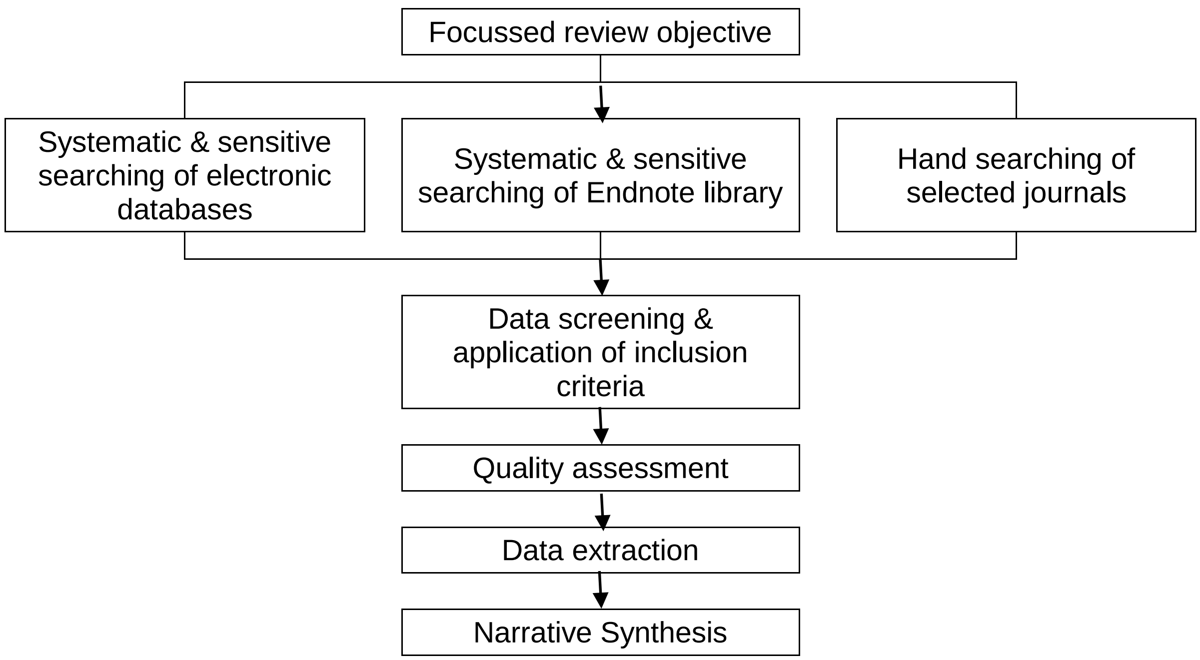


Figure 2: Systematic review process overview

2.4 Literature Search

The strategy adopted for the systematic literature search was key-word searching of electronic databases and Endnote reference bank (compiled throughout this thesis detailed below) and hand-searching of select discipline-specific journals.

2.4.1 Key word searching

Databases used were Medline (Ovid), Embase (Ovid) and Scopus. Databases traversed medical and social sciences, and humanities disciplines reflective of the interdisciplinary nature of obesogenic environment research. Medline and Embase are recommended by the Cochrane Handbook (Lefebvre *et al.*, 2011) and were the basis of the search. Scopus was used in addition to ensure social science journals were included in the search.

Throughout this thesis an Endnote Library of (at the time of searching) 2,232 references has been compiled. This library contained references of all the reading completed throughout the thesis and was obtained from:

- Email alerts for key words ‘childhood obesity’, ‘childhood overweight’, ‘obesogenic environment’, ‘healthy cities’, ‘built environment’, ‘food environment’ and ‘physical activity’ from Mimas Zetoc, BioMed Central and Science Direct (September 2010-May 2014);
- Email alerts of research, reports, resources and news relating to obesity and it’s determinants from Obesity Knowledge and Intelligence Public Health England;
- Subject and methods specific literature searching;
- Reference list searching of key papers.

The databases and Endnote Library were searched using key-word. Search terms used comprised: obesogenic environment, physical environment, neighbourhood environment, food environment, activity environment, PA and diet. Inclusions are outlined in Table 3.

2.4.2 Hand searching

Select discipline-specific journals were hand-searched for relevant papers. Journals comprised: American Journal of Preventative Medicine; Appetite; Children’s Geographies; Environment and Planning; Health and Place; International Journal of Behavioural Nutrition and Physical Activity; International Journal of Health Geographics; International Journal of Obesity; and Social Science and Medicine. These journals were selected as they represented the most common *source* journals within the thesis Endnote Library and are widely regarded as preferential journals for publication within the field of obesogenic environments literature.

2.4.3 Integrity Check

The integrity of the search strategy was assessed by using two key indicator papers which were identified from existing knowledge prior to running the searches (Edwards *et al.*, 2010; Carroll-Scott *et al.*, 2013). Both papers were included in the resultant searched reference list.

2.5 Inclusion Criteria

Table 3 outlines the inclusion criteria applied to literature.

Category	Inclusion Criteria
Population group	7–12 years old
Exposure	Physical/ neighbourhood/ activity/ food environments and physical activity and dietary behaviours within these spaces
Outcome	Physical activity and dietary behaviours and outcomes
Exclusions	Non-English language
	Publications published before 2009
	Peer-reviewed literature only

Table 3: Literature search inclusion criteria

It is widely acknowledged that the way young people interact with their surrounding physical and social environments is rapidly changing. To isolate research pertaining to the studied generation: young people (aged 10–11 years in 2011/12), only publications concerning young people aged 7–12 years old (i.e. school age children) and papers published from 2009 onward were collected. This ensured only timely and generation-specific knowledge was included.

Obesogenic environment literature encompasses all aspects of the physical environment. Sections 2.1 and 2.2 outline literature pertaining to environmental influences on PA and dietary behaviours. As the succeeding thesis is concerned with both PA *and* dietary intake behaviours and outcome measures it was pertinent to incorporate only studies which assessed these behaviours concurrently. Studies which assessed these behaviours independently were excluded. These criteria functioned to streamline included publications ensuring the collated data was manageable for a single researcher, and aimed to draw out interconnected environmental influences on health as a whole.

2.6 Screening

In line with PRISMA guidelines publications were screened at three levels: title, abstract and full text. Titles were scanned (twice) to exclude those out of the scope of the current study. At this phase of screening publications which referred to physical or neighbourhoods environments, PA or dietary intake singularly in the title were retained; this was to avoid inaccurate discard. Abstracts were then read in full and assessed against the inclusion criteria (see Table 3). Finally, full text articles were read. Figure 3 provides an overview of the systematic review literature search and screening process and Table 4 outlines the reason for record exclusion at the three stages of screening.

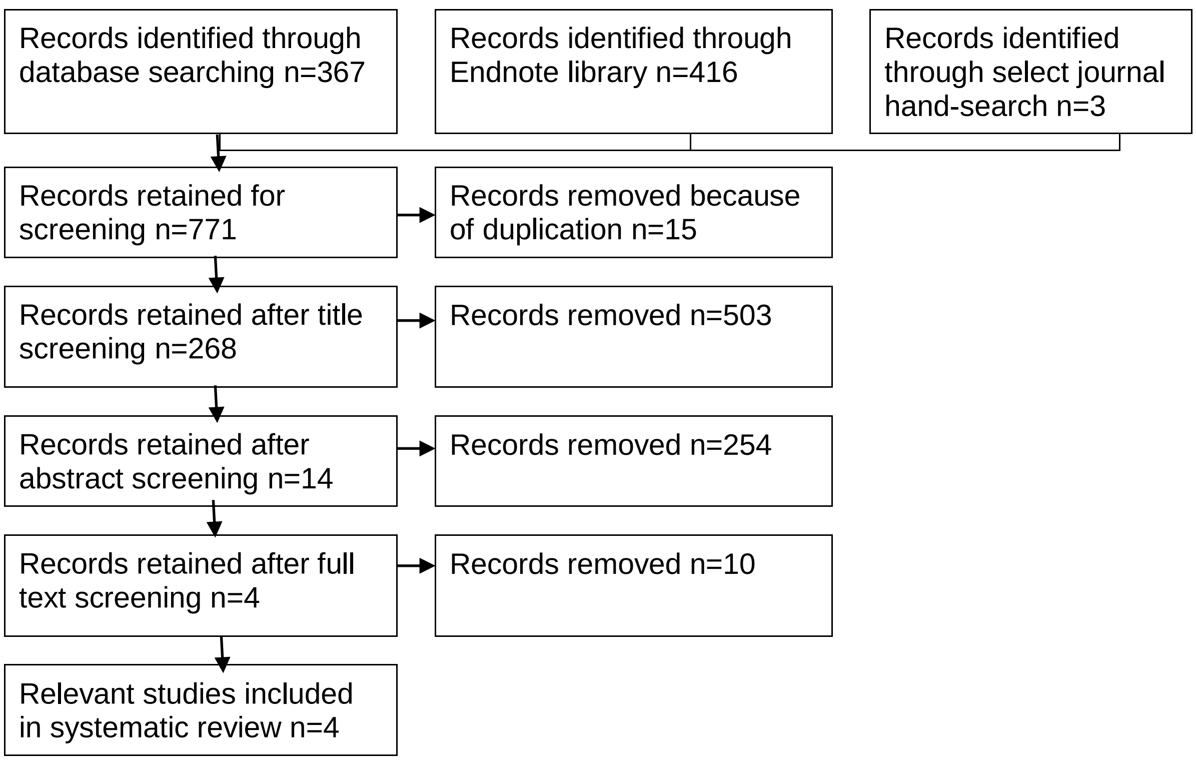


Figure 3: Systematic review overview

Screened exclusion grouping	Title	Abstract	Full paper
Other environment	224	41	
Parenting/ family/ home environment	42		
Activity environment PA only		47	
Food environment/ diet only		39	
PA/dietary intake not environment	40	13	1
Health outcome not diet/ PA	22	15	
Methods development/protocol	101	12	
Excluded population	40	44	3
Natural/ biological science	11	7	
Policy analysis/ review		7	
Subject commentary no population specified		29	5
Full text not available			1
Other	23		

Table 4: Screened exclusion groupings

2.7 Quality Assessment

Quality assessment (QA) is concerned with risk of bias and addresses three facets (Khan *et al.*, 2001; Higgins and Green, 2009):

- Internal validity, also termed bias prevention, which assesses methodological suitability to best answer the research question whilst minimising bias;
- Bias, comprising: selection, performance, attrition, detection and reporting bias or deviation from the truth; and
- External validity or generalizability of conclusions within and outside the research setting.

Despite widespread use of high quality reporting guidelines for systematic reviews (Alessandro *et al.*, 2009), RCTs (Moher *et al.*, 2010) and Observational Study Reviews (Stroup *et al.*, 2000; von Elm *et al.*, 2007) there is no such consistency in quality assessment tool application. In a review of 965 peer reviewed systematic reviews Lorenzo *et al.* (2005) found 11.5% did not apply quality assessment.

Authors found the Jadad Scale (Jadad *et al.*, 1996) was the most commonly applied tool (11.7%); however this tool is for controlled study assessment only and therefore was inappropriate for use in the systematic review. In another review by Mallen *et al.* (2006) which focussed on observational study systematic reviews the authors found only 52.4% of reviewers applied quality assessment in a sample of 105 studies. The majority of reviews developed and used bespoke quality assessment tools. The lack of a quality assessment gold standard for observational study reviews has led to the proliferation of assessment tools; Sanderson *et al.* (2007) identified 86 of these.

Across quality assessment reviews and commentaries, checklists are emphasized as preferable to scoring assessments due to the complexities in weighting exposures and outcomes; this is particularly pertinent in observational studies (Jüni *et al.*, 1999; Mallen *et al.*, 2006; Sanderson *et al.*, 2007). To avoid further proliferation of quality assessment tools, the pre-set criteria used by Evidence for Policy and Practice Information Centre (EPPI) in their paper examining obesity-related dietary and PA behaviours in young children was used (Lakshman *et al.*, 2013). An additional variable assessing outcome measurement was added to the criteria to account for the robustness of data both cause and effect. This is particularly pertinent for study of PA, diet and weight which are known to have high self-reporting bias (Klesges *et al.*, 2004; Elgar *et al.*, 2005).

2.8 Data Extraction

Data was extracted using a pre-defined schedule. For consistency with QA the piloted EPPI schedule was utilised (Lakshman *et al.*, 2013). Data is summarised in Table 5 (parts 1 and 2) which is divided across two pages for easier reading.

Data extraction variable	Edwards *et al.*	Leung *et al.*
Internal validity		
Participant number	33,594	215
Participant age range	3–13 years	6–8 years
Setting	Leeds, UK (Urban)	North California, US (Urban)
Study design	Cross sectional	Cross sectional
Risk of Bias		
Exposure measure	*Subjective*: Neighbourhood environment questionnaire data from Health Survey for England (HSE) & Expenditure & Food Survey (EFS)	*Objective*: Neighbourhood land mix; transport; facilities, parks & playgrounds & physical disorder audit by researcher
Outcome measure	*Objective*: BMI data from Primary Care Trust, RADS & Trends studies *Subjective*: Health questionnaire data from HSE & EFS	*Objective*: BMI (researcher assessed) *Subjective*: 24 hour dietary recall, PA questionnaire
Analysis	*Univariate*: geographically weighted regression	*Multivariate*: exploratory factor analysis (and ordinal logistic modelling)
Key findings*	Obesity (OB), PA & dietary outcomes resultant from environmental exposures are not geographically uniform All areas: perceived poor supermarket & leisure facility access > OB Affluent area: daily fruit & vegetable (FRV) intake < OB; perceived problem with teenage loitering > OB Mid area: daily FRV intake < OB, observed home environment influence Deprived area: home & school environment influence	Neighbourhood deprivation is correlated with all neighbourhood environment variables Total energy intake < with ↑ neighbourhood food & retail destinations Crude < association lower PA and ↑ neighbourhood mixed land use & ↑ physical disorder PA outcomes resultant from neighbourhood environment exposure are not racially uniform
External Validity		
Representative-ness/ generalizability	Good: mixed socioeconomic status neighbourhoods & large sample size	Limited: higher ethnic diversity & affluence than wider US & female participants only

Table 5: Data extraction table (part 1 of 2)

Data extraction variable	Findholt *et al.*	Carroll-Scott *et al.*
Internal validity		
Participant number	47 school aged & 95 adults	1,048
Participant age range	11–13 years	10–12 years
Setting	Oregan, US (Rural)	Connecticut, US (Urban)
Study design	Cross sectional	Cross sectional
Risk of Bias		
Exposure measure	*Objective*: Neighbourhood PA resource, community food access & cost, & school marketing assessments by researcher audit	*Objective*: Neighbourhood business listings location and classification (bought datasets), local authority park location, police crime data. Walking distance to park & food retail destinations
Outcome measure	*Objective*: PA during school play-time *Subjective*: Interviews/Focus groups on community/school physical, economic, political and sociocultural environments	*Objective*: BMI (researcher assessed) & PA fitness test *Subjective*: PA, dietary intake, neighbourhood social ties, park access & safety perception questionnaires
Analysis	*Univariate*: descriptive statistical analysis (quantitative) & thematic synthesis (qualitative)	*Multivariate*: multilevel modelling
Key findings*	PA barriers: ↓ community recreational resource, hazard danger (traffic, street & stranger) & inadequate PE in school PA facilitators: youth sports popularity & proximity to natural areas Healthy eating barriers: limited availability & high cost (time and £) healthy foods, convenience store location near school & healthy lifestyles not encouraged/ enforced/ modelled at school Healthy eating facilitators: gardening, agricultural setting	PA > with ↑ neighbourhood social ties & ↑ perceived park access Healthy eating > with ↑ neighbourhood social ties, ↑ perceived park access, ↑ concentrated affluence & < with ↑ neighbourhood fast food outlet count Unhealthy eating > with ↑ neighbourhood social ties, ↑ fast food outlet count & < ↑ concentrated affluence High BMI > with grocery store access +0.5 miles to home and ↑ levels property crime Perceived access showed greater correlation with behaviour than objectively measured access
External Validity		
Representative-ness/ generalizability	Limited: Representative of a rural US population	Moderate: higher ethnic diversity, deprivation & disease than US, sound sample size

Table 5: Data extraction table (part 2 of 2)

2.9 Narrative Synthesis

Narrative synthesis was used for assimilation and discussion. Narrative synthesis preferences words and text for summary over numeric and statistical assessment and is appropriate for use with heterogeneous studies. In light of the contextual and population differences in reports within this review it was deemed the most appropriate means of synthesis.

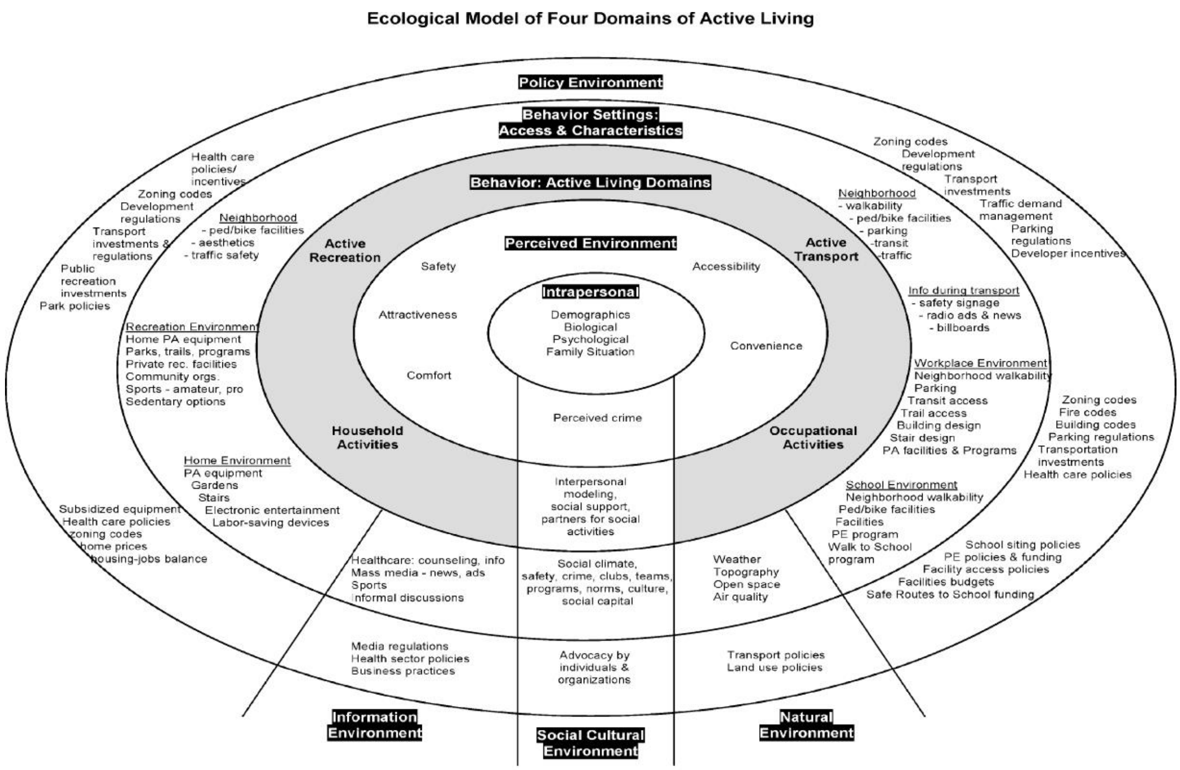
2.9.1 Theory

The underpinning of each of the studies included in this synthesis is the theoretical concept that the environment influences PA and dietary intake in young people by exposure – either enabling or disabling leptogenic or obesogenic behaviours. This is broadly consistent with socio-ecological theory which asserts that behaviour is influenced *by* and *across* multiple environments/ spheres, broadly: Individual, Social, Physical and Political (Glanz *et al.*, 2008). Socio-ecological theory builds upon Kurt Lewin's classical theory of Ecological Psychology where *behaviour* is seen to be the result of interaction between the *environment* and the *person* (or psychological tradition) (Bonnes and Secchiaroli, 1995; Gieseking *et al.*, 2014).

Sallis *et al.* (2006) developed a socio-ecological model to frame the examination of PA within the environment (see Figure 4). Story *et al.* (2008) developed a socio-ecological framework to conceptualize food environments and the conditions influencing food choice (see Figure 5). This review, and succeeding thesis, builds upon the theoretical underpinning of these frameworks.

2.9.2 Synthesis

Four studies were included in the review synthesis: Edwards *et al.* (2010), Leung *et al.* (2010), Findholt *et al.* (2011) and Carroll-Scott *et al.* (2013). All were cross-sectional primary research studies. Three studies were based in the US and one in the UK. Of study from the US one was located in a rural setting; all other studies were in urban areas. Leung studied females only; all other studies were mixed gender.



Sallis JF, et al. 2006.
Annu. Rev. Public Health 27:297–322

Figure 4: Ecological Model depicting the four domains of active living taken from Sallis et al. (2006)

Environment Definition

The definition of the neighbourhood environment was different across all studies. Edwards, Findholt and Carroll-Scott used three classifications of geographically defined neighbourhood units: lower super output areas, school districts and Census tracts, respectively. Leung used a quarter mile radius surrounding research participants home postcode centroid.

Exposure and Outcome Measurement

Measurements of the environment (exposure) were widely heterogeneous. Edwards used subjective questionnaire data whilst the other three studies used a variety of objective measures. Carroll-Scott utilised regional business listings and datasets to characterise the environment by access to and type of resources. Leung and Findholt collected primary data using validated audit tools and instruments; there was however no consistency in tool application between studies.

Findholt collected data on complete neighbourhood environment units whilst Leung adopted a selective approach.

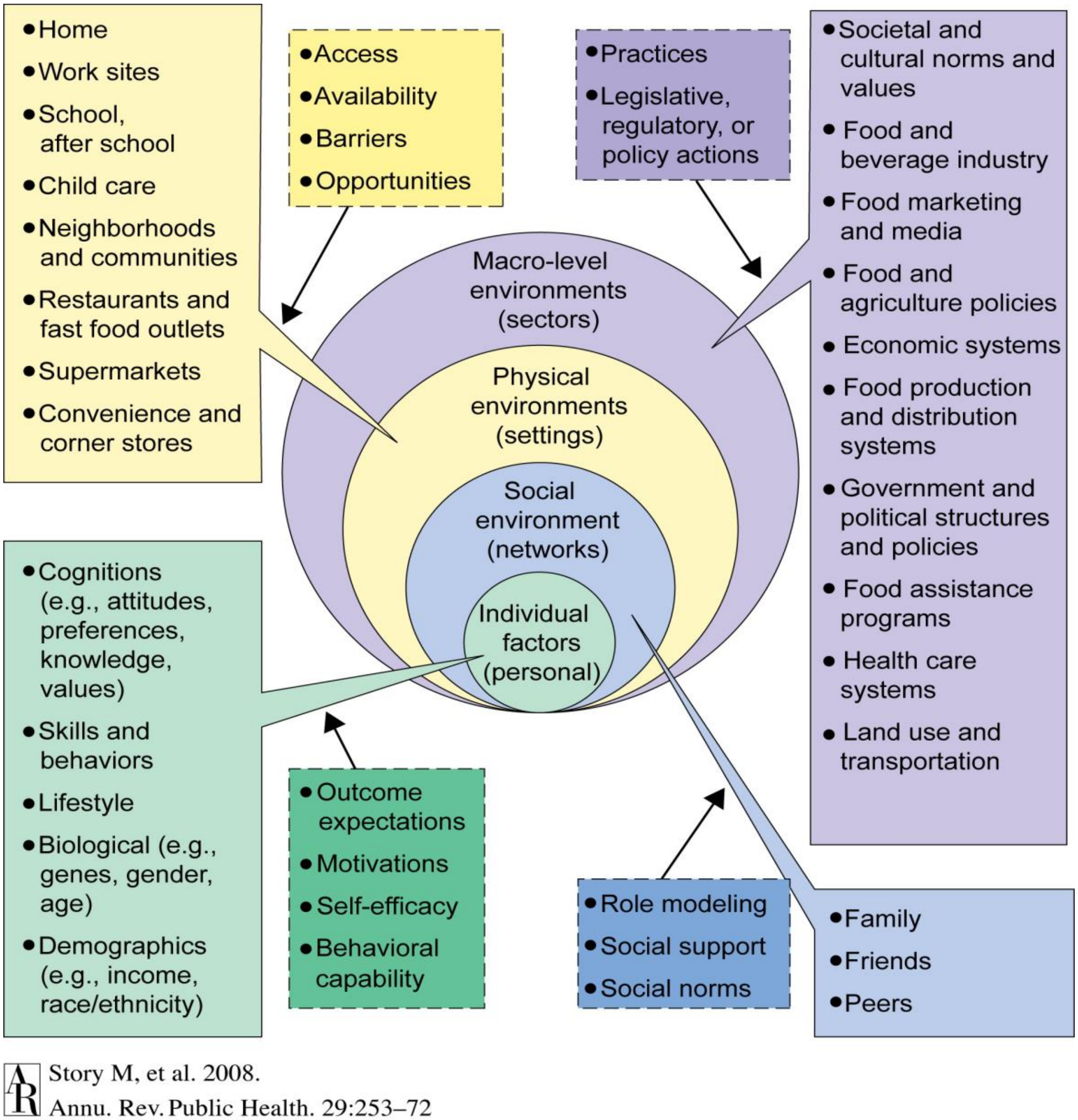


Figure 5: Ecological framework depicting the influences on what people eat taken from Story et al. (2008)

Behavioural outcome measurement showed more homogeny across studies. PA was measured by observation and fitness testing by Findholt and Carroll-Scott respectively. Edwards, Leung and Carroll-Scott collected self-reported PA data by means of questionnaires; there was however no consistency in questionnaire application between studies. Dietary intake was measured differently again across studies: Edwards and Carroll-Scott applied questionnaires (no consistency in tools); Findholt used broad healthy eating discussion; and Leung employed 24 hour dietary recalls.

Heterogeneity in research methods is commonplace in obesogenic environment research and is a source of complexity in cross-study correlation and interpretation. The factors discussed above informed results interpretation outlined in section 2.9.3.

Exposure and Outcome Association

All four studies reported environmental influence on PA and dietary intake behaviour and outcomes. Discussion is thematically grouped below.

All studies found neighbourhood *deprivation* was in some way associated with physical environment, facilities, environmental perceptions and behavioural outcomes. As socioeconomic environment definition was used as a control across all studies there was no interrogation of itemized environmental features associated with levels of deprivation across studies. Edwards' observation that environmental influence on activity and dietary behaviours are not socioeconomically, and by proxy geographically or environmentally, uniform even within the confines of a city may serve as an explanatory variable for the heterogeneous results in the field of obesogenic environment research. As a measurable outcome inherently linked to deprivation low food expenditure and high cost of healthy foods (within the neighbourhood and accessible environment) were asserted by Edwards and Findholt to be positively linked to obesity and represent barrier to healthy eating.

Physical disorder was negatively associated with objective PA and subjective perceived barriers to PA by Leung and Findholt, respectively. Edwards and Carroll-reported higher rates of obesity and higher BMI, respectively, in neighbourhoods with greater incidence of physical and social disorder.

Objectively measured access and subjectively measured perceived access to neighbourhood *leisure facilities* were both shown to be correlated with PA, healthy weight and diet. Findholt and Carroll-Scott reported positive correlation between both objective and perceived access to leisure facilities and PA. Carroll-Scott reported there was stronger association with perceived over objective access. Edwards and Carroll-Scott reported inverse association between greater perceived access to leisure facilities and childhood obesity and healthy eating, respectively.

Leung showed weak inverse association between mixed residential and commercial *land use* and PA; on the other hand Findholt reported both PA and healthy eating were facilitated by proximity to natural environment. Findholt builds upon this finding, reporting limited access to shops selling healthy foods and proximity of convenience stores to schools as barriers to healthy eating. Leung reported inverse association between total food intake and access to neighbourhood food and retail outlets. Edwards and Carroll-Scott reported food outlets by typology and respectively found a protective effect of supermarket access on obesity and two-way correlation between healthy/ unhealthy eating and low/ high fast food outlet density.

Neighbourhood *walkability* was cited by Leung as a positive correlate of PA in Hispanic/ Latina girls. Walkability comprised physical features supportive of safe street usage e.g. pavement presence and safety signage. Concurrently Findholt found street and road safety issues to be a perceived barrier to PA.

2.9.3 Interpretation

Despite heterogeneity in environment definition and research methods between studies included in this this review four factors were consistently associated with PA and one factor consistently associated with dietary intake in young people. The consistency of findings, despite heterogeneity, is indicative of association robustness. This section outlines potential mechanisms of association.

Presence of neighbourhood *leisure facilities* (comprising parks and recreation facilities) were a positive correlate of PA, healthy diet and healthy weight status. The relationship between leisure facilities and PA is intuitive – recreation is enabled by leisure facilities and is consistent with literature overview (sections 2.1.1 and 2.1.2). This, taken in conjunction with the energy balance equation which asserts that weight status is the result of energy intake and expenditure with positive imbalance resulting in higher weight status and negative imbalance resulting in lower weight status, informs the assumed mechanism for leisure facility association with weight. Mechanism of association with healthy diets is less clear. It is assumed that those partaking in PA within leisure facilities are more likely to take a holistic interest in health and healthy living including dietary intake.

Consistent with previous *land use* overview (section 2.1.3) PA was shown to be enabled by natural landscape. Mixed land use is commonly associated in literature with active travel i.e. PA is enhanced by mixed land use due to research participants walking or cycling to access facilities (Handy *et al.*, 2002). The proposed mechanism for this counter-to-literature finding is that for young people the neighbourhood is used preferentially for free play rather than for interaction with/ use of neighbourhood facilities. This postulation is informed by findings from Jones *et al.* (2009) which indicate urban areas are restrictive of movement and rural areas afford a more diverse range of informal play opportunities.

Within the food environment *food outlet access and proximity* were shown to be associated with dietary intake and weight outcome. Access to neighbourhood food outlets was inversely associated with total food intake – whereby those with greater proximity to food outlets ate less. Due to the ambiguity of this finding it shall not be discussed further. Consistent with finings in the literature overview (section 2.2.7) a two-way correlation was observed between healthy/ unhealthy eating and low/ high neighbourhood *fast food outlet* density. The assumed mechanism is that the more a person encounters fast food outlets the greater the likelihood that they will purchase food from this food location and consequently the less healthy their dietary intake will be. Corresponding to findings from the literature overview (section 2.2.4) *convenience store* proximity to schools was reported in the systematic review as a barrier to healthy eating. This mechanism follows with that previously outlined. Finally neighbourhood access to *grocers* were reported to be protective against obesity in young people. This is in line with findings from the literature overview (section 2.2.5) and it can be assumed that ready access to healthy foodstuffs, typically available in grocers, would enable and encourage intake and consequently heathy weight status outcome.

Neighbourhood *walkability* facilitates PA. Walkability in reviewed studies pertained to physical features supportive of safe street usage. Between studies there was no cross-over in walkability feature definition therefore the concept of walkability remains nebulous. This finding is broadly consistent with literature overview findings discussed in section 2.1.1.

Neighbourhood environment *physical disorder* hinders PA in young people. It is reasonable to assume that the mechanism of this association is the *chosen* or *enforced* (by parents/ guardians) limitation of time spent outdoors ensuing to an increase in time spent indoors. It is well established that in young people time spent indoors is correlated with engagement in sedentary pursuits whereas time spent outdoors is correlated with engagement in active pursuits (Ferreira *et al.*, 2007; Cleland *et al.*, 2008; Jones *et al.*, 2009; Cooper *et al.*, 2010). This finding is at odds with the broad *null* association reported between PA and neighbourhood safety in the literature review overview (section 2.1.5). As previously discussed this may be due to the lack of consistency in examination of neighbourhood environment physical disorder across papers included in reviews ensuing to a false null association.

In contrast to findings from the literature overview in section 2.1.3 this systematic review found PA was disabled by mixed residential and commercial land use.

2.10 Review Strengths and Weaknesses

The systematic review search strategy was comprehensive and inclusive with regards research discipline (medical and social science) and search terms ensuing to a broad interaction with available literature. Quality assessment was performed using a piloted tool which augments the soundness of included studies. Also review methods are comprehensively detailed and are therefore reproducible.

Publication bias, linked to skewing in the peer review process towards positive or negative results above null results, was poorly mitigated with a lack of engagement with grey literature. Exclusion of non-English studies may be a further source of bias. Both of these factors were consequence of time (single reviewer) constraint. Furthermore due to the practical constraints of this review being fulfilled by a single researcher search terms were potentially too narrow to capture the full complement of obesogenic environment literature. Due to the bias towards predominately US studies generalizability to the rest of the world is questionable when country specific social, political and cultural environmental features are considered.

Literature Review Implications for Research

A number of features within the neighbourhood environmental are indicated to be associated with PA and dietary behaviours and outcomes; see section 2.3 (page 19) for full summary. There is however, general acknowledgement that further research is required to fully understand the complex interplays of environmental influence on distinct population groups and geographical contexts.

Within the field of obesogenic environment literature there is very little multi-disciplinary (i.e. urban design, public and medical health) examination of the complete environment (i.e. complete neighbourhood environments not restricted environment types e.g. food environments, parks and schools). Therefore to better comprehend common environmental effects on activity and dietary intake behaviours and resultant health outcomes trans-disciplinary research is required.

Accordingly, the research objectives for this thesis are to:

- Identify physical environment correlates with energy intake and expenditure;
- Identify physical environment features associated with overweight & obesity;
- Identify personal correlates which mediate the relationship with the physical environment.

Chapter 3: Methodology and Methods

This chapter outlines methodological approaches used within this thesis and the subsequent chapter sections according to methods phase. This chapter comprises five sections: Case Study Site Selection and Participant Recruitment, Focus Group, Methods Development, Pilot and Main Study and Detailed Case Studies.

3.1 Methodology

Research was performed within a pragmatic research paradigm. Pragmatism adopts a 'what works' approach giving preference to answering research questions above methodological, epistemological and ontological debate and purism (James, 1907; Tashakkori and Teddlie, 1998; Feilzer, 2010). Analysis followed hybrid inductive and deductive thematic and statistical analysis.

3.1.1 Mixed Methods

This research employed a sequential mixed methods approach with partiality towards quantitative study. Mixed methods was defined by Tashakkori and Creswell (2007) as *"research in which the investigator collects and analyses data, integrates the findings, and draws inferences using both qualitative and quantitative approaches or methods in a single study or a program of inquiry"* (p. 4). Quantitative analysis enabled quantification of behaviours and environmental features utilising objective, reliable and repeatable methods and tools leading to statistical analysis and (some level of) generalisation. Qualitative analysis enabled 'thick description' (Geertz, 1993) and explication of complex and multi-faceted real-world phenomenon.

The mixed methods approach facilitated: 1) triangulation, increasing validity by offsetting method biases, 2) complementarity, utilising lenses of different methods to elaborate a comprehensive understanding and 3) expansion, imparting the breadth and range of different methods for different research components (Greene *et al.*, 1989; Onwuegbuzie and Leech, 2005; Bryman, 2006).

3.2 Ethical Approval

Ethical approval for testing, pilot and main study was applied for through Newcastle University School of Architecture, Planning and Landscape and was granted in May 2011 (see Figure 88 on page 328). Updates to protocols, tools and letters were re-submitted through ethical application and were granted at each stage before implementation.

3.3 Research Process Overview

A three tired approach to research was implemented: exploratory focus group leading to cross sectional empirical analysis utilising mixed and multiple methods, leading to three nested case study analyses comparing ‘typical’ and ‘deviant’ cases based on neighbourhood influence on PA, diet and BMI.

Table 6 outlines the stages of methods development, testing, piloting, data collection and analysis for this thesis. This chapter is structured according to the distinct phases which each section discussed in turn. Within this chapter methods are outlined in their completed form. Methods Development (sections 3.7–3.9) and Pilot Study (pCNES) should be referred to for development stages.

Stage	Task	What measuring/ further detail
One	Case study site selection and participant recruitment	School sites selected for: urbanicity, high/ low socio-economic status, and high/ low obesity prevalence rate
Two	Focus Group	Exploratory discussion of: child's understanding and use of/ participation in: 'the neighbourhood', 'activities', 'neighbourhood activity environment', 'dietary intake' and 'neighbourhood food environment'
Three	Methods development and testing - Participant Attitude, Perception and Behaviour Survey - Physical Activity and Dietary Intake Diary - Outdoor Food and Drink Advertising Tool	- Stages: scoping reading; cognitive interviewing for comprehension testing; feasibility testing - Stages: scoping reading; young person expert opinion; field professional and teacher expert opinion; comprehension, feasibility and validity testing - Stages: scoping reading; field professional expert opinion; feasibility and validity testing
Four	Pilot Study (pCNES)	Process as per CNES
Five	Main Study (CNES) *Objective exposure measurement:* - Neighbourhood environment (400m postcode centroid straight line buffer) *Subjective exposure measurement:* - Participant Attitude, Perception and Behaviour Survey - Parent/ Guardian Attitude, Perception and Behavioural Survey *Objective outcome measurement:* - BMI *Subjective outcome measurement:* - Self-reported active behaviour - Self-reported dietary intake - Photo-voice	- Parks and GSs (location (L), type (T) and quality (Q)), sports facilities (L, T), non-food shops and services (L, T), food outlets (L, T, Q), advertising (L, T), roads (length m (LM), safety), streets (LM, quality), cyclability (count) - Themes: neighbourhood environment activity facilitation, PA, eat well attitudes and body shape satisfaction. Additional: home affluence, club/ class attendance, garden and park descriptive, estimated PA frequency, home food participation - Themes: parent/ child demographics, neighbourhood environment, PA and home food environment - Protocol as per NCMP - Comprising activity: instance, type, intensity, location and companion - Comprising dietary: occasion, composition, sourcing and eating location and companion - Evidence/ prompt PA and dietary intake
Six	Detailed Case Studies - PA - Dietary Intake - BMI	- High/ low activity reporter according to within study population rank - High/ low healthful diet reporter according to within study population rank - High/ low BMI according to within study population rank

Table 6: Overview of methods stages

3.4 Statistical Analysis

SPSS version 17.0 was used to calculate statistics. *P* values were calculated using Monte Carlo significance (99% confidence).

All data was tested for normality, normally distributed data underwent parametric testing and non-normal data underwent non-parametric testing as per following criterion:

- Compare the means or mean ranks of two independent samples: independent *t*-test (t) or Mann-Whitney U test (Z) (nominal/ categorical data Chi-squared (χ^2) or Fisher's Exact test);
- Compare the means or mean ranks of two related samples: paired *t*-test (t), kappa statistics ($\varkappa$) or Wilcoxon Signed Ranks Test (T);
- Compare the means or mean ranks of more than two unrelated samples: One-way Analysis of Variance (*F*) or Kruskal Wallis (H) (nominal/ categorical data Chi-squared (χ^2));
- Linear relationship between two related samples: Pearson's R 2-tailed (r) or Spearman's R 2-tailed (r_s);
- Test for deterministic relationship between two related samples: logistic regression or binary logistic regression.

Case Study Site Selection and Participant Recruitment

This section outlines case study site selection and participant recruitment across the four phases of this study.

The North East of England was the case study site location, comprising: Durham, Northumberland and Tyne and Wear counties. This geographical area was selected on account of PA, BMI[4] and health outcome profiles detailed below.

The HSE found *“no significant variation by Strategic Health Authority regions in children’s summary activity levels [self-reported]”* (Aresu *et al.*, 2009, p. 124). Despite this 28% boys aged 2–15 years from the North East reported ‘Low activity’ which was the highest proportion by strategic health authority. Moreover they reported the fifth lowest average weekly time in PA of ten strategic health authorities (9.8 hours). No such pattern was observed in girls of the same age. North East girls reported the joint second highest total time in PA per week by strategic health authority (9.7 hours).

Both the HSE and NCMP have consistently found childhood overweight and obesity in the North East to be higher than national average rates (Department of Health *et al.*, 2012; Mandalia, 2012).

3.5 School Selection

Multi-stage cluster sampling was employed. Primary schools were case study recruitment sites enabling an equal chance for all young people within the North East to be recruited. Case study schools were purposefully selected for urbanicity, deprivation, and obesity prevalence rates, see Figure 6. Purposeful school

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[4] BMI = Weight (kg) / Height^2 (m^2).

selection was utilised to preferentially recruit cases at the top and bottom ends of deprivation, and obesity prevalence rate spectrums with an aim of isolating interesting and extreme cases for in-depth analysis. Criteria for selection are outlined below and in sections 3.5.1–3.5.3.

<table>
<tr><td></td><td></td><td colspan="2">School socio-economic status</td></tr>
<tr><td></td><td></td><td>Deprived</td><td>Affluent</td></tr>
<tr><td rowspan="2">School obesity prevalence rate</td><td>High</td><td>Deprived & high obesity prevalence</td><td>Affluent & high obesity prevalence</td></tr>
<tr><td>Low</td><td>Deprived & low obesity prevalence</td><td>Affluent & low obesity prevalence</td></tr>
</table>

Figure 6: Purposeful school selection by socioeconomic status and obesity prevalence rate

Primary School postcodes from the North East were obtained from Council websites for: Durham, Gateshead, Newcastle-upon-Tyne, Northumberland, North Tyneside and South Tyneside (i.e. all Primary Schools within Durham, Northumberland and Tyne and Wear counties). In total 425 Primary Schools were identified. Postcodes were spatially referenced using GeoConvert (UK Data Service, 2010). Seven postcodes could not be spatially referenced and were excluded from further analysis. Using ArcMap GIS 9.3 (a geographic information system (GIS) mapping program) postcodes were spatially mapped and overlaid onto Medium Super Output Areas (MSOA) boundaries.

3.5.1 Urbanicity

Disparities between urban and rural areas are widely cited as influencing PA and food environments (Smith *et al.*, 2010; Rind and Jones, 2011; Lake *et al.*, 2012). Within the UK, urban/ rural classification is shown to influence young people's time and type of PA involvement (Jones *et al.*, 2009). To the author's knowledge association between UK urban/ rural classification, food environment and diet have not been studied. International evidence however is suggestive of association (Michimi and Wimberly, 2010; Liu *et al.*, 2012).

Urban/ rural classification was obtained from the 2001 Census and mapped onto MSOA boundaries (Ordnance Survey and Office for National Statistics, 2001). *Urban* areas were defined as: a hectare grid square with population over 10,000 and *Rural* areas: a hectare grid square with population less than 10,000 comprising Town and Fringe, Village, Hamlet and Isolated Dwellings (Office for National Statistics, 2004; Communities and Local Government, 2008).

Primary School postcodes were intersected with Urban/ rural classification. There were 301 schools within 'Urban' areas, 88 within 'Town and Fringe' regions, and 29 within 'Village, Hamlet & Isolated Dwellings' regions (see Figure 7). Only the schools within urban regions were included in this study. Henceforth within this thesis urban schools are referred to as schools.

3.5.2 Socio-Economic Status

Social gradient is consistently shown to be a strong predictor of PA, diet and weight (Marmot, 2010). Stratification by deprivation therefore allowed comparison between areas and controlling of socio-economic factors within analysis.

English Indices of Multiple Deprivation (IMD) were mapped onto lower super output areas (LSOA) and aggregated to MSOA level geography (Department for Communities and Local Government, 2010). Aggregation at the MSOA level was in line with lowest-level geographical scale for urbanicity data.

A three tiered approach was adopted to facilitate comparison of IMD nationally (England), regionally (North East) and locally (North East Schools[5]), see Table 7. Quintile stratification was implemented according to literature precedent with five tiered stratification distinctly differentiating according to affluence and deprivation.

Mean IMD score for England was 21.51 (13.51 SD), North East 26.92 (13.20 SD), and North East Schools 31.90 (17.58 SD). Low scores are indicative of affluence.

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[5] North East schools were according to MSOAs containing primary schools.

The *North East* was more deprived than the national average and *North East Schools* more deprived again.

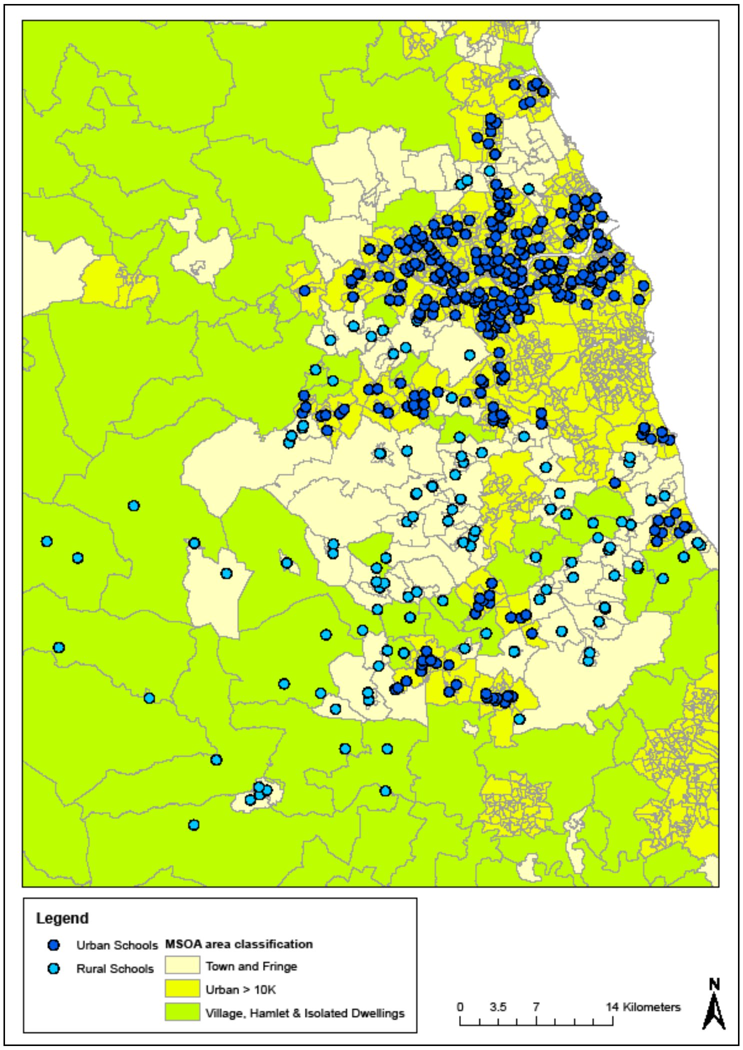

Figure 7: Urban/ rural classification of North East primary schools by MSOA

Region	**1 (Affluent)**	**2**	**3**	**4**	**5 (Deprived)**
England	1.95–9.86	9.87–14.68	14.69–21.61	21.62–32.59	32.60–56.83
North East	3.87–14.29	14.30–21.40	21.41–29.74	29.75–40.29	40.30–55.20
North East Schools	4.78–15.34	15.35–25.27	25.28–35.76	35.77–47.31	47.32–56.07

Table 7: IMD quintiles for England, North East and North East Schools

3.5.3 Obesity Prevalence Rates

The UK government Healthy Weight, Healthy Lives commitment was to *"reverse the rising tide of obesity and overweight in the population, by ensuring that all individuals are able to maintain a healthy weight. Our initial focus is on children: by 2020 we will have reduced the proportion of overweight and obese children to 2000 levels"* (Cross-Government Obesity Unit *et al.*, 2008, p. 10). In response to this, from 2007/ 08 all UK school children aged 4–5 years and 10–11 years have had their height and weight measured under the NCMP (Department of Health and Department for Children School and Families, 2008). The NCMP is a screening programme for cross-sectional monitoring of UK childhood BMI trends.

It was hypothesized that areas with consistently high obesity prevalence rates, according NCMP trend data, were potentially more obesogenic. Accordingly it was hoped that by stratifying areas by obesity prevalence rate environmental level obesogenicity differences would be detectable.

In 2011, NCMP aggregated BMI data from 2007/ 08–09/ 10 was made available at the MSOA level (National Obesity Observatory, 2011). MSOA aggregated BMI data enabled spatial mapping of obesity prevalence[6] at the area level (i.e. graded area obesity prevalence rates according to percentage of obese children in children aged 4–5 years and 10–11 years). For the purpose of this thesis only data for children aged 10–11 years were included in analysis.

In line with IMD data (see section 3.5.2 on page 44) obesity prevalence data was mapped by MSOA and stratified by quintile. Obesity prevalence data was not available for four schools; accordingly these schools were excluded from further analysis.

Obesity prevalence rate data was stratified into quintiles at *National*, *Regional* and *North East School* levels (Table 8). Mean obesity prevalence rate for England was

[6] NCMP defined obesity BMI cut off was adhered to: BMI greater than or equal to the 95th centile.

18.2% (SD 4.7), North East 20.3% (SD 4.3) and ‘North East Schools’ 21.4% (SD 3.9). Obesity prevalence rates in the *North East* were higher than the national average and *North East Schools* higher again. *North East* and *North East School* sampling areas excluded the extreme top and bottom obesity prevalence rates.

Region	1 (Low)	2	3	4	5 (High)
England	4.08–14.00	14.00–16.88	16.88–19.35	19.35–22.29	22.29–36.45
North East	7.54–16.74	16.74–18.97	18.97–21.81	21.81–24.23	24.23–29.69
North East Schools	10.98–18.08	18.08–20.51	20.51–22.99	22.99–24.71	24.71–29.69

Table 8: Obesity prevalence rate quintiles for England, North East and North East Schools

3.6 Participant Recruitment

Recruitment was different according to study phases, each recruitment plan is therefore discussed in turn.

3.6.1 Comprehension Testing

A convenience sample of young people aged 10–11 years was recruited to the Comprehension Testing phase of study via a local youth group and university contacts (April – May 2011). Participants were provided with recruitment literature and informed consent and opted-in to Comprehension Testing by parental written consent.

3.6.2 Activity and Dietary Intake Diary Feasibility and Validity Testing and Focus Group

All primary schools in Durham with *moderate* obesity prevalence rates (North East Schools obesity prevalence rate group 3, see section 3.5.3 on page 46) were contacted for recruitment (n=7, June 2011). With the aim to recruit two schools. Moderate obesity prevalence rate schools were contacted to avoid restricting *high* (group 5) and *low* (group 1) obesity prevalence rate schools for the main study.

All pupils aged 10–11 years were provided with recruitment literature and informed consent. Participants opted-in to Activity and Dietary Intake Diary Feasibility and Validity Testing and Focus Groups by parental written consent.

3.6.3 Activity and Dietary Intake Diary Validity Testing and Pilot Study (pCNES)

All primary schools in Sunderland with *moderate* obesity prevalence rates (North East Schools obesity prevalence rate group 3, see section 3.5.3 on page 46) were contacted for recruitment (n=7, July 2011). With the aim to recruit one school. Moderate obesity prevalence rate schools were contacted to avoid restricting *high* (group 5) and *low* (group 1) obesity prevalence rate schools for the main study.

All pupils aged 10–11 years were provided with recruitment literature and informed consent. Participants opted-in to Activity and Dietary Intake Diary Feasibility and Validity Testing Phase I and Pilot Study (pilot Children's Neighbourhood Environment Study (pCNES)) by parental written consent. Aim to recruit 15 participants.

3.6.4 Main Study (CNES)

Eight schools were purposefully recruited to the Main Children's Neighbourhood Environment Study (CNES) during September–December 2011 (winter, phase I) and March–May 2012 (summer, phase II). Literature supports cross-seasonal analysis of UK activity in young people owing to weather influence on PA and perceptions (Kirby and Inchley, 2009; Bentley *et al.*, 2012; Rich *et al.*, 2012).

Table 9 enumerates schools per affluent/ deprived IMD quintile[7] and high/ low obesity prevalence rate quintile[8] at the three geographical scales. *North East School* scale geography was used for CNES to maximise school recruitment potential at the top and bottom ends of deprivation, and obesity prevalence rate spectrums.

Eight schools were recruited – two from each IMD and obesity prevalence rate upper and lower quintile groupings (see Figure 6 on page 43). Recruitment

[7] See Table 7 affluent = group 1 and deprived =group 5.

[8] See Table 8 low obesity prevalence rate = group 1 and high obesity prevalence rate = group 5.

preference was for top and bottom quintiles to delineate areas by characteristics of choice.

Region	Affluent area		Deprived area	
	High OB	*Low OB*	*High OB*	*Low OB*
England	2	2	85	8
North East	1	16	43	10
North East Schools	2	20	24	7

Table 9: School count per affluent and deprived IMD quintile and highest and lowest obesity (OB) prevalence rate quintile for England, North East, North East Schools

Schools were contacted one-by-one (per type) for recruitment until saturation point was met (i.e. one of each four types per season). The recruitment process was as follows:

- Email brief overview of CNES and three attachments comprising: Formal Recruitment Letter, CNES Leaflet and CNES Consent Form;
- Posted letter comprising: Formal Recruitment Letter, CNES Leaflet and CNES Consent Form;
- Phone call with Head Teacher/ PHSE co-ordinator following-up email and letter clarifying and promoting CNES and detailing participation incentives (School: healthy living lesson/ activity, Participants: £5 shopping voucher);
- Meeting with Head Teacher/ PHSE co-ordinator if required to further clarify and promote CNES participation.

Fifteen participants were recruited from each of the eight schools on a random selection opt-out basis. The recruitment process was as follows:

- Recruited schools were asked to recruit 15 children aged 10–11 years;
- Fifteen Recruitment Fliers detailing CNES and opt-out consent were sent home to randomly selected pupils (as per teachers choosing);
- For each opt-out request returned teacher sent home an additional recruitment flier until saturation point.

Focus Group

This section outlines the methodology behind and methods used in CNES focus groups.

Focus groups were utilised to *"understand, options and views… [and] how these are advanced, elaborated and negotiated in a social context"* (Wilkinson, 2003, p. 189) for young people's 'average sphere of influence' and perceptions of their neighbourhood environment.

Focus groups were conducted on-site at schools in private rooms. Participants were audio recorded and anonymised by ID (#101–109); audio files were transcribed for thematic analysis. Themes were not pre-defined, so as not to influence focus group context, but rather stemmed from focus group output. Summary tables were used to group content by theme (Dixon-Woods *et al.*, 2005).

Topic guide development was aided by healthy living and environment qualitative research on/ with children and young people (Davis and Jones, 1996; Neumark-Sztainer *et al.*, 1999; O'Dea, 2003; Hume *et al.*, 2005; Hattersley *et al.*, 2009; Jago *et al.*, 2009a; Kirby and Inchley, 2009; Pearce *et al.*, 2009; Briggs and Lake, 2011).

Discussion topics included:

- Neighbourhood: what neighbourhood means/ is, what is done in the neighbourhood, what makes a neighbourhood attractive or nice, neighbourhood influences on behaviour;
- Activities: what activities means, influences on activities/ things done;
- Neighbourhood activity environment: activities done in the neighbourhood, neighbourhood influences on activities/ things done;

- Eating and drinking: influences on eating and drinking;
- Neighbourhood food environment: neighbourhood food and drink shops and adverts; neighbourhood food environment influence on dietary intake.

Open-ended questions/ discussion topics were posed to groups. Probing questions and use of examples (e.g. *"I think 'activities' includes energetic things like playing sports and walking to school and gentler activities like using the laptop, what do you think?"*) were utilised to stimulate discussion if necessary.

This section reports stages of methods development for novel methods. Development comprised: Attitude, Perception and Behaviour Survey comprehension testing; Activity and Dietary Intake Diary expert opinion, comprehension, feasibility and validity testing; and Food and Drink Advertising expert opinion, feasibility and validity testing.

3.7 Attitude, Perception and Behaviour Survey Comprehension Testing

Cognitive interviewing was used for the participant Attitude, Perception and Behaviour Survey (see Figure 15 on page 80). Questions were posed to ensure respondents understood question concepts, in a consistent manner, and in the way the researcher intended (Collins, 2003). A semi-structured interview using 'think aloud' and 'probing' techniques was utilised (Czaja, 1998; Willis, 1999). Interviews were conducted till saturation point (i.e. when no new information was presented).

Participants received surveys one hour – one day before interview commencement, in all cases for as long as possible. Participants were asked to *look at* and *complete* surveys.

All participants were from Newcastle-upon-Tyne. One-to-one interviews were carried-out in participant's homes (n=3) and youth club (n=2). The sample population was 100% female, mean age 10 years 5 months (SD 2 months).

Most survey questions were consistently well understood. Amendments post comprehension testing comprised:

- Addition of 'dancing' to activity examples in 'I like to be active' question;
- Addition of 'keep fit' to questions relating to being 'active';

- Questions were re-ordered with ‘neighbourhood environment’ and ‘activity’ questions placed above ‘dietary intake’;
- A ‘neutral’ response category was added resulting in a 5 point likert scale enabling definitive positive, neutral and negative responses.

Some questions were retained unchanged despite inconsistencies with understanding including: phrasing of ‘fruit and vegetable’ questions due to lack of better option, and no given definition of ‘near home’ due to issue complexity and lack of recognised literature standard.

A significant limitation of survey comprehension testing was not testing with male participants. This was due to absence of convenience sample, the reaching of interview saturation point, and time constraints. It is acknowledged that different or further information may have been gleaned from male participants; during the latter stages of testing comprehension questions were posed to male participants in an attempt to remedy this shortcoming.

3.8 Activity and Dietary Intake Diary

Table 10 outlines Activity and Dietary Intake Diary methods development and testing stages. This was an iterative process with diary amends made at each stage. See Figure 89 (page 338 and Appendices Disk) for completed diary.

Stage	Task	Section
One	Scoping reading leading to selection of diaries for consideration	
Two	Young person expert opinion	3.8.1
Three	Initial draft	
Four	Field professional and teacher expert opinion	3.8.2
Five	Comprehension testing (3 parts: diary look and content, activity self-report test exercise and dietary self-report test exercise)	3.8.3
Six	Feasibility and validity testing (diary completion with researcher observation)	3.8.4
Seven	Validity Testing (24 hour recall)	3.8.5

Table 10: Overview of activity and dietary intake diary method development and testing stages

3.8.1 Young Person Expert Opinion

A convenience sample of 60 young people (aged 13 years) at a school science promotion day were consulted about a range of food diaries: Fast Diary (Adamson *et al.*, 2003), Northumberland Schools Diary (Adamson *et al.*, 1992) and MFE Diary (Lake *et al.*, 2013, Under review). Diaries were developed for UK young people and were of varying styles and content. Permission to review diaries was granted from the authors.

Food item tick-list was the most popular dietary intake reporting method (n=42). Pupils thought it was an 'easy' option, especially for younger participants who may have difficultly spelling or writing. They discussed both the time *saving* and *consuming* (finding foods in list) nature of tick-lists, and recommended space to add missing food options was essential.

There were conflicting views on whether to impose eating time options in dietary reporting. Some suggested this may bias data recording whilst others suggested it would improve reporting accuracy. Preferred diary size was not consistently agreed. Pupils consistently championed the use of colour and illustration.

From this consultation it was concluded that no single diary type was consistently *preferred* or *better*. There was slight preference for tick-list reporting, and the need to produce a clear, age-appropriate and visually stimulating diary was clear.

3.8.2 Field Professional Expert Opinion

Expert opinion of field professionals was sought. Three PA assessment specialists (P. Rumbold, B. Saelens and J. Sallis) were consulted to assess diary appearance and content. Amendments to PA section of the diary post-consultation comprised:

- Hour-by-hour activity recording was replaced by activity occasion recording under four categories (general activities, classes or clubs, travelling and TV/ computer use) for morning, afternoon and evening;
- Terminology to explain general activities was changed from *"what activity have you done?"* to *"what did you do this morning/ afternoon/ evening?"*;

- Description of how participants felt was amended from ranked category to Pictorial Participants’ Effort Rating Table (PCERT) (Yelling *et al.*, 2002);
- Pictorial representation of travel methods were added;
- ‘Frequency of use’ and ‘mode of travel’ were added to questions about garden/ outside space, park and street use;
- Question layout was amended.

Two dietary intake assessment specialists (K. Glantz and S. Spence) were consulted to assess diary appearance and content. A dietician was also consulted to discuss utility of food diary for dietary analysis and review food item lists (A. Lake). Amendments to dietary intake section of the diary post-consultation comprised:

- Food item tick-list was used to record all meal times (replaced open self-report for lunch and dinner times);
- Digital photography replaced drawn dietary intake;
- Child body shape illustrations (Truby and Paxton, 2002; Truby and Paxton, 2008), used to assess participants ability to perceive their own body shape size were excluded;
- Quantities of foods consumed were excluded from recording. Food group level analysis was deemed preferable to nutrient level analysis;
- 24-hour recall validity testing was included at comprehension testing stage and repeated at the final validity testing stage.

Five youth specialists, three teachers (Year 6, 10–11 years) and two youth workers (working with young people 5–16 years) were consulted to assess diary content, suitability and appearance. The feedback was generally positive, diary amendments post-consultation comprised:

- Text on the ‘Example’ pages was changed to handwriting font to re-emphasise purpose;
- Diary was re-sized from A6 to A4 square (210 x 210 cm) allowing more space for participants to write;

- The secret agent theme which ran throughout the diary was deemed too childish for the 10–11 year group therefore was dropped.

3.8.3 Comprehension Testing

Comprehension, appeal and age-appropriateness of the Activity and Dietary Intake Diary were tested by cognitive interview. Interviews were semi-structured in design utilising open-ended questioning. The interview was divided into three sections which are discussed below.

Section One: Diary Content Questioning

Table 11 outlines responses to questions about the diary and how the diary was amended accordingly.

Section Two: Self-Report Activity Intensity Test Exercise

Table 12 shows there was only 22.5% agreement between participants rated activity scores and metabolic equivalent (MET) assigned model answers. MET is described in detail by Ainsworth *et al.* (2000). Kappa agreement was slight but significant (κ=0.13, p=0.01). Participants overestimated and underestimated PCERT in 67.5% and 10% cases respectively. The average range of discrepancy however was low (1.7 on a 1–10 scale).

Section Three: Self-Report Dietary Intake Test Exercise

Generally testing of dietary intake diary completion was done well when validated with 24 hour recall.

The two test exercises highlighted the need for researcher-led training to maximise diary completion understanding and accuracy. Accordingly a formal one hour training module was developed comprising discussion, teaching, diary completion and example photography. This training was assessed by three primary school teachers to ensure suitability.

Diary question	Positive comments	Negative/ improvement comments	Amendments
General comments	General liking, especially: size, graphics, speech-bubble instructions, numbering to dictate completion order, language clarity and simplicity	More colourful diary (n=1) More spaced out layout (n=1) Speech-bubble instructions better linked with task (n=1) Training in food photography recommended (n=2) Training in diary completion recommended (n=1)	White backgrounds replaced with colour Layout: text box and speech-bubble spacing and thicker boarders to delineate sections
PCERT scale and instructions	All participants looked at the PCERT scale	Three participants read instructions Confusion about activity complexity/enjoyment as feeling influencers (n=4) Difficult to differentiate between the lower levels on the scale (n=1)	Pages condensed Speech-bubble instructions included Training was considered going forward
Diary Completion Instructions	Participants thought diary was self-explanatory and the instructions were for parents Amount of instruction was perfect (n=1)	Too much text Shorter instructions in speech bubbles recommended (n=1) Add pictures (n=1)	Pages condensed Speech-bubble instructions included Graphics added Training was considered going forward
Example pages	Useful for double checking how to complete diary (n=3)	Two participants questioned need for these pages as they understood without it Remove 'hints and tips' where it blocks example text	Pages condensed Hints and tips repositioned to avoid masking text
Activities normally done	Good comprehension of 'normally', 'time', 'favourite activities' and completed section well	Difficult to include less common activities (e.g. weekly activities) and classify weekends (i.e. more variable) Add more space for completing clubs and classes Add 'outside space' to 'garden' question to be inclusive of yards Add something about playing on street	Speech bubble instructions added Additional space added for clubs and classes 'Outside space' added to 'garden' questions 'Playing on the street' frequency and activity type questions added Time categories were extended
Foods and drinks normally eaten/drunk	Good comprehension of 'normally' and completed section well	Needed help from parent/guardian (n=3) Explain what is included in food shopping and preparation (i.e. cold/hot food preparation) Add 'I don't like/have' option Didn't understand 'squash'	Added 'I don't like/ have' option Replaced 'squash' with 'cordial' 'What do you help with' added to food shopping/preparation Added 'if you don't know ask someone for help' instruction

Table 11: Cognitive interviewing questions, comments and diary amendments (n=5)

Activity Image	Participant assigned PCERT #001	#002	#003	#004	#005	MET* score	PCERT model
Painting	3	3	3	1	2	1.5	2
Lying on the floor exhausted	8	10	2	6	9	N/A	10
Walking to school	2	3	2	3	3	4	3
Playing tennis	7	6	6	5	7	7	7
Running	5	7	4	6	8	10	8
Using the computer	2	3	1	1	1	1.8	2
Playing football	4	7	2	6	6	9	8
Playing on the playground	3	5	1	4	5	5	6
Agreement count	2	2	0	1	4		

* MET scale 1–18

Table 12: PCERT scores for activity types and model answer (n=5)

A significant limitation of this phase of diary comprehension testing was not validity testing with boys, as previously discussed in section 3.7.

3.8.4 Feasibility and Validity Testing

Nine participants (10–11 years) in Durham Primary Schools feasibility and validity tested the Activity and Dietary Intake Diary. The sample population was 55.6% female, mean age 11 years 2 months (SD 5 months).

Participants were trained in diary completion and camera use. Diaries and photography were completed on one school day from break – lunch time (approximately 10.30–14.00). Participants completed the task independently and were advised to seek adult help if they had difficulty. The researcher did not provide participants with help or prompt diary completion. After the exercise participants were asked if they had *"enjoyed completing the diary"*, if it was *"easy or complicated and why"*, and if they had *"any suggestions for changes"*.

A trained researcher observed participant activity and dietary intake during break and lunch times. Information gathered was in-line with participant self-reports.

Physical Activity

Eight of the nine participants completed the Activity section of the Diary in full. ‘Activity instance’ and ‘Activity companion’ variables had very high participant and researcher percentage agreement (Table 13); the latter had a skewed kappa result due to low scoring variability. Fair kappa agreement for ‘Activity type’ was predominately due to participants misusing ‘Play’ instead of ‘Sports’ activity description (constituting 35.3% of activity instances with discrepancies). ‘Time active’ showed moderate kappa agreement; in 29.4% activity occasions participants did not subtract time spent eating from total lunch hour. ‘Activity intensity’ showed fair kappa agreement, though it should be noted mean difference in reporting was low (PCERT range 1).

Study Diary Category	**Kappa agreement (*p*)**	**Percentage agreement**
Activity		
Activity instance	**0.90 (<0.01)***	94.4
Activity type	**0.36 (0.02)***	50.0
Time	**0.53 (<0.01)***	66.7
Activity intensity	**0.22 (0.01)***	33.3
Activity companion	-0.03 (0.80)	88.9
Food and Drink		
Eating occasion	**1.00 (<0.01)***	100
Food/ drink type category	**0.49 (<0.01)***	55.7
Food/ drink item	**0.49 (<0.01)***	54.1
Sourcing location	**1.00 (<0.01)***	100
Eating location	**1.00 (<0.01)***	100
Eating companion	**1.00 (<0.01)***	100

** **Significant** at p<0.05 level*

Table 13: Activity and Dietary Intake Diary completion agreement between participant and researcher

Dietary Intake

None of the participants ate at break time but all participants ate at lunch time. Seven participants completed the Dietary Intake section of the Diary in full. There was perfect kappa and percentage agreement for ‘Eating occasion’, ‘Sourcing location', 'Eating location' and 'Eating companion' (Table 13). Moderate kappa agreement for food 'Type' and 'Item' was predominately owing to participants missing or misreporting foods. Commonly missing or misreported food *types* were: puddings, sauces and side dishes; and *items*: drinks, vegetables, side dishes and sauces. When instances of participant–researcher mismatch were excluded from analysis, kappa agreement rose to substantial for food *type* ($\varkappa$=0.81, p<0.01, 83.3%) and *item* ($\varkappa$=0.78, p<0.01, 80%).

Photographs

Seven participants took photograph(s) at break and lunch time, two only at lunchtime. Participants mostly photographed activity location rather than themselves being active (88.9%). Eight participants photographed activity environments/ equipment which they didn't use during reporting (e.g. playground equipment).

Eight participants took photograph(s) of what they ate and drank. When photos were present 87.5% had partial discrepancy (i.e. some missing/ misreported food items) and 12.5% total discrepancy (i.e. no agreement) with food diary reports.

Questioning

All participants expressed that they had enjoyed completing the diaries with particular emphasis on using the cameras. Two participants suggested that the diary was complicated due to layout, specifically the pages were very full and the separation of activity and food/ drink sections was confusing. Participants did not offer any suggestions for change.

Diary amendments comprised:

- Re-colouring and repositioning of instruction callouts and arrows;
- Image enlargement;
- Activity location was added to PE class description.

Training amendments comprised:

- Added ‘what does activity mean’ discussion to clarifying activity type;
- Extended discussion of PCERT scale with additional activity examples and discussion around activity intensity and personal fitness;
- Addition of a worked example of subtracting time spent eating from a school lunch hour;
- Researcher re-capped diary-completion section of the training prompting participants to complete all activity and dietary intake variables/ sections correctly;
- Greater emphasis placed on photograph training, especially how to photograph dietary intake with worked examples.

Protocol amendments comprised:

- Addition of post-diary completion interview.

3.8.5 Validity Testing

Dietary intake was recalled for the final 24 hours of the 4-day Activity and Dietary Intake Diary Pilot. See section 3.6.3 (page 48) for recruitment information. Seven participants completed 24 hour recall validity testing. Participant’s mean age was 11 years, 2 months (SD 6 months); 57.1% sample female. Recalls were performed on-site at school in a private room.

A short recall interval for the preceding 24 hours was employed in line with findings from (Baxter *et al.*, 2010) showing peak retention at shortest interval. Participants were questioned about what they had eaten and drunk the day before, being asked to recall food and drink consumed at breakfast, midmorning snack, lunch, afternoon snack, dinner and evening snack times. Researcher also prompted on common collectively consumed items (e.g. recalled fish and chips, prompted *“did you have mushy peas or sauce with that?”*).

Moderate and fair kappa agreement between Diary and 24 hour recall were achieved for food/ drink type (κ=0.41, p<0.01, 46.9% agreement) and item

($\varkappa$=0.36, p<0.01, 39.1% agreement). Participants readily mixed up dietary intake across the four days of diary recording in their recall. Table 14 outlines agreement at eating occasion level.

Training amendments comprised:

- Greater emphasis placed on reporting snacks.

Protocol amendments comprised:

- Extended post-diary completion interview with greater depth of questioning;
- Utilised contextual information about activities performed, locations and companions to aid recollection of dietary intake.

Eating Occasion	Total agreement	Partial agreement	Total disagreement
Breakfast	3	2	2
Morning snack	1		4
Lunch		6	1
Afternoon snack			4
Dinner		7	
Evening snack			4

* Snack agreement does not total 7 as not all participants consumed snacks

Table 14: Eating occasion reporting agreement between diary and 24 hour recall (n=7)

3.9 Outdoor Food and Drink Advertising Audit

At the point of Outdoor Food and Drink Advertising Audit Tool (OFDAAT) development, television advertising had been the focus of most food advertising research with/ on children with only preliminary work completed on print advertising in the physical environment (Story and French, 2004; Hastings *et al.*, 2006; Linn and Novosat, 2008; Pasch and Poulous, 2013). Recent studies from New Zealand and Australia reported a clustering of food advertising around schools with a bias towards advertisements for unhealthy foodstuffs (Maher *et al.*, 2005; Kelly *et al.*, 2008; Walton *et al.*, 2009). Hillier *et al.* (2009) found that unhealthy advertisements (comprising: sugary beverage, fast-food restaurants, alcohol and tobacco) were clustered around child-serving institutions in some US cities but not all, indicative of area-level influence. Further evidence from the USA suggests a greater outdoor advertising density in minority and low income communities, especially for obesity-promoting foodstuffs, alcohol and tobacco (Hackbarth *et al.*, 2001; Yancey *et al.*, 2009). These findings were not wholly supported by recent work in the North East of England which found positive associations between advertising space (in metres) and deprivation, and some evidence of negative association between affluence and advertisement nutritional quality (Adams *et al.*, 2011). These insights provided sufficient case to warrant further research examining the extent and impact of outdoor food and drink advertisement within the UK. Furthermore, with inconsistent measures of food and drink advertising within the outdoor environment there was a need to develop a validity tested tool with national and international applicability.

Consistent with the definition provided by Maher *et al.* (2005) outdoor advertisements were defined as: *"stationary objects containing either a recognisable logo and/ or an intended message"* (p.U1556). A broad definition was adopted to capture all food and drink advertising and branding stimulus within the neighbourhood environment. Table 15 outlines the OFDAAT methods development and testing stages. This was an iterative process with tool amends made at each stage. Refer to
Figure 90 on page 341 for final tool.

Stage	Task	Section
One	Food and drink advertising literature, policy and advertising audit instruments researched and summarised leading to initial draft	
Two	Field professional expert opinion	3.9.1
Three	Feasibility Testing	3.9.2
Four	Feasibility and Validity Testing	3.9.3

Table 15: Overview of Outdoor Food and Drink Advertising Audit Tool method development and testing stage

3.9.1 Field Professional Expert Opinion

The expert opinion of a field professional (Senior Lecturer in Food Marketing at Newcastle University M. Brennan) was sought to assess OFDAAT content. Amendments post-consultation comprised:

- Division of USP 'price' variable to 'price' and 'promotion' variables;
- Development of an OFDAAT Manual.

3.9.2 Feasibility Testing

OFDAAT was feasibility tested using a convenience sample of ten static advertisements on a single city centre street segment in Newcastle upon Tyne.

Amendments following feasibility testing comprised:

- Addition of 'Advert Categorisation';
- Addition of five 'Food/ Drink Type' variables;
- Addition of two 'USP' variables;
- Protocol amendment limiting information gathered within-the-field transferring non-contextual analysis to post-hoc using photographic evidence.

3.9.3 Validity Testing

OFDAAT was fully piloted in-the-field by a trained researcher in two socially and economically disparate regions (according to IMD) within Newcastle. Two 400m straight line buffer zones surrounding two primary schools (randomly selected from high/ low affluence schools in Newcastle) were audited in April 2011. Primary data collected in-the-field included advert: GPS location, in-situ location, street level information/ location, size, height, medium, general description and photograph.

For OFDAAT validation a second auditor underwent in-office training using the OFDAAT Manual and worked examples. Auditors completed audits concurrently and independently (April 2011).

More food and drink adverts were present in the *low* than *high* SES area: 275 and 159 respectively. There were comparable proportions of full and limited adverts in both areas (71.1% and 69.5% full adverts, respectively).

Table 16 shows OFDAAT had very high inter-rater reliability across all variables except 'Target Audience'. Percentage agreement shows 'Target Audience' moderate kappa agreement of was a misclassification due to low response variability.

OFDAAT amendments following validity testing comprised:

- 'High fat salt and/ or sugar mixed food items' variable was added to 'Eatwell Category';
- Greater clarification of USP variables were added to the OFDAAT Manual;
- 'Energy drinks' variable was added to 'Food/ Drink Type'.

Category	**Kappa agreement (*p*)**	**Percentage agreement**
Advert Setting	**0.97 (<0.01)***	99.5
Advert Categorisation	**0.95 (<0.01)***	96.5
Main feature/ proxy	**0.92 (<0.01)***	99.3
Eatwell Category 1	**0.83 (<0.01)***	88.2
Eatwell Category 2		94.1
Food/ drink Type 1	**0.91 (<0.01)***	92.4
Food/ drink Type 2		92.3
Unique Selling Point 1	**0.86 (<0.01)***	88.2
Unique Selling Point 2	**0.93 (<0.01)***	94.4
Target Audience	**0.44 (<0.01)***	98.4
Theme		100

* ***Significant*** *at p<0.05 level*

Table 16: Validation results for Outdoor Food and Drink Advertisement Audit Tool

This section details pilot and main study methods, chapter sections are divided on the basis of data collection *phases* and *methods* in order of application. Within each section method selection is discussed and outlined.

Concurrent real-world real-time data was collected on behaviour (by self-report diary), perception and value (by self-completed survey) and the physical environment (by naturalistic objective exposure measurement). All objectively measured environmental exposure data was collected within three weeks of self-reported behaviour to assure timely accuracy of the exposure environment. The CNES pilot study (pCNES) tested the full CNES process as outlined in Figure 8 and is detailed in sections 3.10–3.16.

A non-experimental fixed design was employed in the main study stage guided by literature and Focus Group findings. A fixed design has the advantage of being able to *“transcend individual differences and identify patterns and processes which can be linked to social structures and group or organisational features”* (Robson, 2011, p. 83). Reliability was maximised by using validated tools and strict protocols but participant bias and observer error and bias are acknowledged.

8 schools recruited (2 each per season: winter and summer):

- *Deprived* and *high obesity* prevalence rate area
- *Affluent* and h*igh obesity* prevalence rate area
- *Deprived* and *low obesity* prevalence rate area
- *Affluent* and *low obesity* prevalence rate area

15 participants recruited per school (opt-out)

Target n=120, recruited n=118

1 hour group training:

4-day self-report Activity and Dietary Intake Diary completion and digital camera use

→ School #40008, 13 participants recruited

→ School #40006 opt-in recruitment – replaced #40009

Participants completed 4-day Activity and Dietary Intake Diary, Photography and Attitude, Perception and Behaviour survey:

- 60 participants completed diary Thursday – Sunday
- 58 participants completed diary Saturday – Tuesday

Missing activity/diet/survey data check

Target n=118, completed n=108

→ Diary incomplete – 2 further attempts

→ 10 excluded

Participant one-to-one interview with researcher: *(15–30 minutes)*

- Query all activity behaviour and dietary intake data
- Complete missing data
- Check photos and assign photo ID to activity/diet occasions

Participant anthropometric (height and weight) measurement

Parent/Guardian Attitude, Perception and Behavioural survey (sent and returned with participants)

Target n=118, returned n=70, completed n= 67

→ Survey content assessed >90%

→ 3 excluded

Participant neighbourhood environment walked survey (400m postcode centroid buffer):

- Parks & Green spaces (GPS location/proximity, type & quality assessment)
- Sports Facilities (GPS location/proximity & type)
- Non-food shops and services (GPS location/proximity & type)
- Road Safety (10% neighbourhood streets safety assessment)
- Street Quality (10% neighbourhood streets quality assessment)
- Cyclability (10% neighbourhood streets cycling facilities)
- Food Outlets (GPS location/proximity, type & healthfulness analysis)
- Food and Drink Advertising (GPS location/proximity & content analysis)

Participant neighbourhood environment survey (400m buffer):

- Road and street length & type

Figure 8: Children's Neighbourhood Environment Study process

3.10 Self-Reported Activity Behaviour

Participants self-reported sedentary and active behaviour using a four day diary (see Figure 89 on page 338). The diary was developed-for-purpose drawing from existing validity tested diaries and guidance including: HSE (Aresu *et al.*, 2009), Physical Education School Sports and Club Link Survey (Ofstead, 2005), National

Travel Survey (Department for Transport, 2012), Day in the Life Questionnaire (DILQ) (Edmunds and Ziebland, 2002), Synchronised Nutrition and Activity Program™ (SNAP) (Moore *et al.*, 2008), and Time-use Survey (Gershuny, 2011). Multi-day self-report diary reporting is an established method which was commensurate with study resource and purpose (i.e. to gain insight into time and context of sedentary and active behaviour).

It is acknowledged that there is range of literature opposed to using self-report methods by young people due to issues of inaccuracy, over/ under-reporting, social desirability bias and poor compliance (Kohl *et al.*, 2000; McPherson *et al.*, 2000; Welk *et al.*, 2000; Adamo *et al.*, 2009; Collins *et al.*, 2010; Ekelund *et al.*, 2011). Whilst alternate objective (e.g. biological sampling, GPS tracking devices, accelerometers, pedometers and direct observation) and subjective methods of activity and sedentary behaviour reporting (e.g. parent report, questionnaires and recall) exist and have been reviewed (Kohl *et al.*, 2000; Corder *et al.*, 2008; Dollman *et al.*, 2009; Rachele *et al.*, 2012; Hardy *et al.*, 2013); these methods were not appropriate for this study.

Participants were trained in diary completion by the researcher using worked examples. Training comprised a 60–90 minute in-classroom training session. The training session was devised by the researcher and the content assessed and amended by a consultant teacher to ensure appropriateness of pitch and speed of delivery. During training sessions diaries (and cameras) were given to participants for four-day completion. The researcher collected diaries after four days for review prior to participant interviews.

3.10.1 Activity Instance

Participants self-reported all sedentary and active behaviour by *activity instance*. An activity instance was defined as: any duration of time reported doing any type of activity, in any location, at any activity intensity. Within-school time, except PE class, break and lunchtime, was excluded from analysis.

Activity instances were recorded within a pre-defined series of *activity occasions* for Morning, Afternoon and Evening (e.g. school day morning: travel to school, break time and morning PE class). Division of time into predefined categories was guided by literature showing increased validity of self-reports by providing contextual factors to aid reporting and recollection (Baranowski, 1988; Foley *et al.*, 2012).

Multiple *activity instances* could be reported within a single *activity occasion*. For example 8 minutes travel to school (activity occasion) comprising: 5 minutes sedentary in car and 3 minutes low intensity walking (two activity instances).

3.10.2 Activity Type and Coding

Participants reported *activity type* by open-ended response. Activity types were coded discretely per activity instance. For example Figure 9 shows six activity *types* and *instances* within four activity *occasions* comprising: two 'general activities' (playing out and shopping), one 'club/ class' (football), two 'travel' instances (car travel and walking), and one 'TV/ Computer' instance.

Attempts were always made to fully complete self-reports at the interview. In the absence of full self-reports pre-defined assumptions about sedentary and activity reporting were made (e.g. 'travel to school' assume in 'neighbourhood'). Assumptions were consistently adhered to.

3.10.3 Activity Intensity

Activity intensity was self-rated by participants according to the validated 10-point Pictorial Children's Effort Rating Table (PCERT) (Yelling *et al.*, 2002; Marinov *et al.*, 2008), see Figure 10. PCERT use was in line with literature precedent.

3.10.4 Activity Location

Activity location was self-reported by open-ended response. Location responses were re-categorised into seven overarching groupings:

- Garden – outside space attached to house, comprising home, family and friend's gardens;

- House – comprising home, family and friend's houses;
- Neighbourhood – outside space self-defined as the neighbourhood and taking <60 minutes to travel to;
- Parks, green and open spaces – comprising public and private access;
- School;
- Sports facilities – designated sports/ leisure/ recreation facilities, comprising public and private access;
- Other – all other spaces not previously defined.

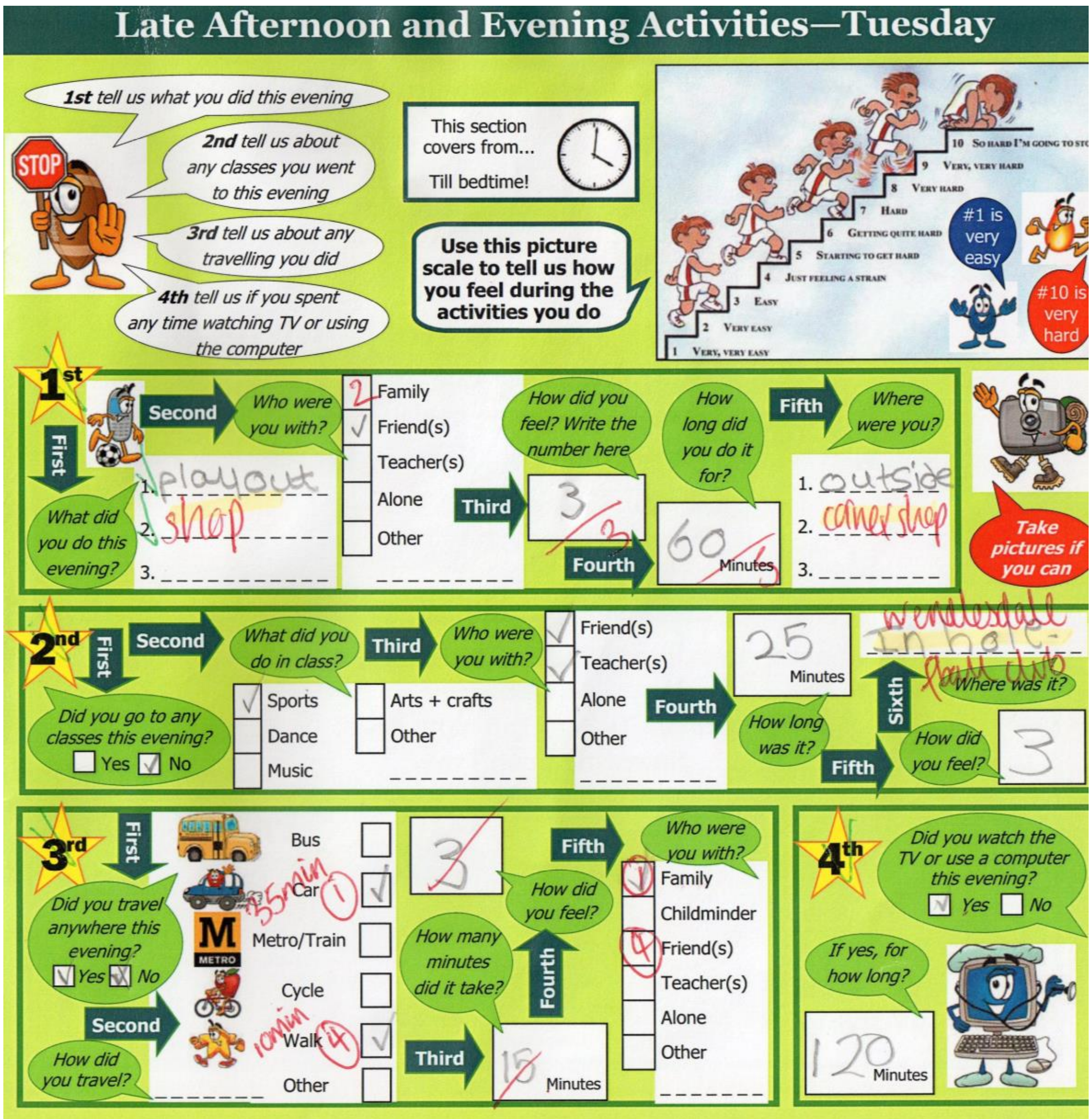

Figure 9: Participant #439 school day afternoon and evening activity

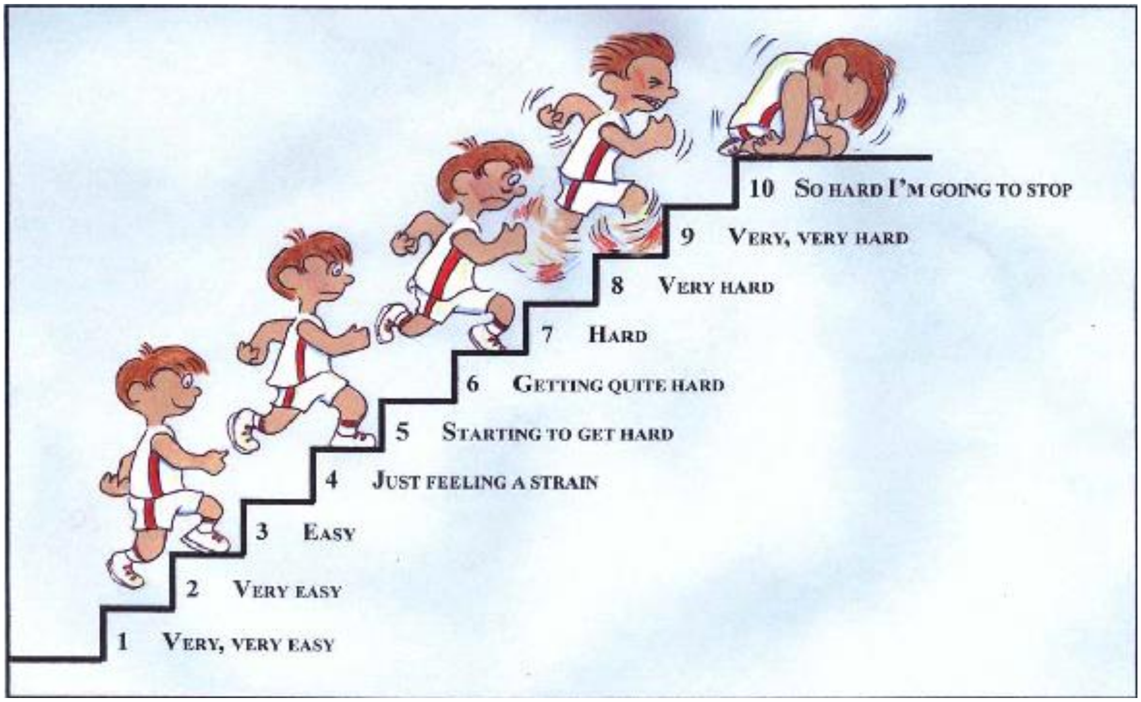

Figure 10: Pictorial Children's Effort Rating Table taken from (Yelling et al., 2002)

3.10.5 Activity Companion

Activity companion was self-reported by tick list and open-ended response (single or multiple companion(s) as applicable). Responses were re-categorised into six overarching groupings:

- Adult – comprising carers, child-minders and teachers;
- Adult and friend(s) and/ or family;
- Alone;
- Family – self-defined family including extended family;
- Family and friend(s);
- Friend(s).

3.10.6 Self-Report Activity Amendments

Digital photographs (see section 3.12 on page 78) were used during participant interviews to correct diary–photography discrepancies.

Verbal prompts were also used during interviews to: 1) provide missing self-reported information (e.g. *"it looks like you forgot to record what you did last night,* *can you remember what you did after dinner?");* and 2) supplement information provided in the diary (e.g. *"you have written that you went swimming on Saturday morning, how long did you swim for?"*). See Figure 9 for an example of diary amendments in red pen.

3.11 Self-Reported Dietary Intake

Participants self-reported dietary intake using a four day diary (see Figure 89 on page 338). The diary was developed-for-purpose drawing from existing validity tested diaries and guidance including: NDNS Food and Drink Diary (Department of Health and Food Standards Agency, 2011), Child and Diet Evaluation Tool (Cade *et al.*, 2006), DILQ (Edmunds and Ziebland, 2002), SNAP^{TM} (Moore *et al.*, 2008), Child Nutrition Questionnaire (Wilson *et al.*, 2008), Fast Diary (Adamson *et al.*, 2003), Northumberland Schools Diary (Adamson *et al.*, 1992) and MFE Diary (Lake *et al.*, 2013, Under review).

Multi-day self-report diary reporting is an established method which was commensurate with study resource and purpose (i.e. to gain insight into food group intake and contextual factors surrounding eating). No minimum dietary intake cut-offs were used (for example see (McCrory *et al.*, 2002) and (Black, 2000)) owing to recognition of the limitations of the measurement tool which cannot provide sufficient granularity of detail.

Frequently cited concerns in the literature with self-report methods are acknowledged including: inaccuracy, over/ under reporting (deliberate or subconscious), social desirability bias and attitude towards food (Schoeller, 1990; Hill and Davies, 2001; Trabulsi and Schoeller, 2001; Maurer *et al.*, 2006). While other objective (e.g. doubly labelled water and direct observation) and subjective methods of dietary intake reporting (e.g. weighed diet records, recall, diet histories and questionnaires – including technological solutions) were available. There are several published reviews on this topic (Brener *et al.*, 2003; Livingstone *et al.*, 2004; Long *et al.*, 2010; Roberts and Flaherty, 2010; Illner *et al.*, 2012). These were not appropriate for this study.

Participants were trained in diary completion by the researcher using worked examples as part of a 60–90 minute in-classroom training session, as previously discussed.

3.11.1 Eating Occasion

Participants self-reported dietary intake by *eating occasion*. An eating occasion was defined as: any occurrence when food or drink was consumed (food and drink items hereafter are referred to as food items).

Eating occasions were reported within six pre-defined daily times: breakfast, morning snack, lunch, afternoon snack, dinner and evening snack. Single or multiple food item(s) could be reported within a single eating occasion. For example Figure 11 shows participant #414’s weekend (day one) breakfast comprised two food items and one drink and mid-morning snack only one drink.

3.11.2 Dietary Composition and Coding

Participant’s self-reported dietary intake by food item tick list. Tick list food items were taken from NDNS commonly consumed food items for 10–11 year olds (Department of Health and Food Standards Agency, 2011; Department of Health and Food Standards Agency, 2012a). Food items not included in tick lists were reported by open-ended response.

Participants reported *usual type* of frequently consumed food items before diary completion (e.g. white bread and semi-skimmed milk); this type was assumed throughout the diary unless otherwise stated. Attempts were always made to fully complete self-reports at interview. In the absence of full self-reports pre-defined consistently adhered to dietary reporting assumptions were made (e.g. when Tuna reported assume canned variety).

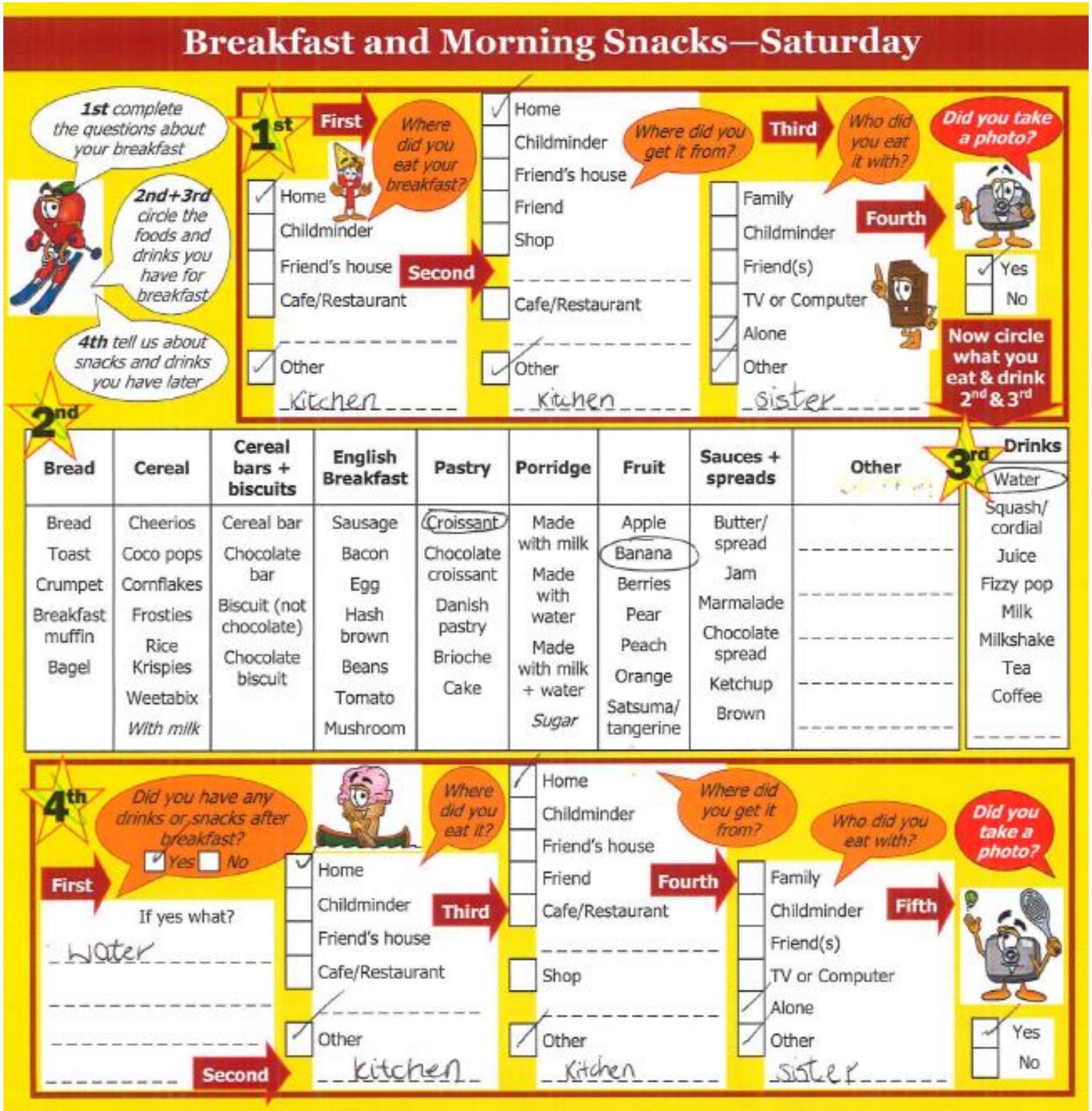

Figure 11: Participant #414 weekend day morning dietary intake

Food items were coded according to NDNS food group and sub-types[9]. Additional food groups and sub-types were added to NDNS groupings in line with dietary reporting, including two food groups: ‘Sauces’ and ‘Other deserts’, and 41 sub-types, for example addition of ‘Water’ and ‘Energy drinks’ to ‘Beverage’ food group. NDNS coded food items were amalgamated into 10 overarching food and drink categories:

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[9] For example food group: Fish (11), sub-types: White fish coated or fried (11.1); Other white fish or shellfish (11.2) and; Oily fish (11.3).

- Carbohydrates – including cereals, cereal products and potatoes;
- Dairy – including milk, cream, yoghurt, diary deserts and cheese;
- Fried/ high fat snacks – including hot snacks (i.e. samosas), chips and other fried/ high fat carbohydrate products (i.e. fried bread, pastry and Yorkshire pudding) and cold snacks (i.e. crisps, popcorn and cheese biscuits);
- Fruit and vegetables – including raw, cooked, juiced and dried varieties;
- Protein – including meat (unprocessed and processed and vegetarian substitutes), fish (unprocessed and processed), eggs, nuts and seeds;
- Puddings, deserts, cakes and biscuits – including buns, cakes, pastries, fruit flavoured deserts, iced deserts (ice cream, frozen yoghurt and lollies) and biscuits (plain, chocolate and cereal);
- Sauces and spreads – including fat spreads (full and low-fat versions), preserves and sugar spreads and all condiments/ sauces (i.e. mayonnaise, satay and curry sauce);
- Sweets and chocolate – including all sugar and chocolate confectionary;
- Low calorie drinks – including diet soft drinks, tea, coffee and water;
- High calorie drinks – including non-diet soft drinks, energy drinks and milkshake.

Food items were coded individually according to *type* by *eating occasion*. Food items were defined as: distinct and nameable items. For example individual items (e.g. apple) or constituent parts of a whole (e.g. sausage roll comprising pastry and sausage). Figure 12 shows a single eating occasion, single food photo, and five food items. Figure 13 and Figure 14 show a single eating occasion; two constituent food photographs; one and four food items per image, respectively.

Figure 12: Participant #402 school day lunch

Figure 13: Participant #402 weekend evening meal part 1

Figure 14: Participant #402 weekend evening meal part 2

3.11.3 Food Sourcing Location

Food sourcing location was self-reported by tick list and open-ended response. Food sourcing location was assigned per eating occasion (single or multiple location(s) as applicable). Locations were re-categorised into four overarching groupings:

- Food outlet – comprising shops, cafés, restaurants, takeaways, hotels, marquees, leisure, sports and entertainment venues;
- House – comprising home, family and friend's houses;
- School;
- Other – all other spaces not previously defined.

3.11.4 Eating Location

Eating location was reported by tick list and open-ended response. Eating location was assigned per eating occasion (single or multiple location(s) as applicable). Locations were re-categorised into seven overarching groupings:

- Food outlet – comprising cafés, restaurants, takeaways, hotels, marquees, leisure, sports and entertainment venues;
- Garden – comprising home, family and friend's gardens;
- House – comprising home, family and friend's houses;
- Neighbourhood – outside space self-defined as the neighbourhood and taking <60 minutes to travel to;
- Parks, green and open spaces – comprising public and private access spaces;
- School;
- Other – all other spaces not previously defined.

3.11.5 Eating Companion

Eating companion was reported by tick list and open-ended response. Companion was assigned per eating occasion (single or multiple companion(s) as applicable). Companion type was re-categorised into five overarching groupings:

- Adult – either alone or with an adult and friend(s) and/ or family[10];
- Alone;
- Family;
- Friend(s);
- TV/ Computer – either alone, with friend(s) or family.

3.11.6 Self-Report Dietary Intake Amendments

Photographs and verbal prompts were used during participant interviews to ensure full diary completion, as per section 3.10.6.

3.12 Photography

Photography (including photo voice, elucidation and interviewing) is widely accepted as an inclusive, empowering and non-intimidating means of communication for young people which can be used alone on in conjunction with other research methods (Christensen and James, 2000; Punch, 2002; Barker and Weller, 2003; Thomson, 2008; Clark and Moss, 2011).

Photography has been used with success with young people to study: the physical environment (Rasmussen, 2004; Anthamatten *et al.*, 2013), PA participation (Walia and Leipert, 2012), school journey (Ross, 2007; Kullman, 2012), the food environment (Pearce *et al.*, 2009; Briggs and Lake, 2011; Findholt *et al.*, 2011; Bibeau *et al.*, 2012) and weight loss (Woolford *et al.*, 2012).

In a study assessing preference for dietary assessment method Boushey *et al.* (2009) found young people (aged 11–15 years) both *preferred* and were *more likely* to use photography than pen and paper recording methods. Furthermore Darbyshire *et al.* (2005) advocated the use of multiple methods, including photography, for recording PA behaviour and use of space. Accordingly photography was used in CNES to provide narrative and/ or contextual factors, aid

[10] This category tended to comprise adult supervised activities i.e. child-minder and groups of children or single child, or teacher and class or single child.

Activity and Dietary Intake Diary completion and the recollection of self-reported behaviour/ intake.

Participants were assigned a digital camera each and instructed to photograph what they did (i.e. sedentary and active behaviours) and what they ate and drank (i.e. dietary intake). No limit was set for number of photographs taken. Instruction was to photograph everything they could and focus images on *what* and *where* (i.e. contextual factors) they were active or eating/ drinking. Participants were trained in camera use using worked examples as part of a 60–90 minute in-classroom training session, as previously discussed.

3.13 Participant Attitude, Perception and Behaviour Survey

A paper survey was used to obtain opinion and behavioural estimation (see Figure 15). This is an established method and was in-keeping with CNES resources and purpose. Surveys pose low-level burden and intrusion, they are simple to administer and complete (when high quality design utilised) and they are free from variation in application enabling direct comparison (Rea and Parker, 2005; Sapsford, 2007; Harrison, 2010).

Attitude and perception survey questions were centred on four themes consistent with study aims and self-reported information gathered: Neighbourhood environment activity facilitation, PA, Eat well attitudes and Body shape satisfaction. Responses were rated on a five-point Likert agreement scale spanning: positive, neutral and negative response categories. Additional survey data comprised: Self-reported home affluence (Wardle *et al.*, 2002); Active or sedentary clubs or class attendance; Garden/ yard/ outside space and park descriptive; Time spent in pre-defined activity categories during week and weekend days; and Food shopping and preparation participation. Survey questions were validity tested with target age group as discussed in section 3.7.

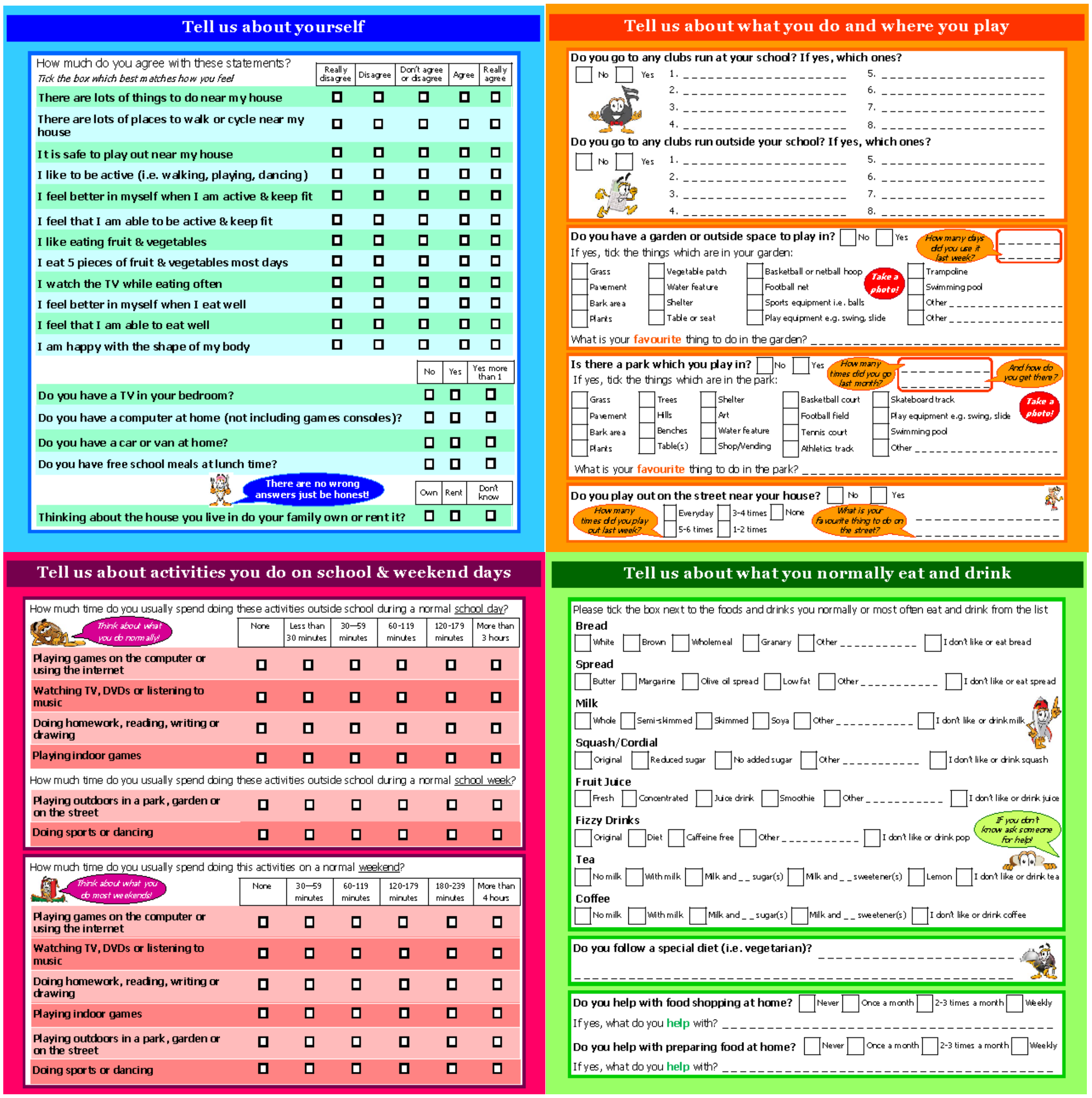

Figure 15: Participant Attitude, Perception and Behaviour Survey

3.14 Anthropometric Measurement

BMI is an established method for assessing adiposity and is accepted to have relatively sound validity when compared to alternate adiposity measures (e.g. waist-to-hip ratio, circumferences, bio-impedance and dual X-ray absorptiometry), especially when categorising by for-age cut offs (Mei *et al.*, 2002; Reilly, 2010; Boeke *et al.*, 2013). Moreover, BMI is used by the NCMP to report adiposity; having used this data to guide section of case study schools (see section 3.5.3 on page 46) it was appropriate to use BMI accordingly.

Frequently cited flaws in childhood BMI literature comprise: age, sex, height, maturation and ethnicity biases and questionable validity with regards measurement of body fatness. Issues are discussed at length elsewhere (Krebs *et al.*, 2007; Freedman and Sherry, 2009; Doak *et al.*, 2013, In Press).

BMI cut offs are not consistently applied in childhood adiposity literature (Neovius *et al.*, 2004; Sweeting, 2007; Rolland-Cachera, 2011). Commonly employed cut offs in the UK are: UK 1990 population thresholds (85th and 95th centiles) (Cole *et al.*, 1995), International Obesity Taskforce (IOTF) cut points (Cole *et al.*, 2000; Cole *et al.*, 2007) and WHO 2007 growth reference for 5–19 year olds (de Onis *et al.*, 2007). CNES employed IOTF BMI cut points as weight status categories spanned the full spectrum of weight statuses.

3.14.1 Measurement Protocol

Researchers underwent training in height and weight measurement by a measurement expert. Height and weight measurement protocol was *informed by* and *consistent with* training and NCMP protocol[11] (Department of Health Obesity Team and Department for Education, 2011). Two researchers completed the measurements. Refer to Table 68 on page 340 for full protocol.

3.15 Parent/ Guardian Attitude, Perception and Behavioural Survey

A paper survey was used to obtain parent/ guardian opinion and behavioural estimation (see Figure 91 on page 342 for final draft). This is an established method and was in-keeping with CNES resources and purpose. See section 3.13 (page 79) for a justification of survey use.

Parent/ guardian survey questions were drawn from previously validated tools centred on three themes consistent with study aims and participant data. These are discussed in turn in sections 3.15.1–3.15.3.

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[11] Protocols closely follow wording and practice of the Department of Health Obesity Team and Department for Education (2011) National Child Measurement Programme: Operational guidance for the 2011/12 school year.

Questions were rated according to a four-point Likert scale. Attitude and perception questions spanned agree/ disagree response categories, behavioural questions frequent/ infrequent.

Parents also reported:

- Child's ethnic group;
- Personal relationship to child;
- Personal height and weight;
- Personal highest academic achievement;
- Parenting style (rated on a four-point agreement/ disagreement scale).

No direct researcher–parent contact was made, consequently survey inclusion criteria was ≥90% content[12].

3.15.1 Neighbourhood Environment

Parent/ guardian neighbourhood environment attitude and perception questions were taken from Neighbourhood Environment Walkability Scale (NEWS) (Saelens *et al.*, 2003) and NEWS for Youth (NEWS-Y) (Rosenberg *et al.*, 2010). NEWS-Y is an adapted version of NEWS and as such there is a high degree of question cross-over. Both tools are validated environment questionnaires suitable for use by adults and parents. NEWS-Y specifically is shown to have high reliability between parent perception and neighbourhood use by children aged 5–11 (being active in the street, being active in a park, walking to a park, walking to shops and walking to school) making it suitable for CNES.

NEWS is divided into nine, and NEWS-Y into eight sub-scales. Of these, six were represented in the included survey questions: Access to services (land use mix),

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[12] Attempts were made during pCNES to send incomplete/part completed questionnaires home to parent/guardians with instructions/encouragement to complete and a stamped addressed envelope. There was a 0% success rate. Coupled with the focus of CNES being predominately 'the child' questionnaires were accepted as given and an exclusion criterion was applied.

Places for walking or cycling, Neighbourhood surroundings (aesthetics), Neighbourhood safety (including pedestrian and automobile), Crime safety and Neighbourhood satisfaction. Question wording was altered from American-English to English where applicable. Sub-scales were further amalgamated into four themes outlined in Table 17.

Definition of 'Neighbourhood' was not provided to parents owing to the complexity of this concept, lack of standardised definition and wide variation in perceived neighbourhood scale (Minnery *et al.*, 2009; Coulton *et al.*, 2013).

Theme	**Questions**
Service access	There are many places to go within easy walking distance of my house
	There are lots of shops & services within walking distance of my house
	There are lots of recreation opportunities & services within walking distance of my house
	I am happy with the number & quality of food outlets in my local neighbourhood
	There are lots of public transport options & routes within walking distance of my house
Places to walk/cycle	There are lots of walking routes within my neighbourhood enabling walking to places
	Cycle tracks & pedestrian trails in or near my neighbourhood are easy to get to
Aesthetics	My neighbourhood is generally rubbish free
	The streets in my neighbourhood are well maintained (i.e. paved, not a lot of cracks)
	My neighbourhood is attractive (i.e. buildings, planting & natural sights)
Safety & crime	I am happy for my child to be alone, or with friends unsupervised, in the neighbourhood
	Traffic speed on the street & nearby streets that I live on is usually slow (<30 mph)
	There is so much traffic in my neighbourhood that it makes it difficult or unpleasant to walk
	My neighbourhood streets are well lit
	There is a high crime rate in my neighbourhood

Table 17: Parent/ Guardian Survey: neighbourhood

3.15.2 Physical Activity

Parent/ guardian PA attitude and behavioural questions were drawn from Activity Support Scale (ACTS) (Davison *et al.*, 2003; Davison and Jago, 2009) and ACTS for Multiple Groups (ACTS-MG) (Davison *et al.*, 2011). ACTS-MG is an adapted version of ACTS and as such there a high degree of question cross-over. Both tools are validated PA questionnaires suitable for use by parents. ACTS and ACT-MG have high reliability between parent perception and child's PA behaviour making them suitable for CNES.

Theme	Questions
Personal PA/ modelling	I enjoy exercise & physical activity I walk/cycle in my local neighbourhood I exercise or am physically active on a regular basis I encourage my child to be physically active by leading by example (by role-modelling)
Encouragement of child's PA	I encourage my child to walk/cycle to school I encourage my child to use resources in our neighbourhood to be active (i.e. park, green space, school or playground)
Facilitation of child's PA	I enrol my child in sports teams & clubs such as football, basketball & dance I enrol my child in community-based programs (i.e. Scouts & Guides) where he/she can be active I find ways for my child to be active when school is out by, for example enrolling him/ her in summer camp & after school programs
Personal participation in child's PA	I walk/cycle with my child in my local neighbourhood I take my child to places where he/she can be active I watch my child play sports or participate in activities such as football, dance & karate
Restriction of sedentary pursuits	I limit how long my child plays video games (including Playstation, Xbox & Gameboy) I limit how long my child can watch TV or DVDs each day (including educational & non-educational programs)

Table 18: Parent/ Guardian Survey: physical activity

ACTS and ACTS-MG are divided into four sub-sections: Use of community resources, Logistic Support, Restricting access to sedentary activities and

Modelling. Questions were drawn from all sub-sections and were separated into five themes outlined in Table 18. Question wording was altered from American-English to English where applicable.

3.15.3 Home Food Environment

Parent/ guardian home food environment questions were taken from the Home Food Environment Questionnaire (HFEQ) (Lake *et al.*, 2009a) and Child Feeding Questionnaire (CFQ) (Birch *et al.*, 2001).

Theme	**Questions**
Positive meal-time practices	My child eats breakfast
	My child eats fast food/takeaway with our family
	My child eats meals in front of the TV/computer
	My child eats at the dining table
	My child has limited portion sizes at mealtimes
	I eat healthy snacks or meals in front of my child
Positive food access and encouragement	I keep sugary drinks/snacks where they can be easily seen/reached by my child (limited)
	I keep fruits & vegetables where they can be easily seen/reached by my child (freely)
	If my child asks for fruits & vegetables I give them to him/her
	How often do you tell your child that confectionary/sugary drinks are bad for their teeth or will lead to weight gain or are unhealthy
	How often do you tell your child that eating fruit & vegetables is good/ healthy?
Permissiveness of child's eating	My child eats snacks without permission
	My child has to eat all the food on his/her plate
	If my child dislikes something I tell him/her that he/she will get desert if they eat it
	I use food to reward my child
	When my child does not like something he/she gets something they do like
	If my child asks for sugary drinks/snacks I give them to him/her

Table 19: Parent/Guardian Survey: dietary intake and food

HFEQ comprises questions from validated surveys comprising: Neopean Kids Growing Up Students Questionnaire (Campbell *et al.*, 2007), DEPA (Lake *et al.*, 2009b), My Place, My Plate, My Perspective (Lake *et al.*, 2009b), Health Behaviours in School Aged Children survey (Roberts *et al.*, 2009) and Home Environment Survey (Gattshall *et al.*, 2008). HFEQ is a questionnaire developed for use by UK parents. Questions based on child-feeding attitudes and practices were taken from the validated CFQ. Questions were selected to elicit information on Monitoring (what child eats), Restriction (what child eats) and Pressure to eat. Questions from HFEQ and CFQ spanned three themes outlined in Table 19.

3.16 Neighbourhood Environment

Various physical and built environment features were objectively assessed within all participants' 400m buffer neighbourhood environments by means of walked environmental assessment.

Straight line buffers were drawn from participants' self-reported home postcode (by centroid) using GIS 10.0 (all subsequent mention of GIS/ mapping/ spatial analysis in this thesis used GIS version 10.0). A straight line buffer was selected in line with literature precedent and to ensure all participants underwent the same environmental assessment (i.e. within an equal area of close proximity) (De Smith *et al.*, 2007).

It is acknowledged that some evidence suggests straight line buffers may be biased, as built and physical environment features can impede pedestrian and automotive travel and/ or environment use, and therefore network buffering may be preferable (Oliver *et al.*, 2007). In a recent paper from the US however,Forsyth *et al.* (2012) found that fast-food restaurant and convenience store counts/ densities and per cent open space were not significantly different using either straight line or network buffers (at 1600m). Moreover they found, there was no significant difference in correlations between environment features and adolescent activity or dietary behaviours using either buffer type. Additionally using a dataset from the North East Burgoine *et al.* (2013) found food outlet density (food bought out of the home comprising 'Grocers' and 'Convenience and incidental outlets', see Table 24) measures were similar for straight line and street network buffers.

A 400m (quarter mile) radius represents approximately 5 minutes walking distance from home. There has been inconsistent application of buffer size in studies examining the physical environment (Dunton *et al.*, 2009). Though some evidence suggests larger buffer areas (>800m) have greater impact than smaller buffers on PA in adolescents this could be due to wider inclusion bias (Boone-Heinonen *et al.*, 2010b; Prins *et al.*, 2011). Contrastingly some evidence suggests that closer facilities have greater influence on PA in adolescents (Scott *et al.*, 2007; Boone-Heinonen *et al.*, 2010a).

There has been inconsistent application of buffer metrics in food environment studies (Charreire *et al.*, 2010; Feng *et al.*, 2010). But 400m buffers have been fairly consistently used for studying adolescent food environments (Sturm, 2008; Jilcott *et al.*, 2011; Leung *et al.*, 2011).

A 400m buffer was selected as it represented the most immediate neighbourhood environment. And primary data collection within a 400m buffer was in-keeping with CNES resources (i.e. single researcher).

Methods used for physical, built and food environment data collection and assessment are outlined according to environmental feature in sections 3.16.1–3.16.5.

3.16.1 Parks and Green Spaces

Location

GPS co-ordinates were taken using a Garmin eTrex Vista HTx handheld GPS. Coordinates were taken at all park and GS entrances within all participants' 400m neighbourhood environments. The researcher stood in the centre of entrance threshold to take co-ordinates. For the remainder of this thesis the terminology *access* shall be used to refer to availability or presence of any given resource within the neighbourhood environment. This is consistent with previous definition provided in the Literature Overview see section 2.1.1 (page 7).

Type

Parks and GSs were assigned a type according to definitions taken from the Improving Urban Parks, Play Areas and Green Spaces Report[13] (Dunnett *et al.*, 2002, pp. 30-31). Table 20 lists park and GS types. ‘Domestic Gardens’, ‘School’ and ‘Other Institutional’ grounds sub-categories were excluded from analysis due to privacy issues.

Environment and Quality Assessment Survey

Table 20 indicates types of Parks and GSs which underwent environment and quality assessment survey. Parks and GSs were assessed using the Observational Park Audit Tool (OPAT) in conjunction with the OPAT Manual (Gallo *et al.*, 2014a).

OPAT utilises quantitative scoring to standardise output and qualitative justification to enable robust retrospective examination. It was designed for UK application and is a comprehensive tool assessing:

- Environment – physical environment, planting, shade/ shelter, paths, fencing and entrances;
- Facilities and Amenities – play (type, quality and age-appropriateness), exercise/ sports (type, quality and age-appropriateness), eating and other facilities and amenities and park and GS events (type and age-appropriateness);
- Maintenance – upkeep of physical and built environment features;
- Safety – CCTV, safety notice(s), telephone/ mobile signal, lighting, staff, evidence of anti-social behaviour and perception.

OPAT was not fit for purpose to assess ‘Outdoor Sports Areas’ (e.g. football and hockey grounds), ‘Disturbed Ground’ or ‘Functional GSs’ (e.g. farmland and allotments). Issues of land privacy and membership-only status were anticipated for these un-audited spaces thus no alternative measurement tool was sought.

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[13] Types and assignment criteria closely follow wording and practice of Dunnett, N., Swanwick, C. and Woolley, H. (2002) *Improving Urban Parks, Play Areas and Green Spaces*.

Grouping and definition	Sub-category	CNES working definition	Survey
Amenity Green Space: Land designed primarily for amenity (visual and enjoyment), access and recreation.	Parks and Gardens	Mixed parks ≥3 types facilities	✔
	Informal Recreation Areas	Mostly grass with ≤2 types facilities	✔
	Outdoor Sports Areas	Predominately sports only function	***X***
	Play Areas	Play parks with limited/ no other function	✔
	Incidental GS	Grass only, leftover land	✔
	Domestic Gardens	Within curtilage of individual dwellings, generally no public access	N/A
Functional Green Space: Land primary functions for: farming, horticulture, burial grounds, educational and other institutional use.	Farmland	Under agricultural management	***X***
	Allotments	Publically available for vegetable/fruit crop cultivation or other use	***X***
	Burial Grounds		
	School Grounds		N/A
	Other Institutional Grounds	Green space on university, hospital, commercial and industrial premises	N/A
Semi-Natural Green Space: Land that is made up of semi-natural habitat including encapsulated areas of the countryside, formed by natural process or by deliberate creation of new habitats.	Wetland	Wet habitats e.g. water bodies, running water, marsh and bog	✔
	Woodland	Urban woodland e.g. deciduous, mixed and coniferous	✔
	Moor and Heath	For example moorland grass, shrub moor, shrub heath and bracken	✔
	Grassland	Grassland not agriculturally improved and not formally part of an amenity GS	✔
	Disturbed Ground	Land disturbed by previous development or land use now abandoned, waste or derelict	***X***

Table 20: Park and Green Space grouping, sub-type and definition

Proximity

Proximity was calculated from home postcode centroid to nearest GS entrance for each of the three GS types using GIS. Figure 16 shows an example of this process.

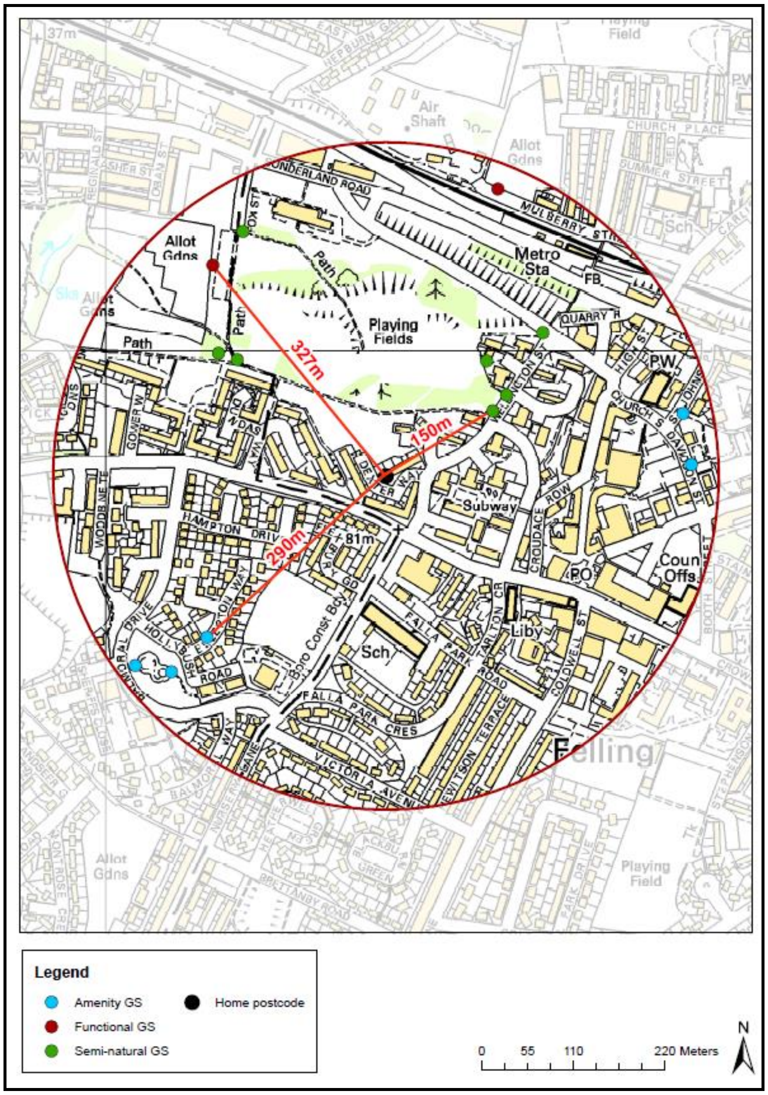

Figure 16: Park and GS proximity to home postcode for participant #418

3.16.2 Sports Facilities

Sports/ leisure/ recreation facilities shall hereafter be referred to as sports facilities, this is in line with terminology used by study participants.

Location

GPS co-ordinates were taken at the main entrance to sports facilities within all participants' 400m neighbourhood environments. Researcher stood in the centre of entrance threshold to take co-ordinates.

Primary data collection was utilised due to the need for accurate and timely data to establish association between neighbourhood environment and behaviour (CNES study aim). The POI dataset (Ordnance Survey, 2010a), an established environmental classification tool and secondary data source, was considered for use but there were a number of issues with its use for small scale environmental assessment. 1) POI coordinates have imperfect positional accuracy, see Table 21. 2) Dataset completeness is varying due to *"…suppliers of the source data provide[ing] updates at different frequencies. For example, some may provide their new, amended or deleted features every two months, whilst with others it may be every six months or only once a year"* (Ordnance Survey, 2010b, p. 24) and therefor ranges from 0–100%. Accuracy of these three factors was essential for thesis accuracy therefore POI dataset was rejected in favour of primary data collection.

Positioning	**Definition**	**Distance from true position**	**%**
Location or address	Coordinates within the footprint of the real-world feature in question, typically a building or structure		71.75
Adjacent location or address	Coordinates placed centrally in the text relating to the feature or close to the true location of a part of the feature	Within 10m of feature or edge of feature's geographic extent	27.21
Road within the address or location	Coordinates placed centrally on the correct road	Majority up to a kilometre away	0.85
Within the geographic locality	Location assigned in correct geographic locality e.g. correct village or industrial estate	Up to a few kilometres	0.20

Table 21: Points of Interest Positional Accuracy, taken from Ordnance Survey (2010b)

Grouping	Type	Sub-type
Private Leisure Centre		Gymnasiums
		Sports halls
		Leisure centres
		Swimming pools
Public Leisure Centre		Gymnasiums
		Sports halls
		Leisure centres
		Swimming pools
Other Sports Facilities	Outdoor pursuits	Angling & sports fishing
		Combat, laser & paintball games
		Hot air ballooning
		Outdoor pursuit organisers & equipment
		Parachuting & bungee jumping
		Paragliding & hang gliding
		Riding schools, livery stables & equestrian centres
		Water sports centres
	Sport support services	Children's activity centres
		Motorsport services
	Sports complex	Athletics facilities
		Bowling facilities
		Climbing facilities
		Golf ranges, courses, clubs & professionals
		Ice rinks
		Motorsport venues
		Racecourses and greyhound tracks
		Shooting facilities
		Ski infrastructure and aerial cableways
		Snooker and pool halls
		Sports grounds, stadia and pitches
		Squash courts
		Tennis facilities
		Velodromes
	Recreational education	Ballet and dance schools
		Performing arts schools
		Diving schools
		Flying schools
		Martial arts instruction
		Sailing schools
		Sports and fitness coaching
	Commercial services	Sports services

Table 22: Sports Facility grouping, type and sub-type, taken from Ordnance Survey (2010a)

Type

Sports facilities were assigned a typology based on definitions from the POI classification scheme version 3.0 (Ordnance Survey, 2010a). POI is an established environmental classification tool; accordingly use of typologies enabled direct comparison with existing literature. Facilities were coded according to POI type and sub-type then amalgamated into three overarching groupings for analysis (Table 22).

Proximity

Proximity was calculated from home postcode centroid to sports facility entrance for each of the three facility types using GIS.

3.16.3 Non-Food Shops and Services

Location

GPS co-ordinates were taken at the main entrance of non-food shops and services within all participants' 400m neighbourhood environments. Researcher stood in the centre of entrance threshold to take co-ordinates.

Type

Non-food shop and service types were drawn from the POI classification scheme version 3.0 as per rational in section 3.16.2. Excluded types were 1) re-assigned to alternate groupings, 2) included in Sports Facilities (see section 3.16.2 on page 90) or 3) replaced by an alternate classification scheme.

Shops and services were coded according to POI type and sub-type then amalgamated into five overarching groupings for analysis, see Table 23[14].

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[14] Definitions closely follow wording and protocol of Ordnance Survey (2010a) Points of Interest classification scheme (3.0).

Proximity

Proximity was calculated from home postcode centroid to non-food shops and services entrance for each of the five amenity types using GIS.

3.16.4 Food Outlets

Location

GPS co-ordinates were taken at the main entrance of food outlets within all participants' 400m neighbourhood environments. The researcher stood in the centre of entrance threshold to take co-ordinates.

Type

Food outlet type was assigned according to the 21-point Food Outlet Classification Tool (21-FOCT) developed in the UK (Lake *et al.*, 2010). The 21-FOCT was used in preference to POI classification scheme as it facilitated more comprehensive categorisation of outlets by type.

'Work place/ education' and 'Medical' outlet types were excluded from 21-FOCT as they were deemed beyond the scope of study/ influence. Outlet type was assigned according to *type* and *sub-type*.

Food outlet types were re-categorised from 19 to 15 types (for example, amalgamation of 'Specialist' and 'Specialist Traditional'). And some outlet types were redistributed according to eating experience (e.g. 'Café/ coffee shop' was divided into *sit-in* and *take-away*).

Outlet types were then re-categorised into five overarching groupings which clustered outlets providing similar food types or catering for similar eating occasions/ experiences. For example 'Takeaway eateries' predominately sold *food type*: fried or high fat, food cooked to order, or food pre-made and held at temperature; and catered for *eating occasion/ experience*: food for immediate consumption and predominately food eaten away from sourcing establishment. Table 24 outlines the food outlet categorisations employed.

Grouping/Type	Excluded	CNES working definition
Attractions & Entertainment		
Attractions	Recreational attractions	Aquatic, botanical, zoological, landscape, historical, cultural and tourism features and facilities
Entertainment	Outdoor pursuits; Sport & entertainment support services; and Sports complexes	Gambling, venue, stage and screen venues
Community services		
Education	Recreational education	Education (primary, secondary, higher, further and vocational) and support services
Health services		Health practitioners, establishments and services
Animal welfare		Animal welfare, upkeep and livery
Central & local government		Buildings, centres, consultancies, services, stations and offices
Infrastructure, facilities & organisations	Recreational facilities; and Sports clubs & associations	Built infrastructure, charity and community managed services and centres (i.e. youth club, place of worship) and libraries
Employment services		
Accommodation	Eating & drinking	All types of holiday let type accommodation
Commercial services	Hire services; and Sports services	Construction, repair and engineering services; intelligence, employment and specialist service agencies/providers
Manufacturing & production	Farming; and Foodstuffs	Consumer products, industries and industrial features and products
Non-food retail		
Retail	Food, drink and multi-item retail	Clothing, accessories, household, office, leisure, garden and motoring
Commercial services		(Hire services) Goods hire services
Other transport		(Road and rail) petrol stations
Transport		
Public transport		Bus transport, public transport, stations and infrastructure
Other transport	Road and rail (some); Walking; Water	Air, road and rail (some)

Table 23: Non-food shops and services grouping, type and definition

Grouping	Type	Sub-types
Traditional sit-in eateries	Traditional/pub/hotel restaurant	Restaurant: Traditional/ Buffet/ Fast-casual/ with takeaway or delivery option/ Pub: Sit down restaurant/ Fast casual/ with takeaway or delivery option/ Hotel: Traditional
	Sit-in café/coffee/ sandwich shop	Café: Traditional/ Greasy spoon/ Specialist/ with delicatessen/bakery/ Sandwich shop: sit-in
Takeaway eateries	Take-away café/ coffee/sandwich shop	Café: Takeaway / Greasy spoon/ Specialist/ Traditional sandwich shop
	Retail Baker	All types
	Takeaway and fast food outlet	Takeaway: Traditional/ with delivery/collection/ with delivery/collection and seating/ Instant fast food
	Mobile food and market	Food provision (food to take home)/ Takeaway/ Ice cream van/ Beverages
Grocers	Supermarket	Multiple: Large/ Small and Discount
	Specialist supplier	Organic/ Health/ Fair trade/ Seasonal/ farmers market/ Artisan/ Delicatessen/ World food/ Sweets or chocolate/ Butcher/ Baker/ Fishmonger/ Greengrocer/ Weigh house or dry goods/ Wine Merchant
Convenience and incidental outlets	Convenience store	Traditional (corner shop)/ Newsagents/ Off-licence/ Petrol Station Shop
	Vending machine	Beverages: hot and cold/ Food
	Non-food store	Shop or store: Clothes and accessory/ Sports/ Gift/ Cosmetic or toiletry/ Stationery/ Furniture or catalogue/ Hardware/ Department/ Discount (large or small)/ Pharmacy/ Post Office
	Entertainment venue	DVD etc. rental shop/ Cinema/ Theatre/ Comedy Clubs/ Music venue / Sports venue/ Motor sports venue/ Casino/ Amusements/ Ten-pin bowling/ Snooker or pool clubs/ Art Gallery/ Library
	Health and Leisure	Gyms/ Health Clubs/ Leisure Centre/ Climbing centre/ Soft Play
Closed/private/ age inappropriate outlets	Pub (no food)	All types
	Closed/private outlet	Clubs and Associations/ Function rooms/ Community centres/ Charitable organisations/ Wholesalers/ Suppliers/ Distribution/ Caterers/ Cash and carry/ Factory

Table 24: Food outlet groupings, types and sub-types

Healthfulness

Food outlet healthfulness was assessed using Measuring Food Environment (MFE) tools (Tyrrell, 2008). Restaurant, Shop and Vending machine MFE tools were used in conjunction with MFE manual (obtained from the author). MFE was selected in preference to alternate food environment tools (e.g. product display and shelf space (Cheadle *et al.*, 1990; Farley *et al.*, 2009), Healthy Eating Indicator Shopping Basket tool (Anderson *et al.*, 2007), and Nutrition Environment Measures Study (Glanz *et al.*, 2007)) because it was developed and tested for UK use and specifically for use with young people.

MFE functions to assess outlet facilitation or inhibition of healthful eating/ food purchase, with special focus on foods and drinks most commonly consumed by young people. Established facilitator and inhibitor variables were positively or negatively weighted to yield an outlet healthfulness percentage score

Food outlets were MFE audited unless they were:

- Shut – not open at the time of audit;
- Closed – not publically accessible (e.g. closed/ private outlet type);
- Had no food available (e.g. 'Pub (no food)' outlet type or 'Wine Merchant' sub-type in 'Specialist supplier' outlet type);
- Inaccessible – researcher denied survey access.

Proximity

Proximity was calculated from home postcode centroid to food outlet entrance for each of the five outlet groupings using GIS.

3.16.5 Outdoor Food and Drink Advertising

Location

GPS co-ordinates were taken at the centre point of free-standing food and drink adverts or at the main entrance threshold of built locations displaying adverts (i.e. food outlet). Where multiple adverts were present at a single location a single set of co-ordinates was taken.

Content Analysis

Food and drink adverts were assessed using the developed-for-purpose Outdoor Food and Drink Advertising Audit Tool (OFDAAT), see Figure 90 on page 341.

OFDAAT collected data on food and drink advert content and location, see Table 25. All adverts were photographed to facilitate post-fieldwork content analysis, and to ensure audit consistency and complete record keeping. Table 25 indicates the OFDAAT data which was collected during fieldwork.

All food and drink adverts were audited but only full adverts (defined as those able to be classified according to specific food/ drink type e.g. food/ drink product or image) underwent comprehensive analysis. Limited adverts (defined as those unable to be classified by specific food/ drink type e.g. brand logo or menu) underwent partial analysis only.

Type

Food and drink advert type was re-categorised from 'Eatwell category' and 'Food/ drink Type' categories into the 10 overarching food and drink categories outlined for Self-Reported Dietary Intake (see section 3.11.2 on page 73) with the addition of 'Mixed food/ drink', 'High fat salt and/ or sugar (HFSS) mixed food/ drink' and 'Alcohol' categories.

Categories were further amalgamated into three groupings for analysis:

- More healthful food/ drinks comprising: Carbohydrates, Dairy, Fruit and Vegetables, Protein, Mixed food/ drink and Low calorie drinks;
- Less healthful food/ drinks comprising: High fat snacks, Puddings, deserts & biscuits, Sauces & spreads, Sweets & chocolate, HFSS mixed food/ drink and High calorie drinks;
- Alcohol.

Categories	Definition	Field	Limited
Photograph		✔	✔
Location	GPS co-ordinates, environment context according to pre-defined category e.g. food outlet or residential area	✔	✔
Size	Size according to pre-defined categories	✔	✔
Height	Height according to pre-defined categories	✔	✔
Medium	Type e.g. billboard, poster or stand	✔	✔
Description	Qualitative description of advert/product	✔	✔
Setting	Context of advertisement image e.g. beach, leisure or shop	✘	✔
Brand	Brand name(s)	✘	✔
Categorisation	Categorisation according to pre-defined categories e.g. logo, menu or food/drink image	✘	✔
Main/Proxy	Advertised product main feature/proxy to advert e.g. Mars bar advert vs. Mars bars on offer 3 for £1 in Tesco	✘	✘
Eatwell category	Categorisation according to Eatwell food groups: Carbohydrate; Fruit and vegetables; Protein; Diary; High fat, salt and/or sugar (HFSS). Also mixed (>3 food/drink items); mixed HFSS (>3 HFSS food/drink items); Drink or Other.	✘	✘
Food/drink type	Categorisation according to food/drink type (multiple predefined categories including the 'big 6' food products: pre-sugared breakfast cereals, soft-drinks, confectionary, savoury snacks, fast food outlets and pre-prepared convenience foods)	✘	✘
Unique selling point	Categorisation according to pre-defined unique selling categories (drawn from literature) e.g. taste, premium/quality or price	✘	✘
Target audience	Target audience according to pre-defined age categories	✘	✘
Theme	Theme if targeted at children (defined for the purpose of CNES as 4–11 years) e.g. brand character or magic	✘	✘

Table 25: Outdoor Food and Drink Advertising Audit Tool categories and definitions

Proximity

Proximity was calculated from home postcode centroid to food and drink advert co-ordinate for each of the thirteen types using GIS.

3.16.6 Roads

Road Length

Integrated Transport Network (ITN) data was downloaded from Digimap (Goffe and Gallo, 2010). ITN data was manipulated in GIS to isolate road lengths by type, see Table 26[15].

Total road length and length by type were calculated for each participant within their 400m neighbourhood environment.

For Detailed Case Study analyses 'Motorway' and 'A' road lengths were assumed to be indicative of higher traffic density and road danger, consequently they were inputted into regression models separately. 'All roads' length included all road types (including 'Motorway' and 'A' roads) to ensure effect of total road length was fully explored independent of type.

Road Safety

Ordnance Survey (2013b) guidance indicates ITN data is 'broken' in the following situations:

- Carriageway start or end;
- Carriageway crossings (including bridges, flyovers and tunnels where there is no connectivity);
- Road name or number changes/ ceases to apply;
- Section of a road between junctions is subject to a 'one-way' restriction.

[15] Definitions closely follow wording of Ordnance Survey (2013a) ITN attribute definitions and values.

Road type	Description
Motorway	Multi-carriageway public road connecting important cities, always numbered and with no addresses
A	Public road, classified as an A road by the Department for Transport (DfT) connecting areas of regional importance, always numbered, sometimes named, often with addresses
B	Public road, classified as a B road by the DfT, connecting places of local significance, always numbered, sometimes named, often with addresses
Minor	Connecting public road with no DfT classification as motorway, A or B road. In urban areas usually named, often with addresses. In rural areas sometimes named and sometimes with addresses
Private (public access)	Privately-maintained road or road within a property boundary where public access is considered usual for at least some part of the day (e.g. road within hospital or school). Normally created to extend to the principal building within a single site or to the boundary of the last of multiple properties served by road. May extend through a site if more than one entrance exists. And may be outside this definition if required to provide restricted connectivity to a track or path.
Private (restricted access)	Privately maintained road or road within a property boundary where access by the public is restricted by physical (e.g. gate) or administrative (e.g. sign) means, or is not considered usual (e.g. within a military base or private residential garden). Such roads are captured only where they exceed 100m or serve more than one addressed or otherwise identifiably separate property. Roads are normally created to extend to the principal building within a single site or to the boundary of the last of multiple properties served by road. Two exceptions exist: • track or path exists that the road is connected to, the road must be extended to that point • roads within a private residential garden extend more than 100m from the property boundary

Table 26: Road type and definition, taken from Ordnance Survey (2013a)

Road *breaks* are commonly referred to as *intersections*. Figure 17 illustrates a T-junction which corresponds to one intersection. Intersections were used as a proxy measure of connectivity.

Multiple street segments were associated with each road intersection, i.e. Figure 17 shows a single T-junction intersecting three street segments. Road safety was surveyed by a 10% sample of each participant's neighbourhood street segments.

Samples were randomly selected using GIS from 400m neighbourhood buffer maps (for example see Figure 18).

Figure 17: Road intersection and street segment with aligning road and street

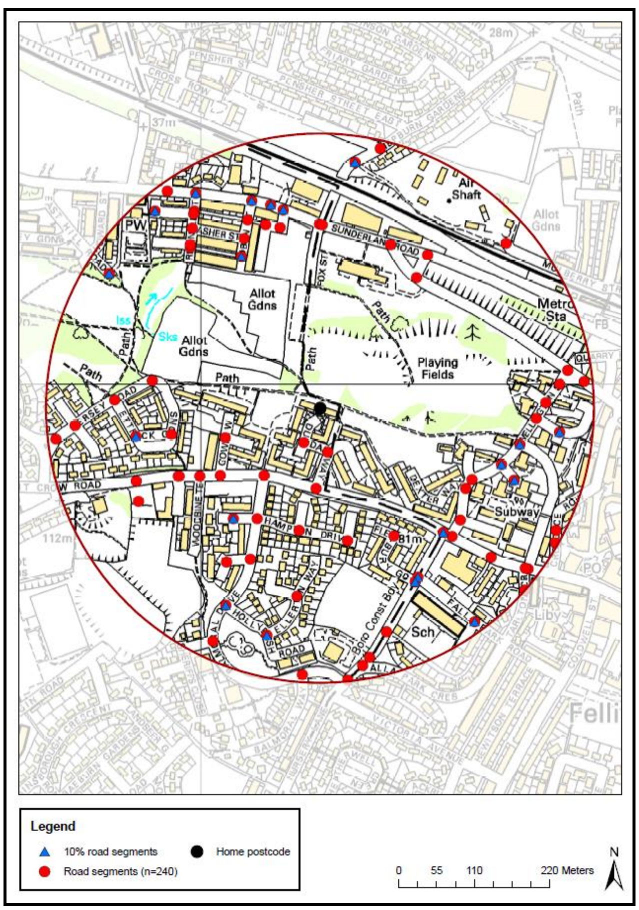

Figure 18: Ten percent street segment selection

Road safety was assessed using the Scottish Walkability Assessment Tool (SWAT) (Millington *et al.*, 2009) in conjunction with SWAT Survey Guidelines (obtained from author). SWAT functions to objectively measure *“street-scale or fine grain attributes of the physical environment that may be related to physical activity”* (Millington *et al.*, 2009, p. 475). Objective physical environment measurement is an established method and there are a number of validated tools (e.g. Systematic Pedestrian and Cycling Environmental Scan (Pikora *et al.*, 2002), St Louis Instrument (Brownson *et al.*, 2004), and Irvine-Minnesota Inventory (Boarnet *et al.*, 2006)). SWAT was selected because it was developed and tested in the UK which characteristically has high levels of residential density and on-street parking and adjoining pavements to roads. These factors were not well captured in alternate tools developed outside Europe.

Five SWAT groupings were excluded from analysis: ‘Types of buildings or features’, ‘Derelict land’, ‘Types of views’, ‘How alike are the building designs’ and ‘Signage’. Groupings were excluded because they were 1) replaced by an alternate classification scheme or 2) deemed beyond the scope of study/ influence. All other groupings were included though some variables were excluded (e.g. path location, condition of road, vehicle parking). Exclusions were on the basis of being beyond the scope of study/ influence. SWAT was subdivided into three sections for analysis: ‘Road safety’, ‘Street quality’ (section 3.16.7, page 104) and ‘Cyclability’ (section 3.16.8, page 106).

Road safety score comprised variables from the ‘On road’ SWAT grouping. Variables listed in Table 27 were enumerated, with a higher score indicative of better road safety. Audited street segment road safety scores were summed per grouping and averaged per neighbourhood to provide an average score. Overall score was the average of all grouping scores.

Grouping	Variable
Traffic control device	Speed humps or ramps Horizontal narrowing Traffic signals
Cu-de-sac/permanent street closing	
Pedestrian crossing aid	Zebra Controlled by lights (pedestrian button) Bridge Underpass
Crossing aid	Median refuge or traffic islands Kerb extensions Dropped kerb Tactile paving
Car lanes	≤2 lanes classed as safer (score 1) than ≥3 lanes (score 0)

Table 27: Road Safety groupings and variables, taken from Millington et al. (2009)

3.16.7 Streets

Street Length

ITN data was downloaded from Digimap (Goffe and Gallo, 2010) and manipulated in GIS to isolate street lengths by type comprising[16]:

- Alley – a road without access restrictions that provides alternate/ secondary vehicular access to land or houses. They may be named but are usually without addresses. They are usually not intended for through traffic, though they may be accessible from more than one location;
- Local Street – street adjoining public road that provides access to land and/ or houses, usually named with addresses.

Total street lengths and length by type were calculated for each participant within their 400m neighbourhood environment.

[16] Definitions closely follow wording of Ordnance Survey (2013a) ITN attribute definitions and values.

Street Quality

Street quality was surveyed by a 10% sample of each participant's neighbourhood street segments using SWAT (Millington *et al.*, 2009) as per section 3.16.6. Table 28 outlines street quality variables.

Audited street segment scores were summed per grouping and averaged per neighbourhood providing an average score. Overall quality scores were re-classified into percentages per grouping. Percentages were combined and divided by six so that all groupings contributed equally to overall score.

Grouping	**Variable**
Walkability (where pavement present)*	Pavement present* Path material* Usable width of pavement* Slope Path condition and smoothness* Permanent path obstructions* Path forms useful and direct route* Driveway crossover* Streetlights present Surveillance (percentage of segment observable from buildings)
Greenness	Grassy verge (grass between pavement and road) Trees (density and height) Hedges (density and height) Garden maintenance (clean, kempt and trim) Verge maintenance
Cleanliness	Graffiti and vandalism Litter/discarded items Dog fouling
Attractiveness	Building attractiveness Overall attractiveness of segment (for walking)
Pollution	Air pollution Noise pollution
Safety	How safe do you feel?

Table 28: Street Quality groupings and variables, taken from Millington et al. (2009)

3.16.8 Cyclability

Cyclability was surveyed by a 10% sample of each participant's neighbourhood street segments using SWAT (Millington *et al.*, 2009) as per section 3.16.6.

Cyclability comprised 'On-road cycle lane marked' and 'Bike parking facilities' variables from 'On-road' SWAT grouping. Audited street segment scores were summed and averaged per neighbourhood providing an average score.

Detailed Case Study

This section outlines the case study approach for in depth study of neighbourhood environmental influence on physical activity and dietary behaviours and BMI outcome.

Case study analysis was used to examine phenomenon in depth in real-life context (Yin, 2009). Instrumental cases were used to facilitate understanding of comparative similarities and differences between ‘typical’ and ‘deviant’ cases according to a given criteria (Stake, 2000).

Neighbourhood Environmental Influence on health behaviours and outcomes: PA, dietary intake and BMI, were assessed using a detailed case study approach. Objectively measured participant-level neighbourhood environment data was regressed with objectively measured health outcome variables using binary logistic regression. Regression was used to 1) predict health outcome group membership and 2) identify outlying cases.

Predicted group membership was cross-tabulated with *observed* group membership and ‘typical’ and ‘deviant’ cases were highlighted. Typical cases were those *observed* and *predicted* to have the *same* health outcome. Deviant cases were those *observed* and *predicted* to have *different* health outcomes. For example *observed* ‘under/ healthy weight’ BMI grouping and *predicted* ‘overweight/ obese’ BMI grouping.

Of those defined as ‘typical cases’ the case with the *median* health outcome value was selected to represent the *most typical* case. Of those defined as ‘deviant’ cases the case with the *most extreme* health outcome value was selected to represent the *most deviant* case (see Figure 19).

Outlying cases were identified by Standardised Residual testing. Outliers were not well explained by the model i.e. they were in some way deviant from the surveyed population and were therefore excluded from further analysis (Field, 2009).
This method of case selection by observed and predicted values derives from nested analysis (Lieberman, 2005) and facilitated the selection of *interesting* or *influential* cases based on objectively surveyed neighbourhood environment features.

		Observed	
		UHW	OWOB
Predicted	UHW	Typical UHW *(median BMI case)*	Deviant HW *(highest BMI case)*
	OWOB	Deviant OWOB *(lowest BMI case)*	Typical OWOB *(median BMI case)*

Figure 19: Cross tabulation and case selection process for BMI 'observed' and 'predicted' categories (under/ healthy weight (UHW) and overweight/ obese (OWOB))

3.17 PA Case Study

The binary response categories used for PA case study binary logistic regression were 'high' and 'low' PA reporters. To produce two respondent categories self-reported time physically active was expressed as a proportion of total time reported in any activity (i.e. time reported physically active/ total time reported).

Time spent physically active was defined as any activity defined by metabolic equivalent (MET) 4-point intensity scores as 'Moderate intensity' and 'Intense' (see Table 31). MET is defined as the ratio of work or activity metabolic rate to a standard resting metabolic rate and is described in detail by Ainsworth *et al.* (2000).

High and low reporter categories were yielded by dividing the CNES sample population into two equal groups according to ranked time spent physically active. This proportionate approach was used to reduce bias by high/ low total reporting time. For example, compare *Participant A* reporting 1200 minutes total activity time of which 600 minutes was defined as physically active, to *Participant B* reporting 2000 minutes total activity time of which 300 minutes was physically active. Both participants reported 300 minutes active time but Participant A spent 50% of their total time active compared to Participant B only 15%.

Activity intensity	**MET score**	**Example activities**
Sedentary	0.9–1.9	Lying or sitting still
Low intensity	2.0–2.9	Sitting with gentle movement (e.g. arts and crafts), standing with gentle movement (e.g. preparing food) or slow walking
Moderate intensity	3.0–6.0	Walking with destination (e.g. active travel), jogging or moving moderately actively (e.g. playing or gardening)
Intense	>6.1	Running (including sports) or vigorous movement (e.g. dancing/skating)

Table 29: Activity intensity MET classification

3.18 Dietary Intake Case Study

The binary response categories used for dietary intake binary logistic regression were ‘high’ and ‘low’ healthful food and drink item reporters. Where more healthful items comprised: Carbohydrates, Dairy, Fruit and Vegetables, Protein, Mixed food/ drink and Low calorie drinks. And less healthful items comprised: High fat snacks, Puddings, deserts & biscuits, Sauces & spreads, Sweets & chocolate, HFSS mixed food/ drink and High calorie drinks.

To produce two respondent categories self-reported intake of ‘more healthful’ food and drink items were expressed as a proportion of total diet (i.e. ‘more healthful food items’/ total food items). High and low reporter categories were yielded by dividing the sample into two equal groups according to ranked proportional intakes. This proportionate approach was used to reduce bias by high/ low total reporting as per section 3.17.

3.19 BMI Case Study

The binary response categories used for BMI case study logistic regression analysis were ‘under and healthy weight’ (UHW) and ‘overweight/ obese’ (OWOB).

Chapter 4: Results

The Results chapter is sub-divided into eight sections:

- Exploratory Focus Group results are presented thematically;
- Preliminary results from pCNES are outlined and methods amendments are outlined;
- Population characteristics of CNES participants are detailed comprising: demographics, anthropometrics, photographic data, self-reported activity and dietary intake behaviour, and attitude, perception and behavioural survey results;
- Parent characteristics and attitude, perception and behavioural survey results are detailed and correlated with participant perceptions;
- Neighbourhood physical, built and food environments variables are outlined descriptively then discussed in relation to participant and parent perceptions;
- Neighbourhood environment influences on physical activity are explored using binary logistic regression and detailed case study interrogation;
- Neighbourhood environment influences on dietary intake are explored using binary logistic regression;
- Neighbourhood environment influences on BMI are explored using binary logistic regression and detailed case study interrogation.

Results are both distinct (i.e. interesting on their own merit) and interconnected hence the Results chapter should be reflected upon in its entirety. The detailed case studies function to explicitly associate the complete neighbourhood environment with health behaviours (PA and diet) and outcomes (BMI) and contextualize findings with detailed interrogation of interesting cases; this is a unique feature of this thesis.

Focus Group

This section reports focus group findings thematically: neighbourhood environment, neighbourhood physical activity, dietary intake, neighbourhood food environment and food and drink advertising.

Two schools held one focus group each. Group 1: one male and three female participants; Group 2: three male and two female participants. Mean age of sample was 11 years 2 months (SD 5 months). Thematic analysis follows.

4.1 Neighbourhood Environment

Both groups foremostly described their neighbourhoods in terms of their ‘street’, ‘estate’ and ‘local houses’. Some participants extended this explanation to include the ‘community’ and/ or ‘neighbours’. One participant described it as *“Like your close family or your friends around you, your mam and brothers and sisters”* (participant #103) but they were the only one to only talk in these terms.

Across both focus groups ‘happy people’, ‘nice neighbours’, ‘environmental upkeep and maintenance’ and ‘absence of vandalism’ were deemed important in a *nice neighbourhood*. Additional themes included: *“big houses”* (#104), *“If you see no ‘for sale’ signs”* (#108) and having *“a field that you can play in and you’ve got lots of room”* (#105).

4.2 Neighbourhood Physical Activity

Peers, peer pressure and personal likes and desires were deemed the most important influences on activity across all participants. The second focus group also talked about their families as influencers, suggesting ‘expectations’, what families ‘can do’ and ‘allowed them to do’ were also factors in what they did.

Generally participants talked about being *physically active in their neighbourhood*: playing out with friends, playing in the park, bike rides, scooting, playing football, playing cricket and walking the dog. Participants suggested they used neighbourhood facilities for these activities at varying distances including: ‘across the road’, ‘a mile away’ and ‘5–30 minutes away’. One participant suggested they ‘talked’ on the street (#102) and another described using the ‘library and shops’ (#107); but they were the only ones who discussed these things.

There was mixed and inconclusive consensus regarding *neighbourhood environment influence* on use and activity in these spaces. Both focus groups talked about use of ‘neighbourhood facilities’ for activity and recreation. Furthermore one participant talked about inaccessibility of facilities *“Well I like to go like onto the BMX tracks but they’re like too far away and you’re having to pass like main roads and stuff where there’s no traffic lights”* (#106). Both groups also discussed ‘people in the neighbourhood’, both positively (e.g. friends) and negatively (e.g. bullies). One participant talked about the external influence of weather *“Say like, say like if it was raining really heavily and everything I would probably just go on my PlayStation or on the computer or something”* (#108). Generally participants thought the neighbourhood had some influence on what they did, but if they wanted to be in the neighbourhood (being active or otherwise) they would do so regardless of what it was like.

4.3 Dietary Intake

Parents and parents cooking appeared to be the most important influences on dietary intake across both groups. Some participants also talked about their ‘personal involvement with cooking’, ‘parental encouragement’ and ‘food availability at home’. One participant talked about ‘breaking family rules’ buying and eating sweets secretly at the park as they weren’t allowed to ‘spoil their tea’ at home.

There were mixed responses about *food choice* spanning the spectrum of no–full choice. For example *“I don’t get a choice really for my tea like my mum and dad like do it for me”* (#106) compared to *“if my mum puts something that I don’t like in* *there I can just say, cause I go to a childminders 'I'm not eating it' cause I'm not going to be forced to eat something I don't like, like let's say it was broth like at Aunty A's and I'd say 'give me some proper soup please' and then she cooks it for me and I eat that"* (#105) and *"sometimes if my parents are having something I don't like sometimes I just go to like the Spar or something and get something microwavable"* (#108). There was also some discussion around 'peer suggestion' (food items and eating outlets), and 'food appearance' as influencers of choice.

4.4 Neighbourhood Food Environment

When asked about the influence of shops on diet although both groups talked about shops within their neighbourhood there was consistent agreement that parents shopped mostly at large multiples (i.e. Tesco and Sainsbury's) and usually in cars. One participant expanded this highlighting limited availability in local shops *"we've got a Co-op and Nisa and they're only full of bread, tea bags and sweets and pop and that"* (#103). The first group talked about eating 'sweets' and 'fast food' from shops proximal to parks, and that visibility in locations they spend time in led to intent and/ or desire to buy.

Both groups discussed their purchasing power being limited due to *'expensive'* prices and *'not having any money'*.

4.5 Food and Drink Advertising

Both focus groups suggested television food and drink advertising was the most important form of advertising to them. The first focus group talked around the influence of both television and print advertising making them 'want it' or 'want to go' to fast food outlets. Notably *brand* and *product name* were also deemed important.

There was also some discussion in one group around food and drink advertising being misleading *"sometimes they look nicer than what they are"* (#101) and *"sometimes when you get it you like don't really like it but you have to pretend you like it cause your mam and dad have paid a lot of money for it"* (#104).

The second group talked about print media in their neighbourhoods being vandalised and this diminishing impact because it was ‘harder to see’ and ‘not nice to look at’. The first group did not discuss neighbourhood environment print media.

Focus Group highlights:

- The neighbourhood was understood to include physical and social environments but was not strictly determined by scale/ size
- Neighbourhood quality determinants included physical and social order and conduct
- Young people reported using the neighbourhood predominately for physical activity
- Young people knew about and used neighbourhood activity and food facilities and services
- The neighbourhood was deemed to have some influence on behaviour
- Parental choice was the most important factor in food choice. Peers, food appearance, marketing and personal choice were shown to have varying degrees of influence
- Young people reported most food was obtained by parents from large multiple supermarkets
- Food outlets in the neighbourhood and recreation localities had some influence on desire to have and dietary intake
- Young people’s purchasing power was deemed to be limited by finance
- Television advertising was reported to be the most influential form of advertising; neighbourhood print media was discussed as influencing desire to have

Pilot Study

This section outlines CNES pilot study (pCNES) sample population demographics and anthropometrics. Self-reported activity behaviour and dietary intake data is summarised with contextual factors (e.g. location and companion type). Finally amendments from pCNES to CNES are outlined and justified.

Twelve participants were recruited to CNES pilot study (pCNES) with seven completing the study in full. Table 30 outlines total and completing sample population demographic information. Completing sample population was marginally more affluent, taller and heavier than the total sample population. Only data from the completing sample population is included in analysis.

Factor	Total sample (n=12)	Completing sample (n=7)
Age (years and months)	11y 2m (4.3m)	11y 2m (5.5m)
IMD score	35.16 (9.69)	34.90 (10.04)
Height (m)	1.49 (0.04)	1.51 (0.04)
Weight (kg)	42.68 (6.59)	45.71 (6.92)
BMI	19.09 (2.38)	19.97 (2.63)
Gender:		
Male	6	3
Female	6	4
BMI grouping:		
Underweight	0	0
Healthy weight	9	4
Overweight	3	3
Obese	0	0
Ethnicity:		
White British	12	7
Ethnic minority British	0	0

Table 30: Mean (SD) age, IMD score, height, weight and BMI and counts per BMI and ethnic groupings for total (n=12) and completing (n=7) pCNES samples

4.6 Physical Activity

In total 196 activity instances (8.7% photographed) comprising 17 activity types (e.g. arts and crafts, walk, play and sport) were reported by the completing sample population (n=7). Mean activity time reported per participant was 1,521 minutes over four days equating to 6 hours 20 minutes daily.

4.6.1 Activity Intensity

Participants assigned 'activity intensity' scores to 81.1% activity instances (n=159), only this data is analysed in this section. There was wide variability in activity intensity scoring per activity type. Six of the 17 activity types (sedentary travel, sitting, bathing, walking, playing and sports) representing 83% (n=132) of all activities instances, had PCERT scoring ranges between 4 and 8. This is suggestive that: 1) single activity types spanned a wide range of exertion intensities; 2) participants had wide ranging physical fitness and as such found activities much harder/ easier than their peers; or 3) participants were poor at reporting activity intensity.

Evidence for conclusion *one* is questionable in light of activity types attributed high scoring range. It would be assumed that sedentary and sitting activities would be scored PCERT <2 (very, very easy – very easy) and the remaining activities at least PCERT >3 (just feeling a strain – so hard I'm going to stop). Conclusion *two* cannot be substantiated as fitness level measurement was beyond the scope of study. Therefore conclusion *three* is assumed.

To validate conclusion three participant–researcher activity intensity scoring agreement was evaluated. Participant scoring was re-coded from PCERT 10-point scale to MET 4-point intensity scores, see Table 31.

Scoring showed significant association (T=-7.00, p<0.01) but only 27.7% agreement. For example, the most frequently self-reported activity type was 'Play' (35.6% all activity instances). 'Play' was MET assigned 'moderate' intensity activity.

Participants scored ‘Play’ as MET equivalent sedentary, low, moderate and intense activity in 27.7%, 59.6%, 10.6% and 2.1% activity instances respectively.

On average participants scored activities at lower intensities than researcher (mean 1.6 (SD 0.7) and 2.4 (SD 1), respectively) which could indicate over-estimation of activity intensity by researcher or inaccurate reporting/ understanding of PCERT by participants. Despite this bias for consistency purposes researcher assigned MET scoring is referred to throughout the rest of this thesis.

Activity intensity	**PCERT score**	**MET score**	**Example activities**
Sedentary	1–2	0.9–1.9	Lying or sitting still
Low intensity	3–4	2.0–2.9	Sitting with gentle movement (e.g. arts and crafts), standing with gentle movement (e.g. preparing food) or slow walking
Moderate intensity	5–7	3.0–6.0	Walking with destination (e.g. active travel), jogging or moving moderately actively (e.g. playing or gardening)
Intense	8–10	>6.1	Running (including sports) or vigorous movement (e.g. dancing/skating)

Table 31: Activity intensity PCERT and MET classification

Figure 20 shows time reported in minutes at by activity intensity. Participants spent the majority of their time at low intensity activity.

4.6.2 Activity Location

Participants failed to assign *location* to 3,400 minutes of activity; consequently this data was excluded from this section of analysis.

Figure 21 shows participants spent the majority of *sedentary* time in the ‘House’, *low* activity intensity time in ‘Other’ locations, *moderate* intensity activity time in ‘Parks, green and open spaces’ and *intense* activity time at ‘School’.

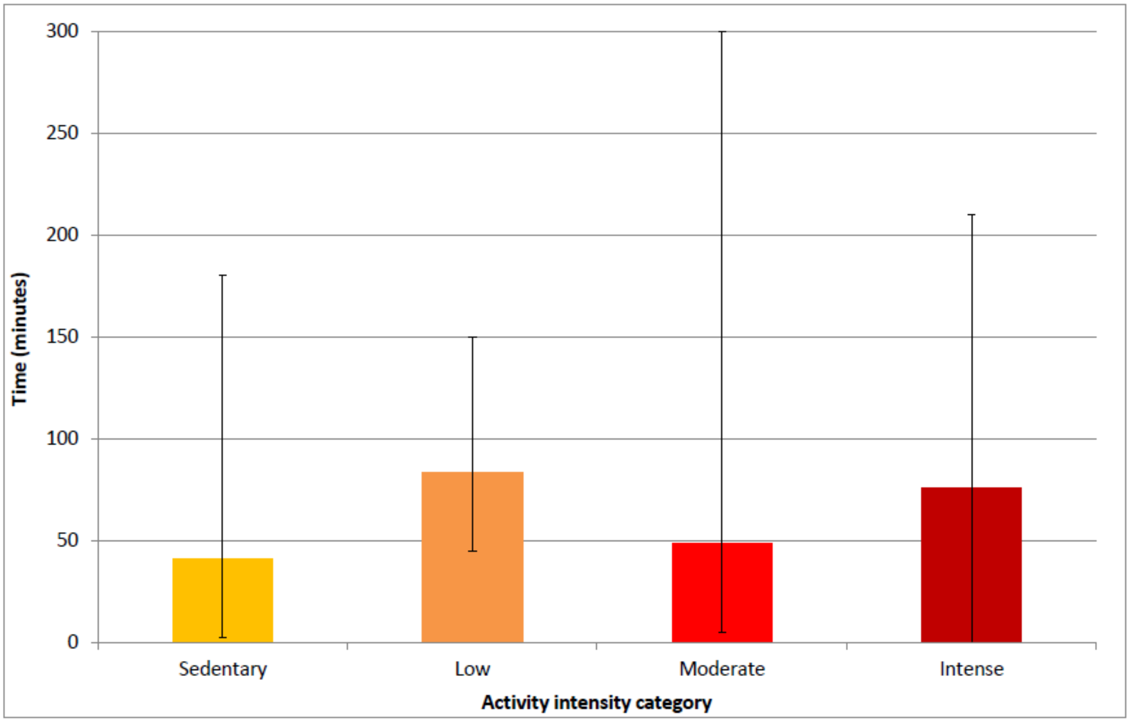

Figure 20: Mean activity time (minutes) per day by activity intensity (n=7)

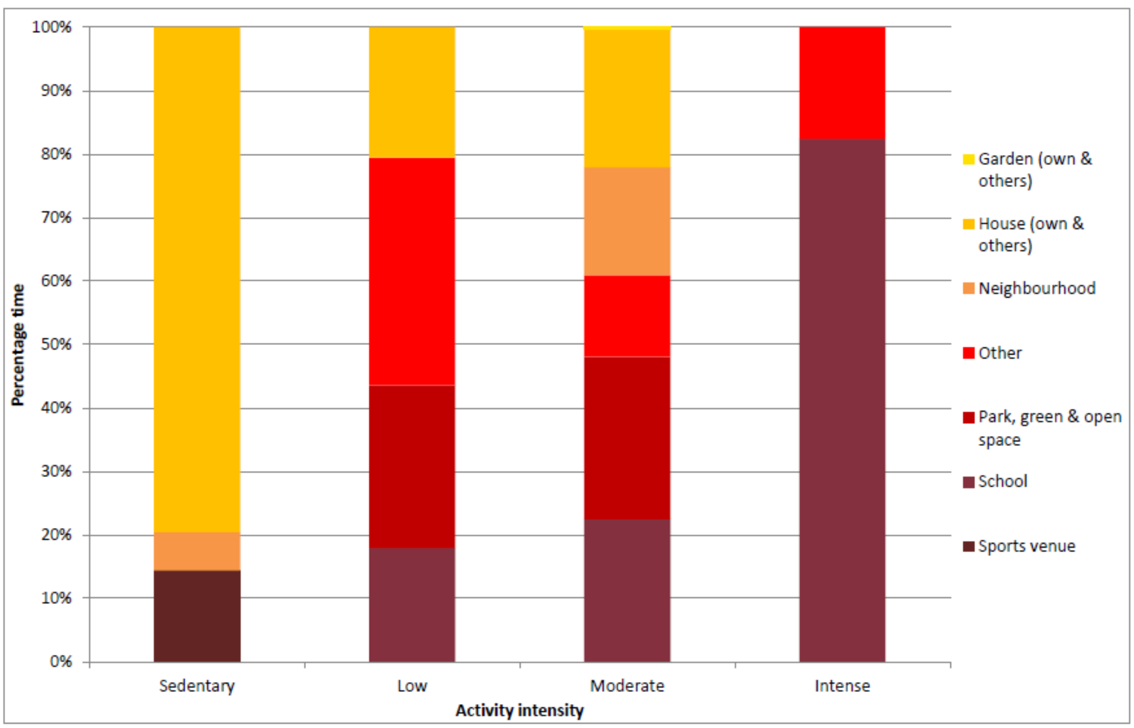

Figure 21: Percentage of reported time per activity intensity by location (n=7)

4.6.3 Activity Companion

Participants failed to assign ‘Activity companion’ to 2,690 minutes of activity; consequently this data was excluded from this section of analysis.

Figure 22 shows participants spent the majority of time *sedentary* and at *low* intensity activity with ‘Family’. The majority of *moderate* activity time was spent with ‘Friends’ and *intense* activity with ‘Adult and Friends and/ or Family’. The latter, in line with Figure 21, was owing to participants doing ‘Sports’ in PE class.

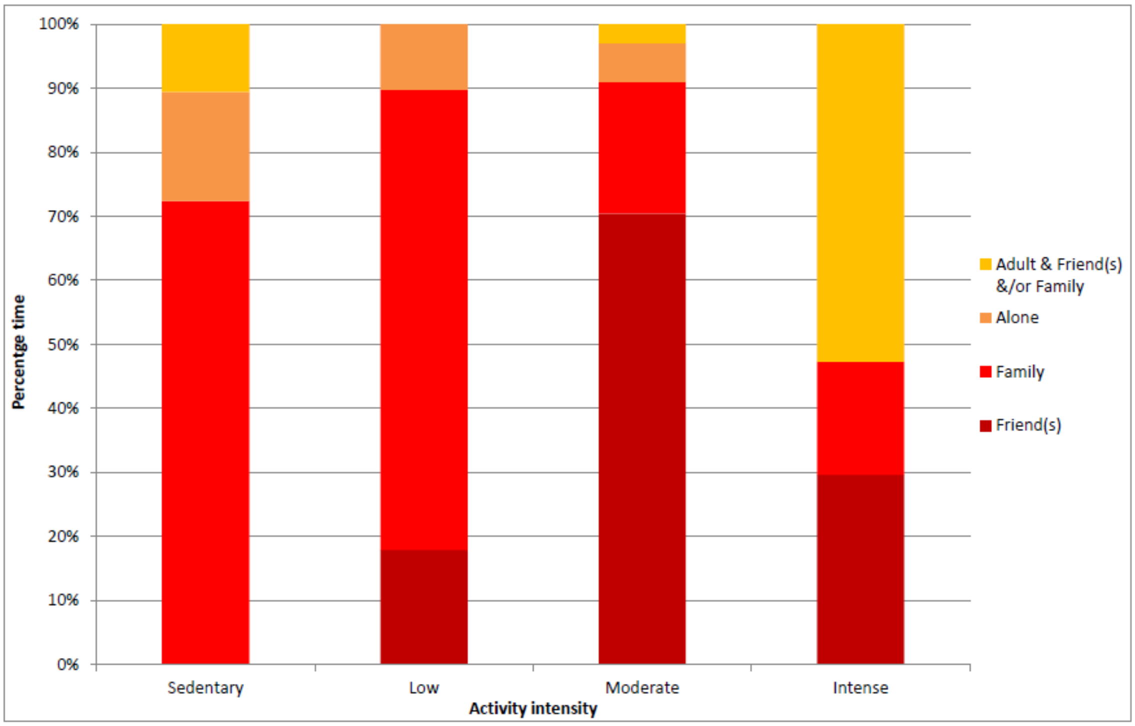

Figure 22: Percentage of reported time with companion type per activity intensity (n=7)

4.7 Dietary Intake

On average participants ate 3.9 times daily (109 total eating occasions, 65.1% photographed). Figure 23 shows statistically significantly more food items were eaten at weekend than school day ‘Breakfast’ and ‘Dinner’ times but significantly fewer at ‘Lunch’ ($t=2.65$, $p=0.04$, $t=-2.26$, $p=0.02$ and $t=-2.59$, $p=0.04$ respectively).

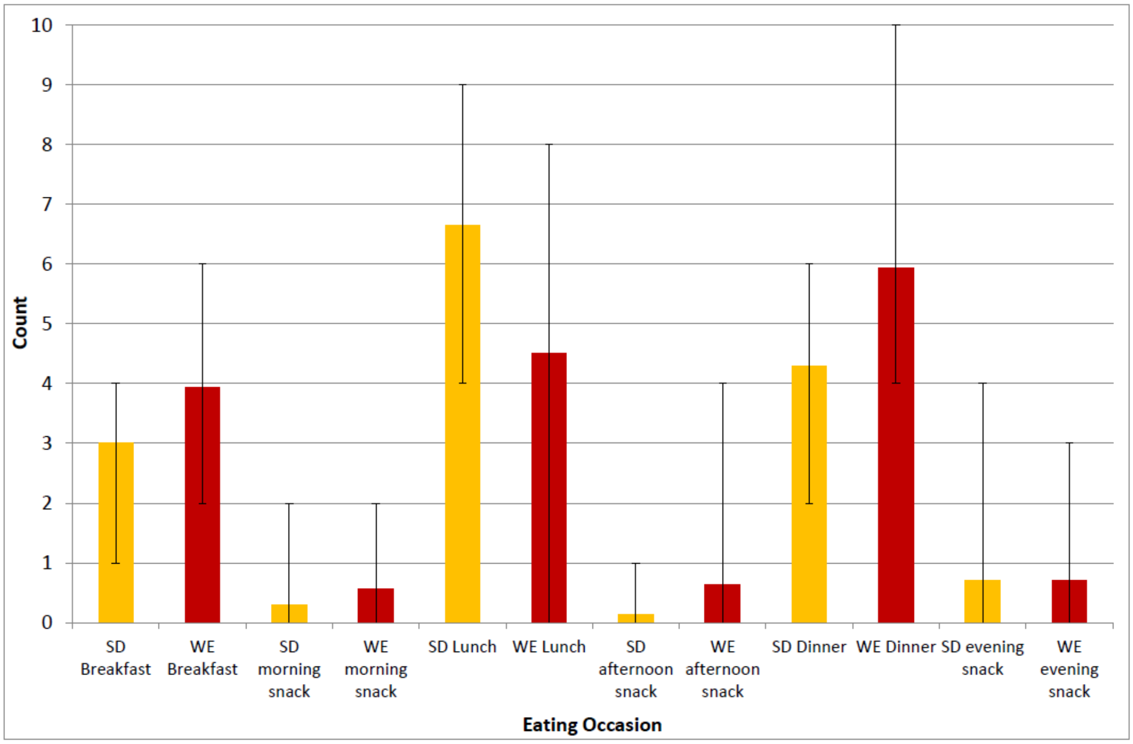

Figure 23: Mean daily food item count per eating occasion by gender for school (SD) and weekend (WE) days (n=7)

4.7.1 Food Item Intake

Table 32 details average daily diet by food item count. Dietary data is interpreted cautiously as self-reports did not account for portion size.

Dietary intake was compared with Eatwell recommendations (Food Standards Agency, 2007) which define diet in terms of servings[17] (low calorie drinks were excluded from analysis). Figure 24 shows self-reported food item counts of 'Protein' and 'Dairy' were in line with Eatwell recommendations. Food item counts of 'Carbohydrates' and 'Fruit and vegetables' were low and 'HFSS'[18] very high.

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[17] A ratio of 5:5:2:2:1 serving's was assumed for carbohydrates, fruits and vegetables, diary, protein and high fat and/or sugar foods and drinks.

[18] High fat and/or sugar foods comprised: Fried/high fat snacks, Puddings, deserts, cakes and biscuits, Sauces and spreads, Sweets and chocolate and High calorie drinks.

Food group type	Mean	SD	Range
More healthy foods			
Carbohydrates	2.7	0.6	2–4
Dairy	2.1	1.0	1.3–4.3
Fruit and vegetables	2.8	1.5	1.3–4.5
Protein	2.0	0.4	1.5–2.3
Low calorie drinks	1.7	1.0	0.3–3.3
Less healthy foods			
Fried/ high fat snacks	1.5	0.9	0.5–3.3
Puddings, deserts, cakes and biscuits	1.0	0.4	0.5–1.5
Sauces and spreads	1.3	0.4	0.8–1.8
Sweets and chocolate	0.1	0.2	0–0.5
High calorie drinks	0.5	0.5	0–1

Table 32: Daily mean, SD and range of food items by food group type (n=7)

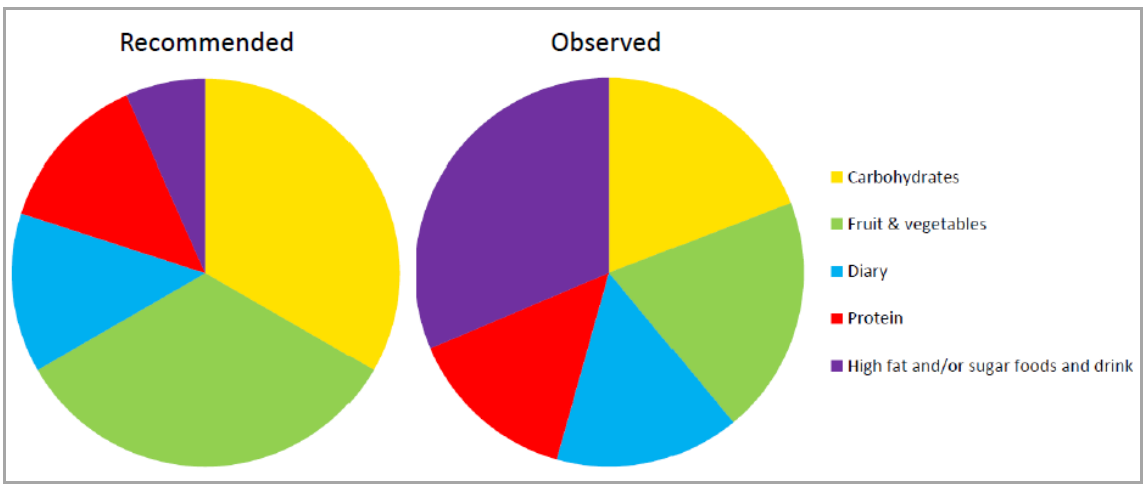

Figure 24: Recommended and observed mean dietary intake (by serving and food item count)

Location	Sourcing	Eating
Food outlet	10 (9.1)	1 (0.9)
House	94 (85.5)	86 (78.9)
School	6 (5.4)	18 (16.5)
Parks, green & open spaces		1 (0.9)
Other		3 (2.8)

Table 33: Location of food and drink sourcing and eating (count (%)) (n=7)

4.7.2 Sourcing and Eating Location

Table 33 shows where food and drink was sourced and eaten. Eating location showed 80% agreement with sourcing location ($T=-2.23$, $p=0.03$). Percentage agreement was further increased to 90.1% when eating location 'School' incorporated 'House' to include packed lunches.

4.7.3 Eating Companion

'Family' and 'Friends' were the most common eating companions accounting for 72.5% and 18.4% eating occasions respectively. Minimal eating occasions were reported 'Alone' or watching/ using the 'TV/ Computer' (7.3% and 1.8% respectively).

4.8 Physical Environment

Physical environment GPS data was unusable due to incorrect device settings. Due to project time restrictions this data collection wasn't repeated thus is omitted from pCNES analysis.

4.9 Discussion and Amendments

pCNES recruitment rates were low. It was postulated that this was owing to time-of-year (end of summer term), opt-in consent, and lack of school commitment and priority. Consequently for the Main Study (CNES) dates were better planned around school events and holidays, opt-out consent was utilised (involving ethical approval re-application and re-approval) and recruitment information was altered to make it more appealing to schools, parents and participants.

Only 58.3% of the sample completed pCNES in full. When questioned, participants who did not complete the diary suggested the process was *'good'*, *'ok'*, *'fine'* and *'easy to complete'*. It was assumed from this that the pCNES and successive CNES process was acceptable. Therefore for CNES the researcher focussed on increasing buy-in and commitment of schools and participants. Researcher spent time with and provided written instructions to classroom teachers, to enhance their understanding of CNES and increase awareness of their role in supporting students' participation. Secondly participant training was modified to include diary completion re-cap further ensuring participant understanding and ability. Emphasis was placed on completing all questions. Interview protocol was amended ensuring all participant data was completed with increased use of photograph and verbal prompting utilised. Furthermore a protocol to implement second and third CNES attempts by participants was introduced. Finally, parental reminders, sent at the mid-point of CNES, were introduced to encourage parental prompting and encouragement.

Minor amendments were made to the 'Instructions' page of the Activity and Dietary Intake Dairy simplifying terminology to increase clarity. A Home Affluence Scale was also added to participant's general questions (Wardle *et al.*, 2002).

The GPS device was tested and a protocol for maintenance of settings was also introduced.

pCNES highlights:

- On average 6 hours and 20 minutes of all activity types were reported daily
- Participant and researcher activity intensity agreement was low (27.7%)
- The majority of activity time reported was at low intensity
- Sedentary activity was most commonly reported at 'House' and intense activity at 'School'
- Sedentary time and low intensity activity was most common with 'Family', moderate activity intensity with 'Friends' and intense activity with 'Adult, friends and/ or family'
- On average participants ate 3.9 times daily (3 meals and 1 snack)
- Participants ate significantly more at school day 'Lunch' but less at 'Breakfast' and 'Dinner' than on weekend days
- 'HFSS foods and drinks' represented a higher proportion of participant's diets than recommended by Eatwell guidance
- Food and drink tended to be sourced and eaten from the same location,

predominately home and school

- Most participants ate most frequently with ‘Family’ and ‘Friends’
- Amendments to recruitment and training protocols were made to enhance CNES uptake both by schools and parents
- Minor amendments were made to Activity and Dietary Intake Dairy terminology to simplify for participants and parents
- GPS device protocol was put in place

CNES Participants

This section reports CNES study completion rates by stage and gender and participant demographics and anthropometrics. Photographic data and self-report amendments are reported descriptively. Then self-reported activity behaviour and dietary intake data is summarised with contextual factors (e.g. location and companion type). Finally Participant Attitude, Perception and Behavioural Survey responses are outlined descriptively and correlated with demographic, physical, behavioural and environmental factors.

Of the 118 participants recruited to CNES, 108 (91.5%) completed the self-report diary in full and consequently underwent full anthropometric, demographic, behavioural and neighbourhood environment analysis (Table 34). More female than male participants were recruited-to and completed CNES.

CNES phase completion	**Male**	**Female**	**Total**
All recruited participants	52	66	118
Activity and diet diary (4 days)	45 (41.7)	63 (58.3)	108 (100)
Photograph(s) – activity	42 (38.9)	51 (47.2)	93 (86.1)
Photograph(s) – food	43 (39.8)	61 (56.5)	104 (96.3)
Participant Interview	45 (41.7)	63 (58.3)	108 (100)
Participant Survey	45 (41.7)	62 (57.4)	107 (99.1)
Parent Survey	30 (27.8)	37 (34.3)	67 (62.0)

Table 34: Recruitment and CNES completion counts (%) by gender (n=118)

Two participants opted out of CNES post-training without attempting diary completion. Eight participants who did not complete the full four day self-reports partially completed their diaries but after two given re-attempts they did not adequately complete the task and thus were excluded. Participants were required to report at least some dietary intake at all mealtime eating occasions and some activity at all activity occasions. If data was missing and a plausible explanation was provided at interview (i.e. missed dinner after late lunch or went to bed early after tea) then diary was not excluded.

4.10 Participant Demographics and Anthropometrics

Table 35 details CNES population demographic and anthropometric characteristics by gender. Low levels of ethnic diversity were reflective of the geographical area; the North East has a high White British population (Office for National Statistics, 2012). On average male participants were older and marginally more deprived than female participants. Female participants were marginally taller, heavier and subsequently had higher BMI's than male participants. Participant BMI and IMD were not correlated in this study population.

Factor	**Male**	**Female**	**Total**
Age (years and months)	10y 10m (5.4m)	10y 7m (5.1m)	10y 8m (5.4m)
IMD score	36.74 (21.39)	35.11 (18.57)	35.79 (19.71)
Height (m)	1.45 (0.06)	1.47 (0.08)	1.46 (0.07)
Weight (kg)	38.44 (7.96)	40.64 (10.00)	39.73 (9.23)
BMI score	18.17 (3.27)	18.75 (3.39)	18.50 (3.34)
BMI grouping:			
Underweight	4	9	13
Healthy weight	33	34	67
Overweight	5	16	21
Obese	3	4	7
Ethnicity:			
White British	36	55	91
Ethnic minority British	9	8	17

Table 35: Mean (SD) age, IMD score, height, weight and BMI score and counts per BMI and ethnic groupings by gender for CNES sample (n=108)

Participant demographics and anthropometrics highlights:

- Female participants were on average taller and heavier than males
- 25.9% of the CNES sample population were overweight or obese

- BMI and IMD were not correlated in the CNES sample population

4.11 Self-Reported Diary Amendments

In total 2,693 amendments were made to self-reported data attributable to photo and verbal discrepancy prompting, an average of 24.9 amendments per child. The majority of prompts were verbal (67.8%) and for eating occasions (66.8%).

Diary Amendments data highlights:

- 25.1% of self-reported activity and dietary behaviour data was attributable to amendments made by photo discrepancy (8.1%) and verbal prompts (17%)

4.12 Photographic Data

In total 1,241 activity instances[19] and eating occasions[20] were photographed; 28.4% (353) activity instances and 71.6% (888) eating occasions (Table 36). At least one photograph was taken by 98.2% participants (n=106); two female participants did not take any photographs. Of the 106 participants who took at least one photograph 85.8% (n=91) photographed both activity instances and eating occasions, 1.9% (n=2) activity instances only, and 12.3% (n=13) eating occasions only.

Total activity and food image count was significantly associated with gender (F=4.46, p=0.04); on average female participants took more photographs than male participants (+2.4 images per participant). No correlation was observed with BMI but significant moderate to low negative correlation was observed with IMD and total image count (r=-0.22, p=0.02 2-tailed). Increasing affluence was

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[19] An activity instance was defined as: any duration of time reported doing any type of activity, in any location, at any activity intensity

[20] An eating occasion was defined as: any occurrence when food or drink was consumed (food and drink items hereon are referred to as food items).

positively associated with higher mean photograph count (on average +3.4 images per participant from IMD quintile 5 compared to quintile 1).

Photo type	Male		Female		Total	
	Total	*Mean*	*Total*	*Mean*	*Total*	*Mean*
Activity image	137	3.0 (2.9)	216	3.4 (2.1)	353	3.3 (2.5)
Eating occasion	336	7.5 (4.1)	552	8.8 (3.9)	888	8.2 (4.0)
Food image	386	8.6 (5.1)	684	10.9 (4.8)	1,070	9.9 (5.1)
Food item	1,264	28.1 (18.2)	2,083	33.1 (17.2)	3,347	31.1 (17.7)

Table 36: Total and mean (SD) photo counts by gender (n=106)

Photographic data highlights:

- 28.4% activity instances and 71.6% eating occasions were photographed
- Greater affluence and being female was significantly positively associated with taking more photographs

4.13 Activity Behaviour

In total 3,585 activity instances were self-reported by all participants, mean 8.3 daily (Table 37). Mean activity time reported per participant was 1,662 minutes over four days, or 6 hours 56 minutes per day. Neither activity instance *count* nor *time* were associated with gender or correlated with BMI or IMD.

Activity instance	Male	Female	Total
Count:	1,463	2,122	3,585
Mean/4 days	32.51 (4.60)	33.68 (5.10)	33.19 (4.91)
Range	25–45	22–45	22–45
Time (minutes):	78,736	100,749	179,485
Mean/4 days	1,750 (642)	1,599 (368)	1,662 (503)
Range	592–3,837	918–2,571	592–3,837

Table 37: Total, mean (SD) and range of participant self-reported activity instances and activity time (in minutes) by gender (n=108)

4.13.1 Activity Type

Twenty unique activity types were reported. Table 38 outlines reported activity types by activity intensity category as categorised in Table 31 on page 118.

4.13.2 Activity Intensity

Figure 25 shows male participants spent significantly *more* time in 'Intense' activity but significantly *less* time in 'Low' and 'Moderate' intensity activities than female participants ($H=15.20$, $p<0.01$, $H=4.40$, $p=0.04$ and $H=10.12$, $p<0.01$). The same pattern was observed for activity instance counts (data not shown).

Neither BMI nor IMD was correlated with activity time reported by activity intensity.

Intensity	**Activities**
Sedentary	Sedentary travel Sitting (reading/writing/board games/listing to music) Sleeping (during waking hours i.e. napping) Talking TV/computer
Low	Bathing and dressing Art/crafts/writing Food preparation Walking without destination (i.e. when shopping)
Moderate	Activity club Housework/gardening/DIY Play Theatricals (music/singing/acting) Walking with destination (i.e. active travel)
Intense	Athletics Cycling/scooting/skating Dance Running Sports

Table 38: Activity type by activity intensity category

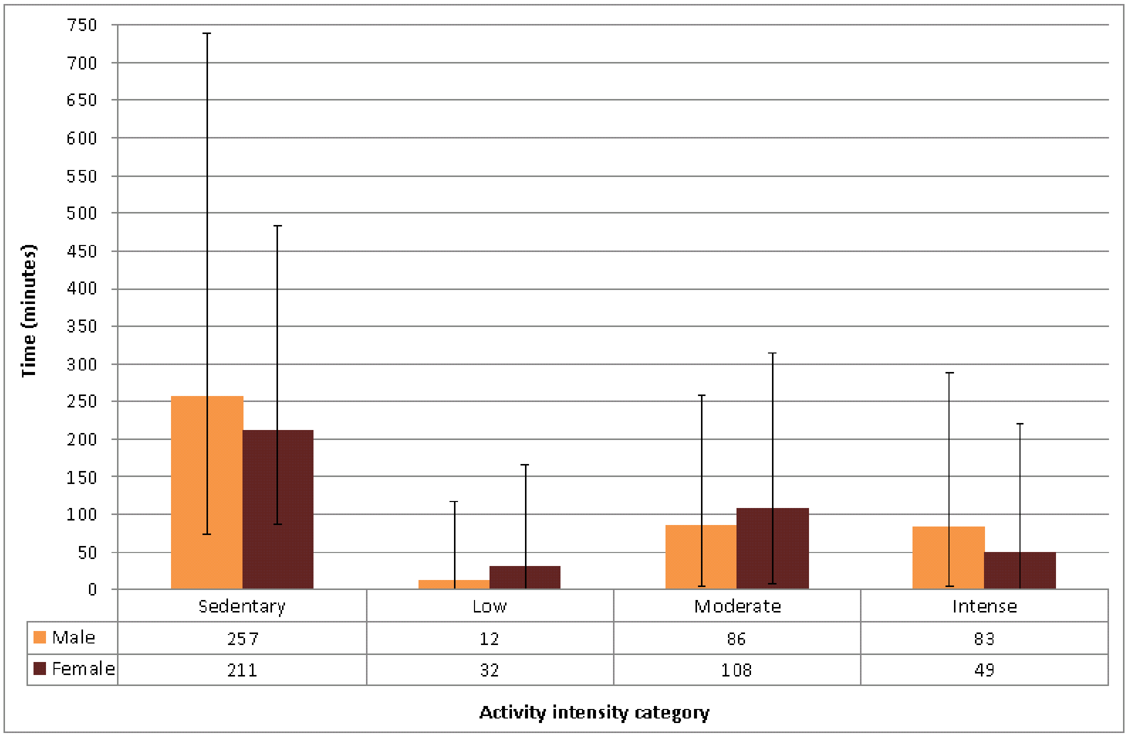

Figure 25: Mean activity time per day by activity intensity and gender (n=108)

4.13.3 Activity Location

Figure 26 and Figure 27 illustrate gender differences between percentage times reported at activity intensities by location. Male participants reported significantly more time in ‘Sports venues’ than female participants, on average +57 minutes (H=4.28, p=0.04). Gender was not significantly associated with time reported in any other location.

BMI was not correlated with reported activity time at any given location for all participants. Time reported in ‘School’ showed moderate to low *negative* association with IMD (r_S=-0.30, p<0.01 2-tailed), i.e. decreasing activity time reported with increasing deprivation. This was mainly attributable to misreporting of break time: participants from IMD quintile 1 (most affluent) mean 83 minutes and IMD quintile 5 (most deprived) 43 minutes per day. Both times are inaccurate when compared than the actual 15–20 and 45–60 minute break and lunch times in schools.

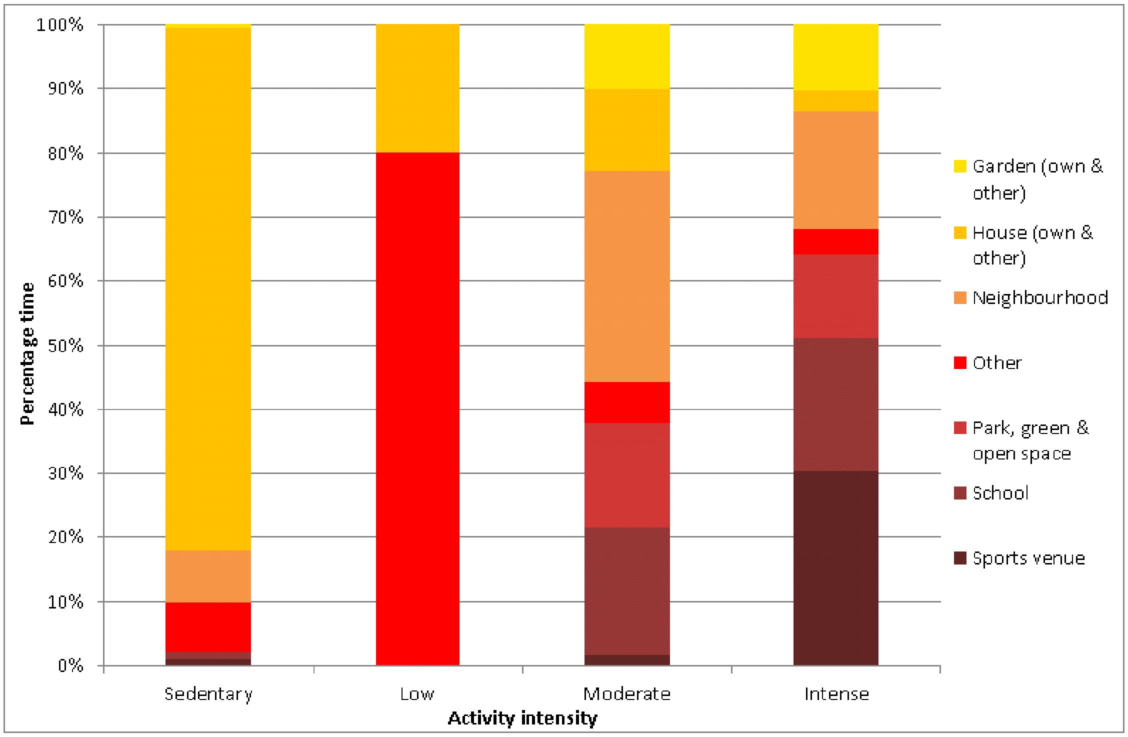

Figure 26: Percentage of reported time per activity intensity by location for male participants (n=45)

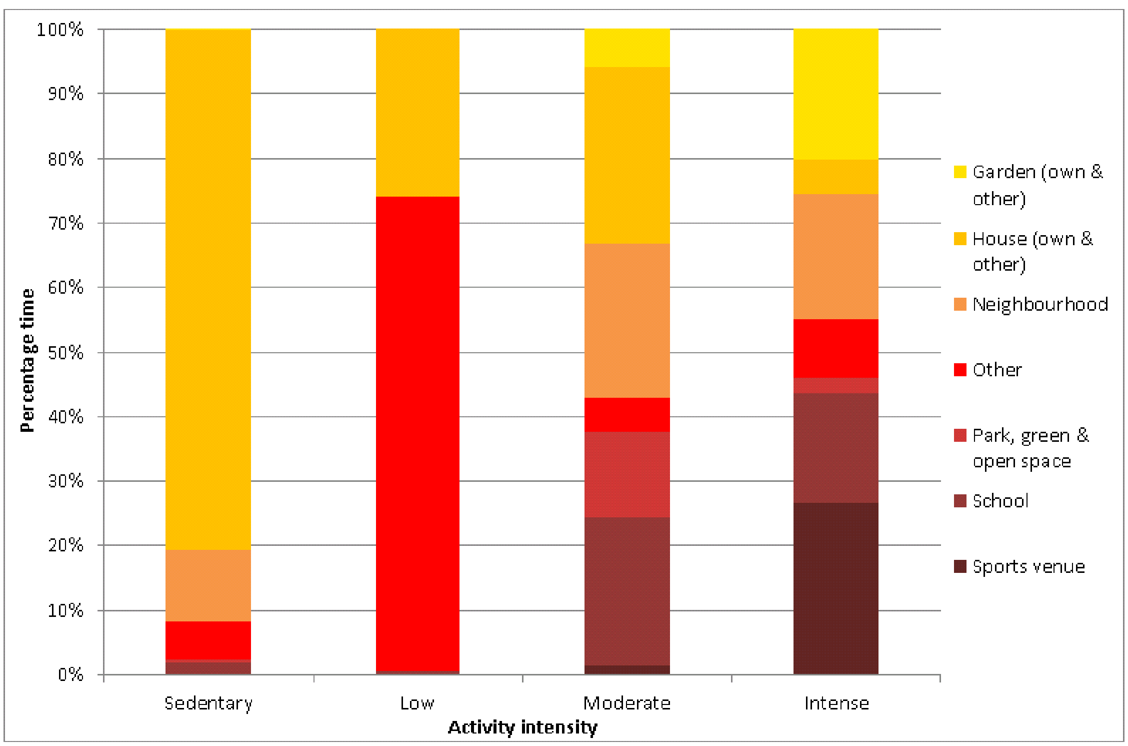

Figure 27: Percentage of reported time per activity intensity by location for female participants (n=63)

4.13.4 Activity Companion

Gender difference between percentage times spent with companion grouping by activity intensities are illustrated in Figure 28 for male participants and Figure 29 for female participants.

Time reported by companion grouping showed no association with gender or correlation with BMI. Time reported with an 'Adult, friend(s) and/ or family' showed weak to low positive correlation with increasing deprivation status (r_s=0.22 p=0.03). No other companion type grouping was correlated with IMD.

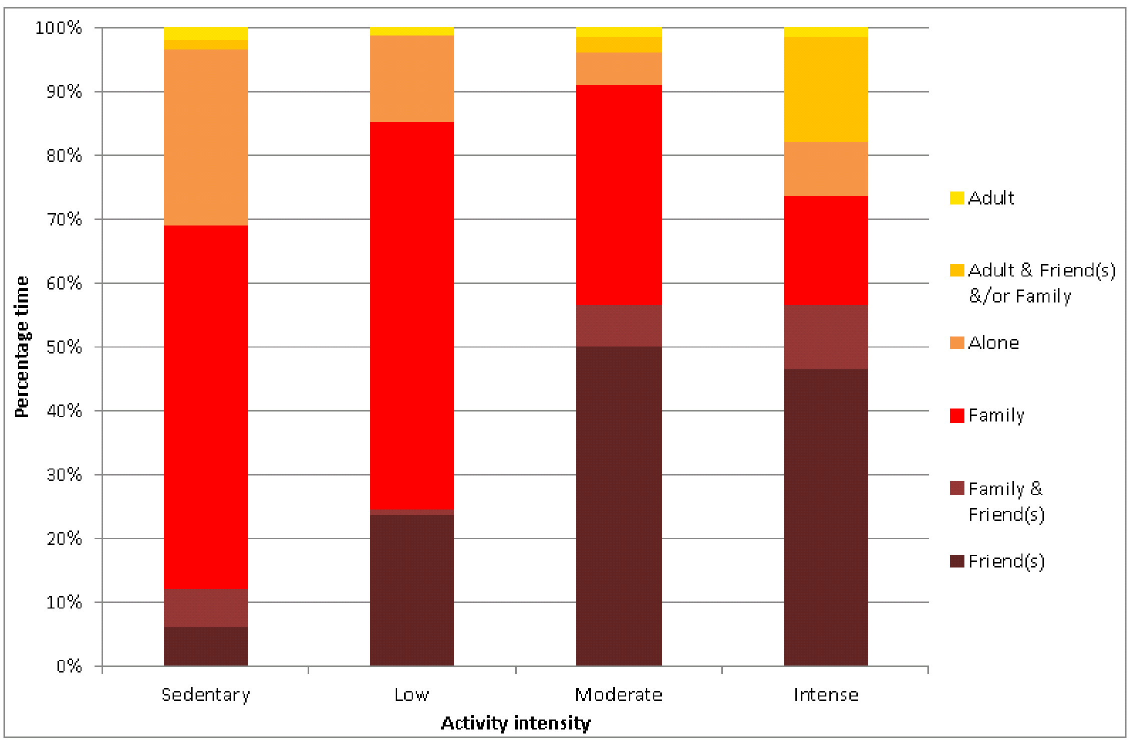

Figure 28: Percentage reported time per activity intensity by companion grouping for male participants (n=45)

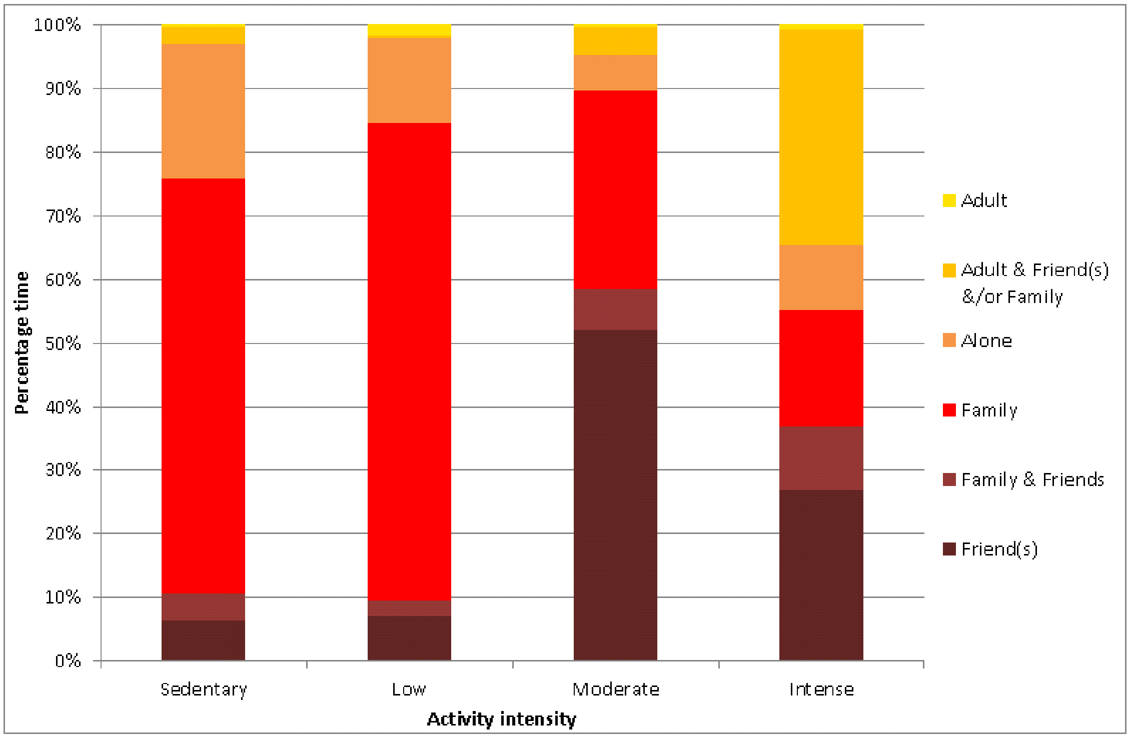

Figure 29: Percentage reported time per activity intensity by companion grouping for female participants (n=63)

Activity Behaviour highlights:

- Participants reported an average 8.3 activity instances equating to a mean of 6 hours and 56 minutes of activity (all types) daily
- Male participants spent significantly more time in ‘Intense’ activity than female participants
- Female participants spent significantly more time in ‘Low’ and ‘Moderate’ intensity activities than male participants
- Significantly more time was reported in ‘Sports venues’ by male participants
- Activity companion did not influence reported activity time
- Though not significant intense activity companion grouping was markedly different between genders with male participants spending most time with ‘Friends’ and female participants ‘Adults’

4.14 Dietary Intake

In total 1,806 eating occasions were reported by all participants equating to a mean of 4.2 times daily (SD 0.6, range 3–6). Eating occasion count was not correlated with BMI or IMD, or associated gender.

Figure 30 shows statistically significantly *more* food items were eaten at *weekend* 'Breakfast' than on *school days*, mean +0.5 food items per participant per eating occasion (T=-2.11, p=0.04). And significantly *more* food items were eaten at *school day* 'Lunch' and 'Evening snack' times than at *weekends*, on average +2.5 and +0.5 food items per participant per eating occasion (T=-6.04, p<0.01 and Z=-2.07, p=0.04).

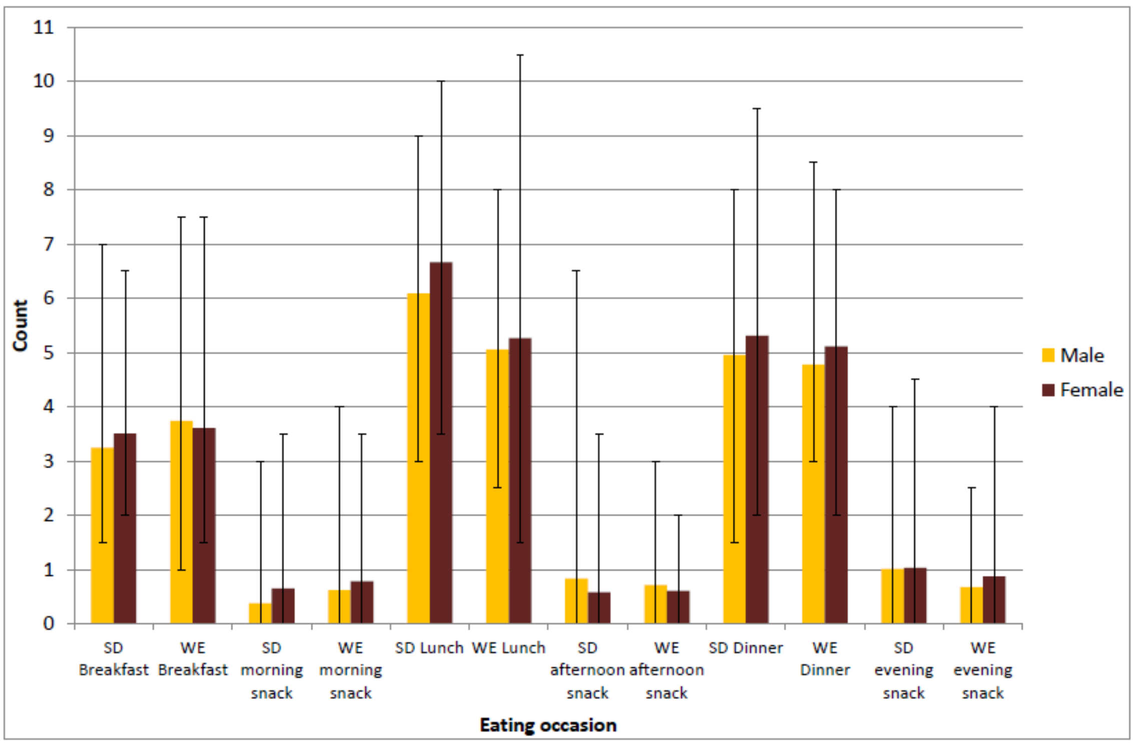

Figure 30: Mean daily food item count per eating occasion by gender for school (SD) and weekend (WE) days (n=108)

4.14.1 Food Items

In total 7,175 food items were reported by all participants over four days. Table 39 shows mean food item count per eating occasion by gender.

Eating occasion	Male		Female		All	
	Total	*Mean*	*Total*	*Mean*	*Total*	*Mean*
Breakfast	629	3.5 (1.2)	897	3.6 (0.9)	1,526	3.5 (1.0)
Lunch	1,003	5.6 (1.1)	1,504	6.0 (1.1)	2,507	5.8 (1.1)
Dinner	876	4.9 (1.3)	1,314	5.2 (1.0)	2,190	5.1 (1.2)
All snacks	381	2.1 (1.5)	571	2.3 (1.2)	952	2.2 (1.3)

Table 39: Four day total and daily mean (SD) food item counts per eating occasion by gender (n=108)

Gender was not associated with food item count per eating occasion. BMI showed very weak (all r_s<0.2) and non-significant correlations with food item count per eating occasion. More affluent participants ate statistically significantly more food items at 'Dinner' than deprived participants (r_s=-0.26, p=0.01 2-tailed).

4.14.2 Dietary Composition

Table 40 shows average daily diet of all participants by food item count. Dietary data is interpreted cautiously as self-reports did not account for portion size.

Food Group	Mean	SD	Range
More healthful foods:			
Carbohydrates	2.9	0.8	1.3–5.5
Dairy	1.8	0.9	0.3–4.8
Fruit and vegetables	2.5	1.2	0.3–5.5
Protein	2.0	0.7	0.5–4.0
Low calorie drinks	1.7	0.9	0–4.5
Less healthful foods:			
Fried/ high fat snacks	1.5	0.6	0–3.0
Puddings, deserts, cakes and biscuits	1.4	0.7	0–4.5
Sauces and spreads	1.7	0.8	0.3–5.0
Sweets and chocolate	0.3	0.4	0–1.8
High calorie drinks	0.9	0.8	0–3.3

Table 40: Daily mean, SD and range of food items by food group type (n=108)

Dietary intake was compared with Eatwell guidance (Food Standards Agency, 2007). Figure 31 shows food item counts of 'Protein' and 'Dairy' were in line with Eatwell recommended servings. 'Carbohydrate' and 'Fruit and vegetable' counts were low with only four participants reporting five fruit and/ or vegetables items per day. Counts of ‘High fat and/ or sugar foods and drinks’ were very high; ‘Less healthful foods’ constituted 34.7% of participant’s dietary intake.

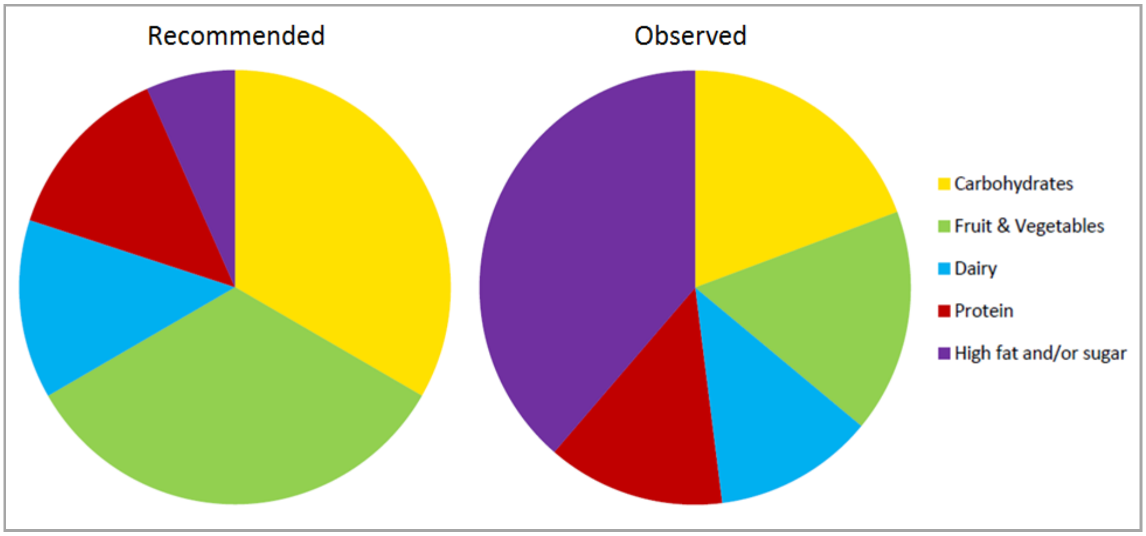

Figure 31: Observed dietary intake (food item count) comparative to Eatwell recommended intake (servings)

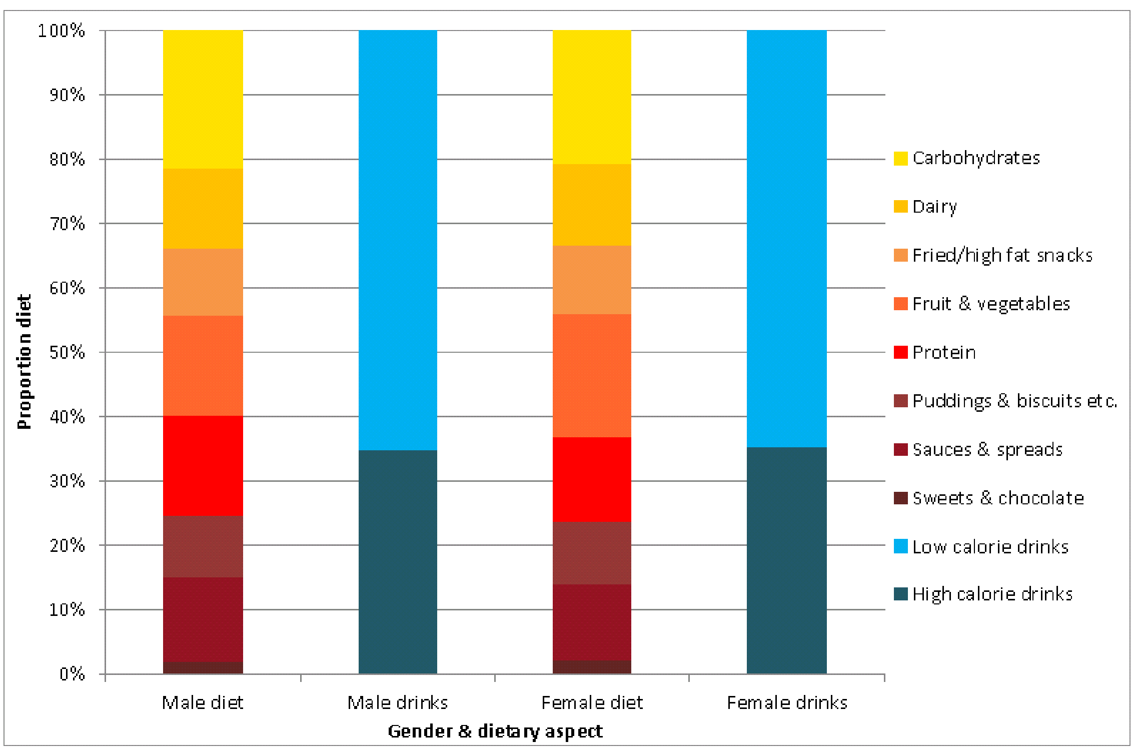

Figure 32: Proportion of total diet and drink consumption per food and drink type by gender (n=108)

Figure 32 illustrates gender differences in proportional dietary composition. Daily counts of food items mirrored gendered proportional dietary composition, data not shown. Female participants ate a significantly *higher* proportion of ‘Fruit and vegetables’ than male participants (+3.3%, H=8.80, p<0.01). All other dietary gender differences were non-significant.

BMI was not correlated with dietary intake according to food group. More affluent participants reported statistically significantly *more* ‘Fruit and vegetables’ (r_s=-0.32, p<0.01), ‘Puddings, deserts, cakes and biscuits’ (r_s=-0.19, p=0.05) and ‘Low calorie drinks’ (r_s=-0.23, p=0.02), but significantly *less* ‘High calorie drinks’ (r_s=0.22, p=0.03) than deprived participants.

4.14.3 Sourcing Location

Food was sourced from a single location on 99.2% eating occasions (1,806). Most food was sourced from ‘House’ (79.8%, 1,454 eating occasions). Food sourced from ‘Food outlets’, ‘School’ and ‘Other’ locations accounted for 9.4% (171), 8.5% (155) and 2.3% (41) of eating occasions, respectively.

On average female participants sourced food from ‘Food outlets’ +0.4 eating occasions than male participants (Z=-1.932, p=0.05). No other significant gender associations, BMI or IMD correlations were observed.

4.14.4 Eating Location

‘House’ and ‘School’ were the most common eating locations representing 76.6% (1,395) and 15.2% (276) total eating occasions respectively.

Gender was not associated with eating location. BMI showed very weak *negative* correlation with ‘Food outlet’ eating location (r_s=-0.20, p=0.04 2-tailed) but Figure 33 shows the non-linear relationship observed.

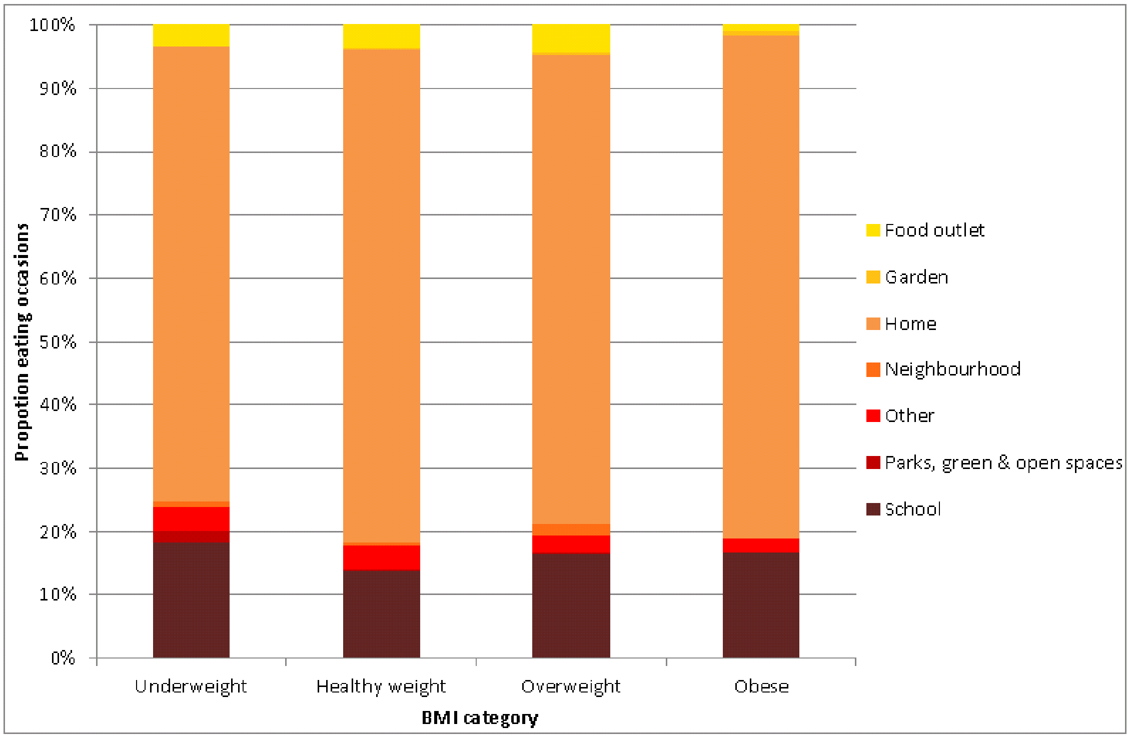

Figure 33: Proportion of total eating occasions by eating location by BMI category (n=108)

IMD showed low to moderate *negative* correlation with 'School' eating location (r_s=-0.28, p<0.01 2-tailed). Only school day 'Lunch' remained significant when correlation was ascertained per eating occasion (r_s=-0.44, p<0.01 2-tailed). Two lunches were eaten at school by 52.8% participants in deprived schools compared to >90% in affluent schools. One deprived school was unexpectedly closed on one school day which explains this anomaly.

Eating location showed 85.4% (1,560) agreement with sourcing location (T=-11.09, p<0.01). Percentage agreement was further increased to 92.3% (1,685) when eating location 'School' extended food sourcing location to include 'House' to incorporate food sourced from home for packed lunch.

4.14.5 Eating Companion

Participants ate with a single companion grouping 97.5% (1,806) times. 'Family' and 'Friends' were the most common eating companions, accounting for 57% (1,057) and 19.8% (367) eating occasions respectively.

Eating companion grouping showed no correlation with BMI and no association with gender. Figure 34 shows more affluent participants reported statistically significantly more eating occasions with 'Friends' than deprived participants (r_s=-0.24, p=0.02 2-tailed). IMD was not significantly correlated with any other companion grouping.

Eating companion was significantly associated with eating location (χ^2=4824.40, p<0.01[21]). The majority of eating occasions reported 'Alone', with 'Family' and the 'TV/ Computer' were in 'House and Garden' (94.7% 608; 91.7% 3,810; and 98.6% 362). The majority of eating occasions reported with 'Friends' were at 'School' (74.8% 1,248).

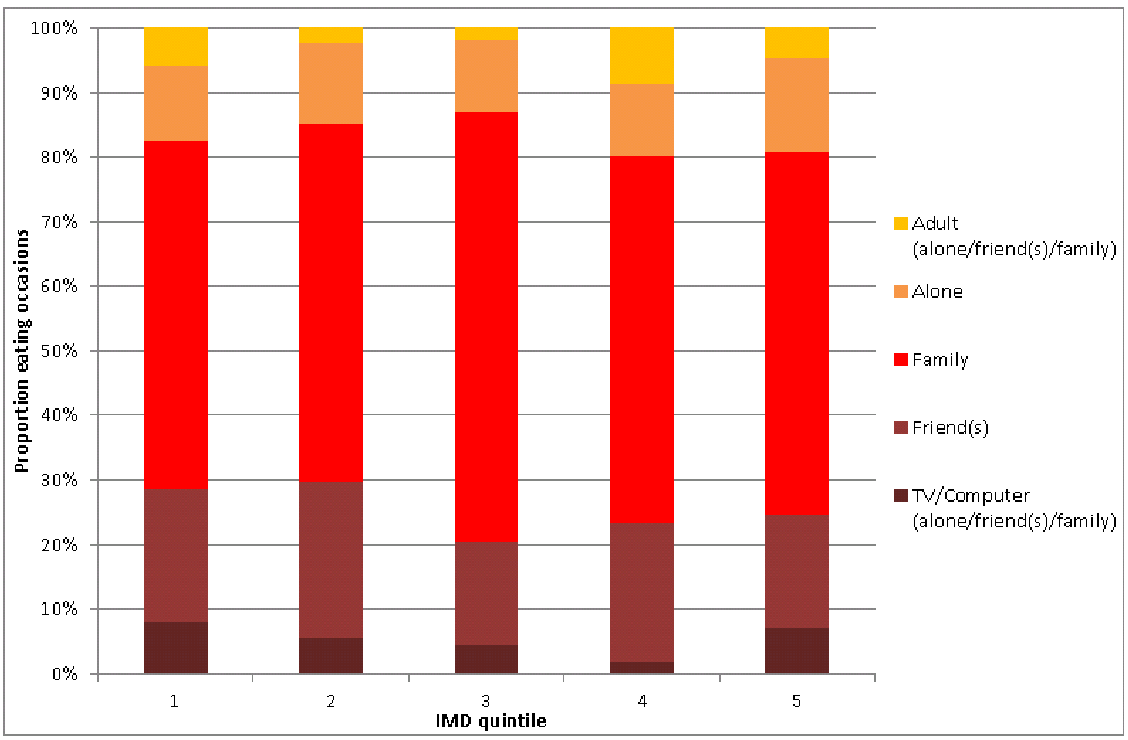

Figure 34: Proportion of total eating occasions by food sourcing location by IMD quintile (IMD quintile 1 most affluent, IMD quintile 5 most deprived) (n=108)

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[21] To satisfy test assumptions 'House' and 'Garden', and 'Parks, green and open spaces' and 'Other' locations were combined.

Dietary Intake highlights:

- Participants reported an average of 4.2 eating occasions daily comprising 16.7 food items (SD 2.6)
- Less healthy foods represented 34.7% (5.8 food items) of participant diets
- Female participants reported significantly higher 'Fruit and vegetable' intakes than male participants
- Being affluent was significantly positively associated with 'Fruit and vegetable', 'Pudding, desert, cake and biscuits' and 'Low calorie drink' intakes
- Being deprived was significantly positively associated with 'High calorie drink' intakes
- The majority of food was sourced (79.8%) and eaten (76.6) from 'House'
- Female participants sourced food from 'Food outlets' on significantly more eating occasions than male participants
- Overweight participants reported more eating occasions in 'Food outlets' than any other BMI category
- 85.4% eating occasions food was sourced and eaten from the same location
- Eating companion showed significant associated with eating location

4.15 Attitude, Perception and Behavioural Survey

Figure 35 shows average survey scores by response category (overarching theme) by gender. Perceptions and attitudes are represented in yellow and behaviour in red.

Proportionately male participants had *more positive* perceptions than female participants on 'Neighbourhood environment activity facilitation' and 'Body shape satisfaction'. Female participants had *more positive* attitudes towards 'Physical activity' and 'Eating well' and were *more involved* with 'Food shopping and/ or preparation' than male participants. Gender differences were non-significant.

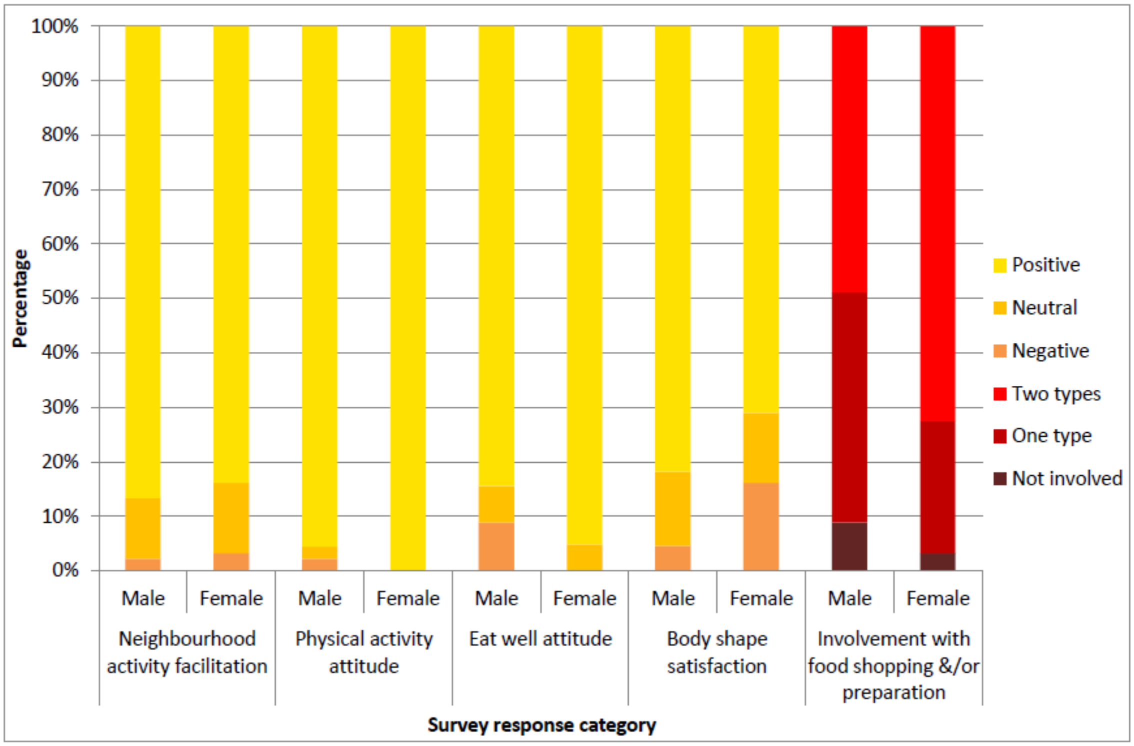

Figure 35: Participant perception, attitude and behaviour (involvement) survey response by response category and gender (n=107)

4.15.1 IMD and BMI

Having a *higher* BMI was statistically significantly associated with *lower* 'Body shape satisfaction' (Table 41). Though non-significant, heavier participants had *less* favourable attitudes towards PA.

Perception/ attitude category	BMI	IMD
Neighbourhood environment activity facilitation	0.24 (0.89)	**13.94 (<0.01)***
Physical activity attitude	4.79 (0.09)	3.20 (0.20)
Eat well attitude	0.88 (0.64)	5.62 (0.06)
Body shape satisfaction	**8.73 (0.01)***	5.05 (0.08)

* ***Significant*** *at p<0.05 level*

Table 41: Participant perception, attitude and behaviour survey response by response category and associations with BMI and IMD (H (p)) (n=107)

Affluent participants had statistically significantly *more* positive perceptions of 'Neighbourhood environment activity facilitation' than deprived participants. Though non-significant increasing affluence was linked with more *positive* 'Eat well' attitudes but *decreasing* 'Body shape satisfaction'.

4.15.2 Neighbourhood Active Travel and Physical Activity

Perception of 'Neighbourhood environment activity facilitation' was *not associated* with time reported in *neighbourhood active travel*[22] but showed statistically significant *negative* association with *within neighbourhood activity*[23] (H=8.61, p=0.01). Negative respondents reported *more* time active in neighbourhoods than neutral and positive respondents.

Attitude towards PA showed *no association* with time reported in moderate or intense activity.

4.15.3 Dietary Intake

Though not significant, there was a trend towards more *positive* 'Eat well' attitudes with increased interaction with 'Food shopping and/ or preparation'.

Participants with *positive* eat well attitudes reported marginally, not significantly, more 'Fruit and vegetable' items and fewer 'High fat and/ or sugar foods' per day than *negative* respondents (+0.3 and -1.3 respectively). Participant reported access to 'Fruit and vegetables': *seeing* and *getting,* was not linked to reported preference for these foodstuffs.

Participant Attitude, Perception and Behavioural Survey highlights:

- Lower body shape satisfaction was significantly associated with higher BMI
- Higher BMI was non-significantly negatively associated with PA perceptions
- Being affluent was significantly positively associated with perceptions of

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[22] Defined as all-time reported by participants walking, jogging, running, cycling, skating or scooting for the purpose of travel within the neighbourhood.

[23] Defined as all-time reported by participants playing, doing sports, athletics, dance, activity clubs, walking, jogging, running, cycling, skating, scooting, gardening or DIY within the neighbourhood.

neighbourhood environment activity facilitation

- Positive perceptions of neighbourhood environment activity facilitation were significantly negatively associated with active time in these spaces
- Involvement with food shopping and preparation were non-significantly positively associated with positive attitudes towards eating well
- Positive attitudes towards eating well were non-significantly associated with healthier dietary intake

Parent/ Guardian Perception, Attitude and Behavioural Survey

This section reports Parent/ Guardian Perception, Attitude and Behavioural Survey results. Neighbourhood Environment perceptions and Physical Activity and Dietary Intake attitudes and behaviours are outlined descriptively and correlated with participant attitudes and behaviours.

Parent/ guardian surveys were distributed to all participant's parents/ guardians (n=108) of these only 70 (64.8%) were returned. Three returned surveys were excluded according to content criteria (>90% content); missing data instances were excluded from analysis on a case-by case basis. The majority of surveys were completed by parents (94%); accordingly parents/ guardians are hereon referred to as parents. Table 42 outlines parent survey population.

Factor	N	Male	Female	Undeclared gender	Mean/Total
IMD score	67	22.54 (21.4)	33.6 (17.5)	33.2 (30)	31.96 (18.5)
BMI score	54	26.8 (3.6)	24.8 (4.3)	37	35.4 (4.5)
Ethnicity:	58				
White		5	44	1	50
Ethnic minority		3	5		8
Relationship to child:	67				
Parent		10	53		63
Other family member				2	2
Guardian			2		2
Academic achievement:	66				
None/undisclosed		2	7	1	10
High school/College		6	37	1	44
Undergraduate degree		1	6		7
Postgraduate degree		1	4		5

Table 42: Mean (SD) IMD and BMI scores and counts per ethnic, relationship to child and academic achievement groupings by gender for CNES parent population (n=67)

Proportional distribution of ethnicity was consistent between parent and participant populations. Mean IMD of the parent survey population was lower than participant population (low score denotes affluence), i.e. more parents from affluent areas completed surveys. And there was 33.3% agreement between participant and parent BMI grouping, i.e. participants and parents fell within the same BMI category.

Figure 36 shows average survey scores by response category (overarching theme); perceptions are represented in yellow, frequencies in red and permissiveness in purple. The majority of parents reported *positive* perceptions, *frequent* behaviours and *non*-permissiveness.

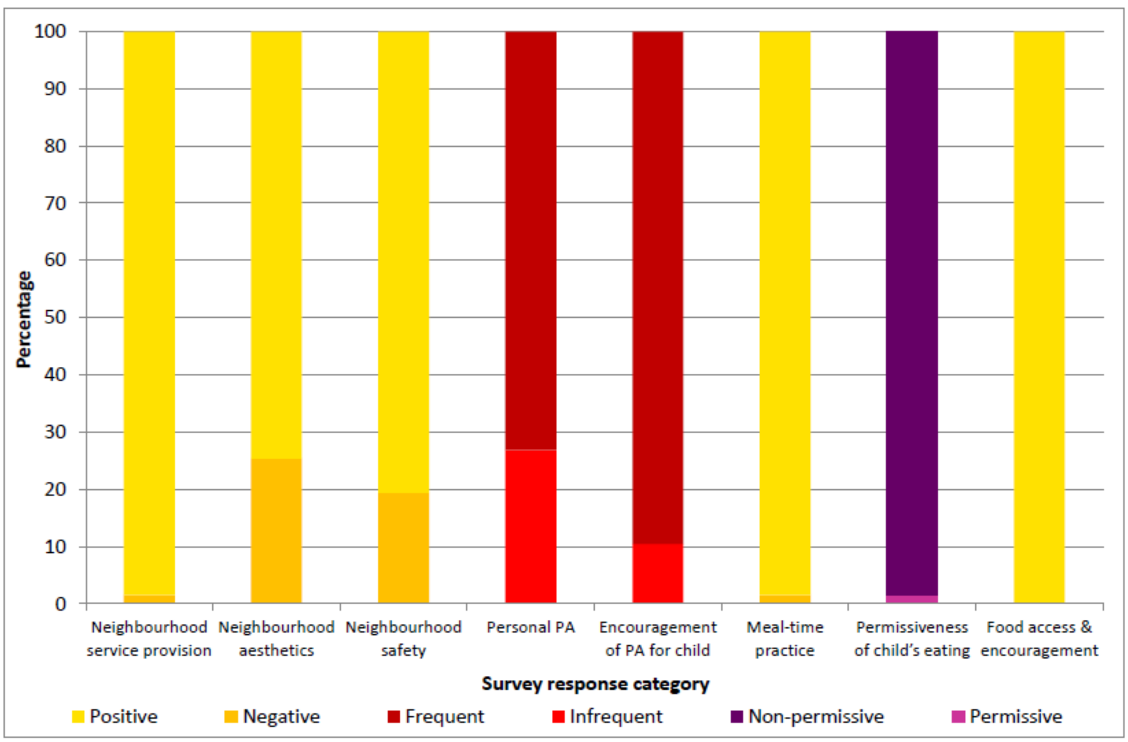

Figure 36: Parent perception (yellow), frequency (red) and permissiveness (purple) survey responses by response category (n=67)

4.16 BMI and IMD

Parent BMI was not associated with any survey response. Parents from more *deprived* neighbourhoods perceived statistically significantly *poorer*

‘Neighbourhood aesthetics’ (F=5.53, p=0.02) and were more *permissive* of ‘Child’s eating’ (F=7.15, p=0.01).

4.17 Child’s Neighbourhood Activity and Active Travel

Positive ‘Neighbourhood aesthetic’ perceptions were statistically significantly *positively* associated with participant reported *within neighbourhood activity* (+134 minutes, H=6.37, p=0.01); and non-significantly *positively* associated with *neighbourhood active travel time* (+23 minutes, H=2.85, p=0.09).

Parent’s perceptions of neighbourhood ‘Safety’ and ‘Services’ showed *no* association with *neighbourhood activity* or *neighbourhood active travel*. Parent and participant perception percentage agreement for ‘Neighbourhood safety’ and ‘Service provision’ were 61.2% and 74.6%, respectively.

4.18 Child’s Physical Activity

Parent reported personal ‘PA frequency’ showed non-significant *positive* association with participant reported time spent in ‘Moderate’ and ‘Intense’ activities. On average +76 (F=1.05, p=0.31) and +27 (H=0.90, p=0.34) minutes, respectively. Parent and participant ‘PA liking’ percentage agreement was 47.8%.

Though associations did not reach significance, participants whose parents reported *frequent* ‘PA encouragement’ reported *more* time in ‘Moderate’ intensity activity (+117 minutes, F=1.20, p=0.28) but *less* time in ‘Intense’ activity (-105 minutes, H=1.32, p=0.25) than those whose parents reported *infrequent* encouragement.

4.19 Child’s Dietary Intake

Parent reported ‘Mealtime practices’ and ‘Permissiveness’ showed *no association* with participant ‘Fruit and vegetable’ or ‘Less healthful food’ item intakes.

Positive ‘Food access and encouragement’ was non-significantly linked to *higher* mean ‘Fruit and vegetable’ and *lower* ‘Less healthful food’ item intakes (+0.6 and -1.5 food items per day, respectively).

Parent Survey highlights:

- Positive perceptions of ‘Neighbourhood aesthetics’ were significantly positively associated with affluence and participant reported neighbourhood activity, and non-significantly positively associated with neighbourhood active travel
- Parents reporting frequent ‘PA participation’ were more likely to have children reporting time in ‘Moderate’ and ‘Intense’ activities
- Parental encouragement of PA showed non-significant positive association with participant reported ‘Moderate’ intensity activity time but negative association with ‘Intense’ activity time
- Deprivation was significantly positively associated with greater permissiveness in child’s eating
- Positive food access and encouragement was non-significantly associated with higher ‘Fruit and vegetable’ intakes and lower ‘Less healthful food’ item intakes
- Parental and participant perceptions of the neighbourhood environment showed moderate agreement

Neighbourhood Environment

This section outlines participant neighbourhood physical, built and food environments per participant 400m periphery buffer. Physical and built environment variables comprise: parks and green spaces (GSs), sports facilities, non-food shops and services, food outlets, outdoor food and drink advertising roads (length and safety), streets (length and quality) and cycling facilities. Variables are outlined descriptively then discussed in relation to participant and parent perceptions.

4.20 Parks and Green Spaces

Two hundred and ninety two Parks and GSs (583 entrances) were present within 89 participant neighbourhoods. There were a mean of 2.7 and 5.4 parks and GSs per participant (n=108); and mean 3.3 and 6.6 per participant when only those participants with at least one neighbourhood facility (n=89) were included.

Table 43 shows 'Amenity' GSs were the most common neighbourhood GS type. Parks and GSs are heron referred to as GS.

Park and GS type	**N (NC)**	**Count**			**Proximity**		
		Mean	*SD*	*Range*	*Mean*	*SD*	*Range*
Amenity	155 (80)	1.4	1.3	0–5	160	124	0–395
Functional	98 (51)	0.9	1.2	0–4	115	133	0–380
Semi-Natural	39 (33)	0.4	0.6	0–2	68	118	0–400

Table 43: Total count (N) (neighbourhood count (NC)), mean, SD and range of GS provision and proximity (in meters) in all participant neighbourhoods (n=108)

4.20.1 Proximity

Mean distance from home postcode to any neighbourhood GS was 149 metres. This figure should however, be interpreted with caution due to the large SD of 103. When only participants with at least one neighbourhood GS were included in analysis (n=89), mean proximity was 181 meters (SD 84). Proximity to ‘Semi-Natural’ GS was on average better than the other two GS types.

4.20.2 Environment and Quality Assessment

Of the total 292 GSs present in participant neighbourhoods, 155 (53.1%) underwent Environment and Quality Assessment Survey using OPAT. As detailed in section 3.16.1 OPAT was not fit for purpose to assess ‘Outdoor Sports Areas’, ‘Disturbed Ground’ or ‘Functional GSs’ all other GS types were audited. Figure 37 and Figure 38 illustrate the types of spaces and facilities examined.

Figure 37: Amenity GS playground and safety facilities

Figure 38: Semi-natural GS facility

Figure 39 shows wide ranging provision of GS facilities. ‘Playground Structures’ and ‘Exercise and Play Areas’[24] were more common in ‘Amenity’ than ‘Semi-Natural’ GSs. All ‘Amenity’ and just over half the ‘Semi-Natural’ GSs (n=20) had either a ‘Playground’ or ‘Exercise/ Play Area’. At least one ‘Safety Feature’ was present in all GSs. ‘Maintenance’ was rated above *fair* for all GSs, and *good* in 12% (n=19) cases.

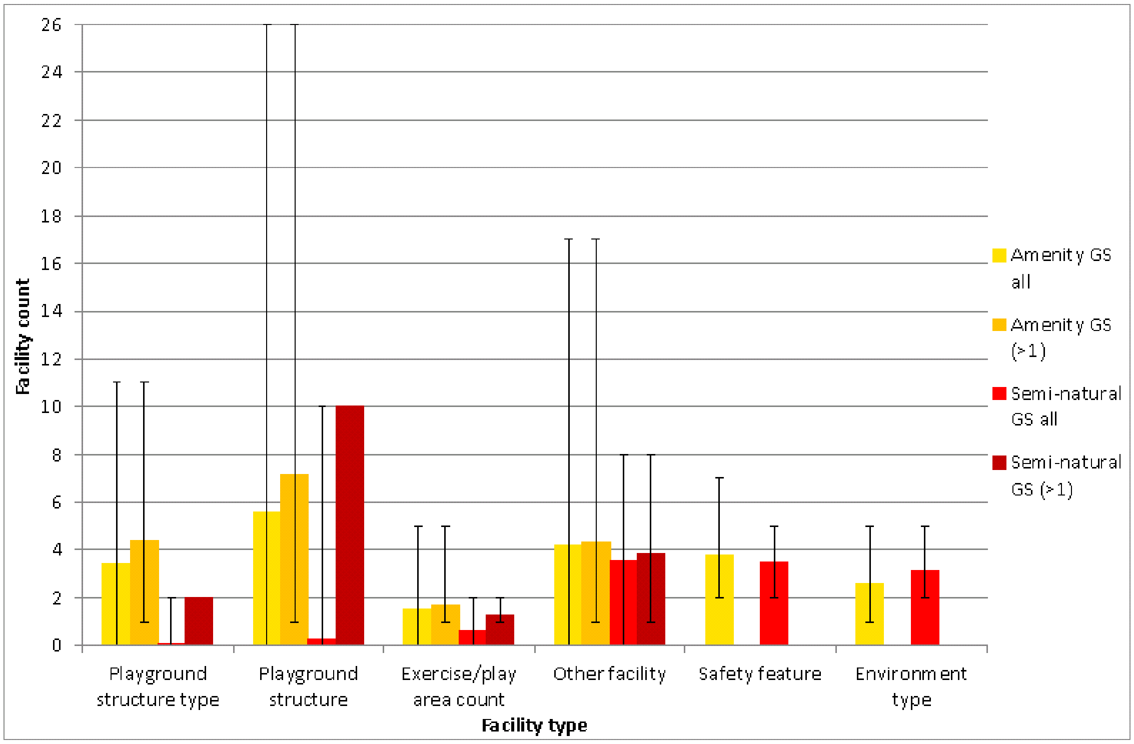

Figure 39: Amenity and Semi-Natural GS facility counts by type in all participant neighbourhoods and only those containing at least one target facility (>1)

4.20.3 Participant Perceptions

Ninety seven participants reported ‘Park use’[25]; the majority of which (68%, n=66) reported *weekly* usage. No association was found between GS *access* (by count) and participant reported *park use* (H=0.36, p=0.55) or *usage frequency* (H=8.29, p=0.22).

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[24] Comprising: sports lawns, fields and courts; athletics and skateboarding tracks; assault courses; and green gyms.

[25] Positive response to question: ‘Is there a park you play in?’.

Marginally more participants reporting *weekly* park use had at least one neighbourhood GS compared to those reporting *monthly* use: 86.4% (n=57) and 74.2% (n=23) respectively.

The majority of participant's *agreed* or *strongly agreed* there were 'Lots of things to do near home' (57.5% n=61). Perception of 'Things to do' was statistically significantly associated with GS *count* (H=10.09, p=0.04) but not *proximity* (H=5.69, p=0.22). The direction of association with count was not straightforward. Those who *strongly agreed* and *strongly disagreed* with the statement had the best GS provision (mean 3.7 and 3.3 GSs per neighbourhood, respectively) and those who reported *neutral* opinion had the lowest provision (mean 2.2).

4.20.4 Parent Perceptions

The majority of parents (59.7%, n=40) *disagreed* there were 'Lots of recreation opportunities and services within walking distance of my house'. There was no association with statement perception and GS *count* or *proximity* (H=1.30, p=0.79 and H=7.61, p=0.06).

The majority of parents either *agreed* (32.8% n=22) or *strongly agreed* (40.3% n=27) with the statement 'I encourage my child to use resources in our neighbourhood to be active (i.e. park, GS, school or playground)'. No association was observed between perception and GS *count* (H=1.96, p=0.58) or *proximity* (H=0.64, p=0.89).

Park and GS highlights:

- 292 Parks and GSs (mean 2.7 per neighbourhood) were observed in 89 participant neighbourhoods
- Parks and GS proximity was 149 metres (SD 103) for all participants and 181 metres (SD 84) for those with at least one neighbourhood Park or GS
- All 'Amenity' GSs and 51.3% 'Semi-Natural' GSs contained either 'Playground Structures' or 'Exercise and Play Areas'

- 90.7% participants reported park use of which 68% reported weekly usage
- Park use showed no association with Park and GS access or proximity
- Participant perception of ‘Things to do within the neighbourhood’ was statistically significantly associated with Park and GS access
- Neither Park and GS access nor proximity showed any association with parental perceptions of neighbourhood recreation opportunities or reported encouragement of child’s neighbourhood resource use

4.21 Sports Facilities

One hundred and three sports facilities were observed in 64 participant neighbourhoods (Table 44).

Type	N	NC	Count			Proximity		
			Mean	*SD*	*Range*	*Mean*	*SD*	*Range*
Public leisure centre	17	108 17	0.2 1	0.4 0	0–1	40 255	100 92	0–390 137–390
Private leisure centre	57	108 41	0.5 1.4	0.8 0.7	0–4 1–4	97 257	134 80	0–391 70–391
Other Sports Facilities								
Riding stable/school	11	108 11	0.1 1	0.3 0	0–1	30 298	97 109	0–396 114–396
Indoor climbing wall	11	108 7	0.1 1.6	0.4 0.5	0–2 1–2	10 150	38 320	0–172 93–172
Indoor karting	2	108 2	0.02 1	0.1 0	0–1	7 390	53 9	0–396 384–396
Snooker club	1	108 1	0.01 1	0.1 0	0–1	3 290	28	0–290
Soft play	4	108 4	0.04 1	0.2 0	0–1	14 382	72 0	0–382

Table 44: Total count (N), neighbourhood count (NC), mean, SD and range of sports facility provision and proximity (in meters) in all participant neighbourhoods and in those with at least one target facility (n=108)

On average one (SD 1.1) sports facility was observed per participant neighbourhood with an average proximity of 150 metres (SD 144). For only those participants with at least one neighbourhood sports facility mean count was 1.6 facilities (SD 0.9) at 254 metres proximity (SD 92) per neighbourhood.

4.21.1 Participant Perceptions

The majority of participants either *agreed* (n=50) or *strongly agreed* (n=48) they were 'Able to be active and keep fit'. No association was observed between perception and sports facility *count* or *proximity* for all participants (H=2.86, p=0.41 and H=3.22, p=0.36) or only those with at least one neighbourhood sports facility (H=1.03, p=0.60 and F=0.51, p=0.61). Of the survey respondents who *agreed* or *strongly agreed* with the statement 40.8% (n=40) had *no* proximal sports facilities.

Sixty one participants (56.5%) reported attendance at 'Out-of-school activity clubs', mean 1.7 clubs per child (SD 1). Reported attendance was not correlated with sports facility *count* or *proximity* for all participants (r_s=0.01, p=0.95 and r_s=0.03, p=0.77 2-tailed) or only those with at least one proximal neighbourhood sports facility (r_s=-0.16, p=0.21 and r=-0.05, p=0.69 2-tailed).

4.21.2 Parent Perceptions

Parent perceptions of 'Recreation opportunities and services' were statistically significantly *positively* associated with sports facility *count* (H=11.41, p=0.01). Significance did not hold when only those parents with at least one neighbourhood sports facility were included in analysis (n=42). Within this group however, closer facility proximity was statistically significantly *positively* associated with increasing agreement (F=3.38, p=0.03).

The majority of parents *agreed* their local leisure centre was a 'Useful resource for their child'[26], and reported *usually* 'Enrolling [their] child in sports teams and clubs' (both n=43, 68.3%). Perception and frequency associations with sports facility *count* and *proximity* were not significant (data not shown).

[26] Comprising: age-appropriateness for child, provision of good classes and value for money.

Sports Facility highlights:

- 103 sports facilities (mean 1 per neighbourhood) were observed in 64 neighbourhoods
- Participants perceptions of ‘Ability to be active’ and reported attendance at ‘Out-of-school activity clubs’ showed no association with sports facility access or proximity
- Sports facility count showed significant positive association with parental perceptions of recreation opportunities and services; moreover of those with at least one neighbourhood sports facility closer proximity was associated with more positive perceptions

4.22 Non-Food Shops and Services

In total 4,145 non-food shops and services were present in all participant neighbourhoods, mean 38 per neighbourhood (range 4–151). Table 45 shows whilst the ‘Employment Services’ grouping was most commonly observed (48.1%), only ‘Transport services’ were present in all neighbourhoods.

4.22.1 Proximity

Mean proximity to all non-food shops and services was 106 metres (SD 63) (Table 46). ‘Transport services’ were the most proximal neighbourhood service in 51.9% cases (n=56).

4.22.2 Participant Perceptions

Participant perceptions of ‘Lots of things to do near home’ showed no association with total neighbourhood non-food shop and service *count* or *proximity*. At service *grouping* level greater *disagreement* with the aforementioned statement was statistically significantly *positively* associated with counts of neighbourhood ‘Attractions and Entertainment’ services and ‘Retail outlets’ (H=11.46, p=0.02 and H=11.01, p=0.03). Associations did not hold however when only neighbourhoods containing at least one target shop or service were included in analysis. No other grouping level associations were significant (data not shown).

Type	N (%)	NC	Mean	SD	Range
Attractions and Entertainment:					
Attractions	10 (0.2)	10	0.09	0.29	0–1
Entertainment	123 (3)	52	1.14	1.92	0–8
Community services:					
Education	195 (4.7)	77	1.81	2.47	0–12
Health services	205 (4.9)	72	1.90	1.99	0–8
Animal welfare	52 (1.2)	37	0.48	0.73	0–2
Central and local government	84 (2)	34	0.78	1.45	0–5
Infrastructure, facilities and organisations	343 (8.3)	90	3.18	3.33	0–13
Employment services:					
Accommodation	7 (0.2)	6	0.06	0.28	0–2
Commercial services	1,275 (30.8)	89	11.81	14.36	0–50
Manufacturing and production	107 (2.6)	38	0.99	2.15	0–11
Non-food retail	604 (14.6)	68	5.59	8.36	0–30
Transport:					
Public transport	1,110 (26.8)	108	10.28	5.63	2–28
Other transport	30 (0.7)	23	0.28	0.58	0–2

Table 45: Count (n) and percentage total (%), neighbourhood count (NC), mean, SD and range of non-food shops and services in all participant neighbourhoods by grouping and type (n=108)

Grouping	All neighbourhoods			Neighbourhoods >1 target			
	Mean	*SD*	*Range*	*NC*	*Mean*	*SD*	*Range*
Attractions and Entertainment	130	145	0–388	55	255	95	27–388
Community services	169	99	0–387	105	174	96	14–387
Employment services	172	118	0–391	93	199	102	10–391
Non-food retail	142	128	0–374	68	225	84	35–374
Transport	136	76	22–385	108	136	76	22–385

Table 46: Mean, SD and range of proximity (in meters) of all non-food shops and service by grouping in all participant neighbourhoods and in those with at least one (>1) target shop or service (neighbourhood count (NC)) (n=108)

4.22.3 Parent Perceptions

Eighty five per cent of parents (n=57) *agreed* or *strongly agreed* there were ‘Lots of shops and services within walking distance of home’. Perception showed no association with total neighbourhood non-food shop and service *count* or *proximity*. At the service *grouping* level increasing agreement was *positively* associated with ‘Attractions and Entertainment’ *count* (H=9.03, p=0.03) and ‘Community service’ *count* and *proximity* (H=10.48, p=0.02 and F=3.72, p=0.02). No other associations at the grouping level were significant (data not shown).

Two thirds of parents (n=40) *agreed* or *strongly agreed* there were ‘Many places to go within walking distance of home’. Perception was not associated with total non-food shop and service *count* or *proximity* (H=1.54, p=0.67 and H=5.54, p=0.14) nor were associations observed at the *grouping* level (data not shown).

Only four parents (6.1%) were in *disagreement* with the statement ‘There are lots of public transport options and routes within walking distance of my house’. Neither ‘Transport services’ *count* nor *proximity* showed any association with perception.

Non-Food Shops and Services highlights:

- 4,145 non-food shops and services were observed in all participant neighbourhoods, mean 38 per neighbourhood
- Mean proximity to all non-food shops and services was 106 metres (SD 63)
- ‘Transport services’ were the only shop and service *grouping* to be observed in all participant neighbourhoods; they were also most often the most proximal shop or service
- Participant perceptions of ‘Things to do near home’ were negatively associated with ‘Attractions and Entertainment’ and ‘Retail outlet’ counts
- Parent’s with more neighbourhood ‘Attractions and Entertainment’ and ‘Community service’ facilities were significantly more likely to perceive ‘Lots of neighbourhood shops and services’
- Parental perceptions of ‘Public transport options’ was not associated with objectively measured access or proximity to these services

4.23 Food Outlets

In total 1,592 food outlets were present in all participant neighbourhoods. Table 47 details food outlets by *grouping* and *type*.

Mean food outlet count per neighbourhood was 15 (SD 16). For the 99 participants with at least one neighbourhood food outlet mean outlet count was 16 (SD 16). The most common food outlet grouping was 'Convenience and incidental outlets' representing 29.7% of total outlets.

Grouping and Type	N	NC	%	Mean	SD	Range
Traditional sit-in eateries:						
Traditional/pub/hotel restaurant	77	45	4.8	0.7	1.0	0–5
Sit-in café/coffee/sandwich shop	148	56	9.3	1.4	2.0	0–9
Takeaway eateries:						
Take-away café/coffee/sandwich shop	39	31	2.4	0.4	0.7	0–4
Retail Baker	53	27	3.3	0.5	0.9	0–3
Takeaway and fast food outlet	318	74	20	2.9	3.1	0–11
Mobile food and market	2	2	0.1	<0.01	0.1	0–1
Grocers:						
Supermarket	78	56	5	0.7	0.9	0–3
Specialist supplier	174	49	10.9	1.6	2.7	0–11
Convenience and incidental outlets:						
Convenience store	279	86	17.5	2.6	2.5	0–10
Vending machine	2	1	0.1	<0.01	0.2	0–2
Non-food store	141	55	8.9	1.3	2.0	0–10
Entertainment venue	25	18	1.6	0.2	0.6	0–2
Health and Leisure	26	22	1.6	0.2	0.5	0–2
Closed/private/age inappropriate outlets:						
Pub (no food)	133	48	8.4	1.2	2.16	0–8
Closed/private outlet	97	51	6.1	0.9	1.6	0–7

Table 47: Total count (N), neighbourhood count (NC), percentage contribution to total food outlets (%), mean, SD and range by outlet grouping and type (n=108)

4.23.1 Proximity

Table 48 outlines participant's proximity to food outlets by *grouping*. For all participants mean proximity to food outlets was 157 metres (SD 104) and for those with at least one proximal outlet 172 meters (SD 97). 'Convenience and incidental outlets' were the most common proximal food outlet (44.4% cases, n=44) and 'Grocers' the least common (7.1% cases, n=7).

Food outlet grouping	NC	Mean	SD	Range
Traditional sit-in eateries	108	134	133	0–396
	66	219	100	19–396
Takeaway eateries	108	148	129	0–399
	76	211	101	10–399
Grocers	108	150	141	0–400
	68	238	102	47–400
Convenience and incidental outlets	108	170	112	0–372
	93	197	95	25–372
Closed/private/age inappropriate outlets	108	139	138	0–395
	65	230	101	40–395

Table 48: Food outlet proximity (in metres) mean, SD and range by neighbourhood count (NC) in all participant neighbourhoods and those with at least one target food outlet by grouping (n=108)

4.23.2 Healthfulness

Food outlet healthfulness was audited for 1,059 (66.5%) total food outlets. Table 49 shows the basis for not auditing. Ten 'Closed/ private/ age inappropriate outlets' were audited but were excluded from further analysis. Therefore 1,049 (65.9%) outlets were included in subsequent healthfulness analyses.

Table 50 shows 'Convenience stores', 'Retail bakers', 'Takeaways' and 'Fast food outlets' were the least healthy food outlet types. Food outlets in 'Entertainment venues', 'Vending machines' and 'Sit-in café/ coffee/ sandwich shops' were the healthiest food outlet *types*[27].

Grouping	N	% total	% type	Shut	No food	Closed
Traditional sit-in eateries	34	2.1	15.1	33	1	0
Takeaway eateries	204	12.8	49.5	204	0	0
Grocers	27	1.7	10.7	26	1	0
Convenience and incidental outlets	48	3.0	10.1	41	0	7
Closed/private/age inappropriate	220	13.8	95.7	0	133	87

Table 49: Total count (N), percentage (%) contribution to total food outlets, percentage contribution by outlet type, and basis for not auditing by grouping

Food Outlet	N (%)	Mean	SD	Range
Traditional sit-in eateries:		***45.0***	***4.6***	
Traditional/pub/hotel restaurant	60 (77.9)	42.2	4.7	32.3–64
Sit-in café/coffee/sandwich shop	131 (88.5)	46.2	6.7	29.1–59.7
Takeaway eateries:		***39.7***	***4.2***	
Take-away café/coffee/sandwich shop	29 (74.4)	43.8	6.3	34.2–54.8
Retail Baker	48 (90.6)	38.9	2.0	32.9–41.7
Takeaway and fast food outlet	130 (40.9)	39.5	4.6	28.1–50
Mobile food and market	1 (50)	43.1		43.1–43.1
Grocers:		***42.8***	***5.3***	
Supermarket	68 (87.2)	40.6	4.5	28.36–49.3
Specialist supplier	157 (90.2)	45.8	7.9	28.4–60.5
Convenience and incidental outlets:		***38.3***	***3.8***	
Convenience store	246 (88.2)	34.5	4.6	23.1–47.8
Vending machine	2 (100)	48.1	9.7	41.2–54.9
Non-food store	141 (100)	44.4	8.0	31.3–60.5
Entertainment	10 (40)	49.8	10.3	40–60.6
Health and Leisure	26 (100)	45.2	2.4	40–49.2

Table 50: Count (N), percentage food outlet type (%), mean healthfulness score (higher score indicates health), SD and range of scores by food outlet grouping and type (n=108)

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[27] If food or drink was absent from an outlet then the MFE scoring section pertaining to that which was absent was excluded. This introduced bias and may explain why 'Entertainment venues' and 'Vending machines', which characteristically have a limited offer, were the healthiest outlet types.

4.23.3 Participant Perceptions

The majority of participants reported ‘Helping with shopping at home’ (86%, n=92). Of these ‘Helpers’ 57.6% (n=53) reported *shopping* twice monthly, 25% (n=23) once a month, and 17.4% (n=16) less than once a month. Ninety five participants (88.8%) *agreed* or *strongly agreed* with the statement ‘I feel that I am able to eat well’ (self-defined). Neither factor showed any association with neighbourhood food outlet *count*, *proximity* or *healthfulness* for *all* outlets, or by outlet *grouping* or *type* (data not shown).

4.23.4 Parental Perceptions

Most parents *agreed* or *strongly agreed* with the statements ‘I am happy with the number and quality of food outlets in my local neighbourhood’ and ‘There are lots of shops and services within walking distance of home’ (81.6% n=54 and 85.1% n=57). Perceptions showed no associations with neighbourhood food outlet *count*, *proximity* or *healthfulness*, for *all* outlets, or by outlet *grouping* or *type* (data not shown).

Estimated frequency of ‘My child eats fast food/ takeaway with our family’ showed no association with neighbourhood ‘Takeaway eatery’ *count*, *proximity* or *healthfulness*.

Food Outlet highlights:

- 1,592 food outlets, mean 15 per neighbourhood, were observed in 99 neighbourhoods
- ‘Convenience and incidental outlets’ were the most common food outlet type (29.7%) and were most commonly the closest proximal food outlet (44.4%)
- ‘Traditional sit-in eateries’ were the healthiest food outlet grouping and ‘Convenience and incidental outlets’ the least healthy
- Participant and parent perceptions of the neighbourhood food environment showed no significant associations with objectively measured facilities

4.24 Outdoor Food and Drink Advertising

In total 1,775 *limited* food and drink adverts[28] and 4,673 *full* food and drink adverts[29] were observed in 101 participant neighbourhoods (94 and 97 neighbourhoods, respectively).

Table 51 outlines food and drink advert by *grouping* and *type*. 'Mixed food and drink' types represented the greatest proportion of full adverts by type within both 'Low' and 'High' fat and/ or sugar food and drink groupings.

Grouping and Type	N	NC	%	Mean	SD	Range
Low fat and/or sugar food/drink:	***2,379***		***50.9***			
Carbohydrates	281	48	6	2.6	4.1	0–14
Dairy	125	48	2.7	1.2	1.7	0–8
Fruit and Vegetables	249	44	5.3	2.3	5.6	0–24
Protein	496	65	10.6	4.6	6.8	0–29
Mixed food/drink (>3 items)	979	81	21	9.1	12.7	0–55
Low calorie drinks	249	59	5.3	2.3	3.6	0–16
High fat and/or sugar food/drink:	***1,622***		***34.7***			
High fat snacks	244	58	5.2	2.3	3.3	0–12
Puddings, deserts and biscuits	302	65	6.4	2.8	4.3	0–18
Sauces and spreads	70	25	1.5	0.7	1.8	0–7
Sweets and chocolate	224	71	4.8	2.1	2.8	0–10
Mixed food/drink (>3 HFSS items)	433	71	9.3	4.0	5.8	0–27
High calorie drinks	349	77	7.5	3.2	4.2	0–18
Alcohol	***672***	81	***14.4***	6.2	7.3	0–30

Table 51: Count (N), neighbourhood count (NC), percentage total (%), mean, SD and range of full food and drink adverts in all participant neighbourhoods (n=108)

[28] Limited adverts are those which cannot be classified by specific food/drink type, see Table 25 for full details.

[29] Full adverts are those which can be classified according to specific food/drink type, see Table 25 for full details.

4.24.1 Proximity

Table 52 outlines *full* food and drink advert proximity by *grouping*. For all participants mean advert proximity was 160 metres (SD 102) and for those with at least one proximal outlet proximity was 178 meters (SD 92).

Advert grouping	NC	Mean	SD	Range
Low fat and/or sugar food/drink	108 86	154 194	116 96	0–399 15.1–399
High fat and/or sugar food/drink	108 91	159 189	111 94	0–389 15.0–389
Alcohol	108 81	173 230	131 97	0–393 24.5–393

Table 52: Full food and drink advert proximity (in meters) mean, SD and range by neighbourhood count (NC) in all participant neighbourhoods and in those with at least one target advertising media (n=108)

‘Low fat and/ or sugar’ (LFS) adverts were most proximal in 23.7% cases (n=23), ‘High fat and/ or sugar’ (HFS) adverts 18.5% cases (n=18) and ‘Alcohol’ adverts 9.3% cases (n=9). More than one advert type (e.g. two or more adverts in a single location) were most proximal in 48.5% cases (n=47).

4.24.2 Branding

Branded food adverts represented 42.1% (n=2,715) of all food and drink adverts (both *limited* and *full*). In total 247 brands were represented. ‘Mixed brands’ (>3 items) were the most frequent brand type (13.3%, n=362). ‘Coca Cola’ was the most frequent singe brand type (5%, n=136). The majority of brands (79.8%, n=197) were observed between 1–10 times each.

4.24.3 Unique Selling Point

Advert USP was most commonly ‘Price’ (37.3%, n=1,743) and ‘Promotion’ (23.7%, n=1,107). For example see Figure 40 *‘Energy Chocolate 35p’* for price and *‘Jacobs Oddities 3 for £1’* for promotion USPs. Adverts for ‘Puddings, deserts and biscuits’ were the only advert type to deviate from majority USP price or promotion; the most common USP within this product category was ‘Taste’ (30.8%, n=93).

Figure 40: Food and drink adverts USP price and promotion

4.24.4 Target Audience

The majority of food and drink adverts were targeted at the 'General Public' (97.8% n=4,569). Ninety four adverts were targeted at 'Children and Teenagers'. For example see Figure 41: top two adverts aimed at the 'General public' and bottom two at 'Children'. Of the adverts targeted at 'Children and Teenagers' 41.5% (n=39) were for 'Sweets and chocolates', 31.9% (n=30) 'High calorie drinks' and 19.1% (n=18) for 'Fruit and vegetables'.

Figure 41: Food and drink adverts targeted at 'general public' and 'children and teenagers'

4.24.5 Location

Figure 42 illustrates the statistically significant association observed between *food and drink advert* type and *food outlet* type (χ^2=1376.11, p<0.01).

The most common food and drink advert type at each food outlet by grouping was: 'LFS mixed' at 'Traditional sit-down eateries' (64.8%, n=331), 'HFS mixed' at 'Takeaway eateries' (30.0%, n=283), 'Fruit and vegetable' at 'Grocers' (16.7%, n=202), and 'Alcohol' at 'Convenience' and 'Closed/ private/ age inappropriate' outlets and in 'Other'[30] locations (18.5% n=247, 82.6% n=199 and 17.9% n=77).

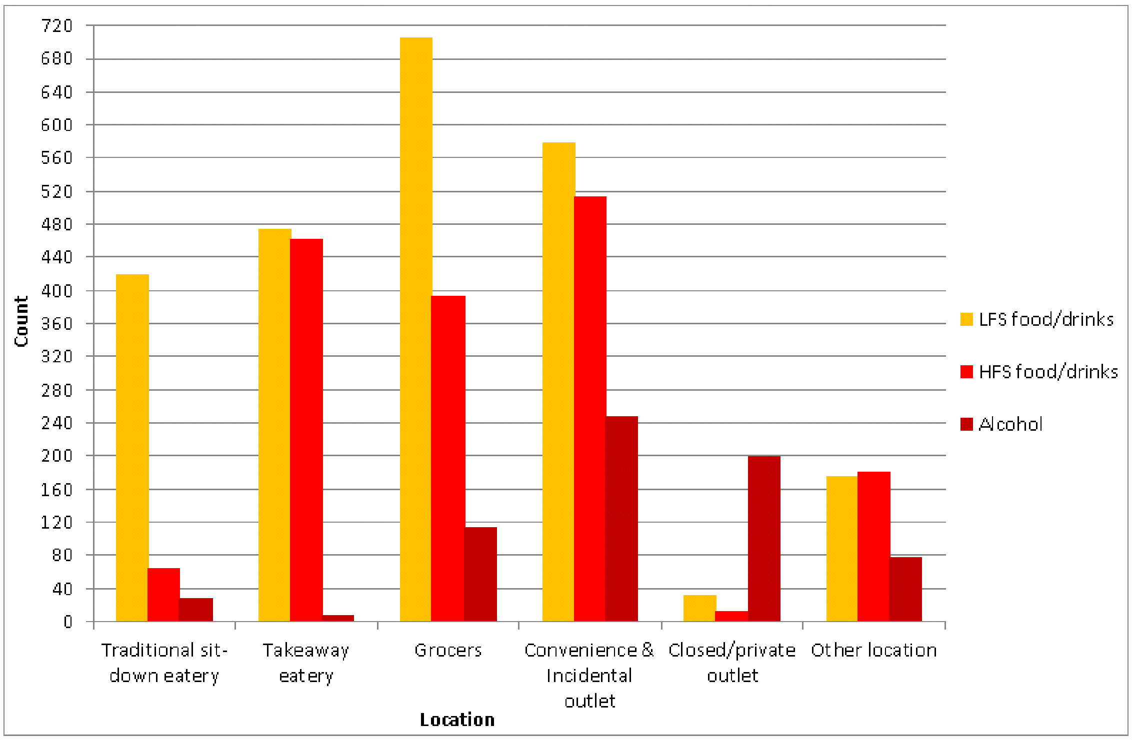

Figure 42: Food and drink advert count by type and location

Outdoor Food and Drink Advertising highlights:
• 6,448 food adverts, mean 60 per neighbourhood, were observed in 101 participant neighbourhoods

[30] 'Other' locations comprised: education/ library facilities, places of worship, retail outlets, residential areas, roads and train/ metro stations.

- Just over half of all full food and drink adverts were for ‘More healthful foods and drinks’ (50.9%)
- Mean *full* advert proximity was 160 metres (SD 102)
- 42.1% of adverts were for branded goods (247 unique brands)
- Price and promotion were the most common USPs of *full* adverts (37.3% and 23.7%)
- Only 5.3% total adverts were targeted at ‘Children and Teenagers’, of these the majority were for ‘High fat and/ or sugar food/ drinks’
- Food advert type showed statistically significant association with advert location

4.25 Roads

On average there were 2,084 metres of roads and 84 (SD 48) road intersections per neighbourhood.

Road/ street type	NC	Total	Mean	SD	Range
All roads:	108	225,124	2,084	984	400-5,429
A	108	70,324	651	886	0–3,956
	54		1,302	848	124–3,956
B	108	44,869	415	343	0–1,528
	60		748	299	57–1,528
Minor	108	68,884	638	535	0–2,510
	89		774	491	8–2,510
Private (public access)	108	1,208	11	53	0–323
	7		172	129	1–323
Private (restricted access)	108	39,840	369	422	0–1,979
	98		407	426	10–1,979
All streets:	108	749,237	6,937	3,570	524–18,001
Alley	108	103,420	958	1,856	0–7,172
	67		1,544	2,160	7–7,172
Local	108	645,819	5,980	2,192	524–10,829

Table 53: Total, mean, SD and range of road and street lengths (in meters) by type in all participant neighbourhoods and only those containing at least some target road or street type (neighbourhood count (NC)) (n=108)

Table 53 shows ‘A roads’ constituted 31.2% of ‘All roads’ and were present in half of all participant neighbourhoods. ‘Private roads with restricted access’ constituted 17.7% of ‘All roads’ but were present in the greatest majority of neighbourhoods (n=98). No participants had any ‘Motorways’ within their neighbourhoods.

4.25.1 Road Safety

As explained in section 3.16.6 (on page 100) a 10% sample of road segments per participant neighbourhood were audited for road safety. There were 27,987 road and corresponding street segments in all participant neighbourhoods, with a mean of 26 road/ street segments per participant (SD 15). Correspondingly 2,807 road/ street segments were audited for road safety and street quality.

In total 4,630 safety enhancing facilities were observed in all participant neighbourhoods, mean 43 per neighbourhood, 1.7 per street segment (Table 54).

Grouping	**Average per**	**Mean**	**SD**	**Range**
Traffic control device	Neighbourhood	15	9	0–41
	Street segment	1	0.3	0–1.2
Cu-de-sac	Neighbourhood	4	2	0–8
	Street segment	0.2	0.1	0–0.5
Pedestrian crossing aid	Neighbourhood	1	1	0–7
	Street segment	0.04	0.05	0–0.3
Crossing aid	Neighbourhood	23	17	1–85
	Street segment	1	0.3	0.3–1.6
Car lanes	Neighbourhood	51	31	6–151
	Street segment	2	0.1	1.5–2

Table 54: Mean, SD and range of safety enhancing facilities per neighbourhood and street segment

4.25.2 Participant Perceptions

The majority of participants *agreed* and *strongly agreed* there were ‘Lots of places to walk or cycle’ and it was ‘Safe to play out on the streets’ near home (85.1% n=91 and 75.7% n=81 respectively). Ninety three participants (86.9%) reported ‘Playing out on the streets’.

Perceptions of these statements showed *no* associations with ‘All’ or ‘A’ road lengths or street ‘Intersection density’ (data not shown). *Negative* perceptions of ‘Places to walk or cycle’ were associated with *higher* road safety scores (F=3.27, p=0.01). No other road safety associations were significant (data not shown).

4.25.3 Parent Perceptions

Marginally *more* parents *disagreed* (53% n=35) that they were ‘Happy for [their] child to be alone, or with friends unsupervised, in the neighbourhood’. Most parents *agreed* there were ‘Lots of walking routes within my neighbourhood enabling walking to places’ (76.1% n=51) and ‘Cycle tracks and pedestrian trails in or near my neighbourhood are easy to get to’ (65.7% n=44). Marginally *more* parents *agreed* ‘Traffic speed on the street and nearby streets that I live on is usually slow (<30 mph)’ (53.8% n=35). Despite this the majority *disagreed* that ‘There is so much traffic in my neighbourhood that it makes it difficult or unpleasant to walk’ (87.7% n=57).

Attitude, Perception and behaviour variable	**Inter-section**	**All roads**	**A roads**	**Road safety**	**All streets**	**Street quality**
Happy for child to be alone	3.46 (0.33)	1.25 (0.30)+	2.99 (0.39)	2.09 (0.11)+	**13.92 (<0.01)***	2.09 (0.11)+
Lots of walking routes enabling walking	3.64 (0.30)	1.42 (0.24)+	2.69 (0.44)	0.76 (0.52)+	3.43 (0.33)	0.76 (0.52)+
Cycle tracks and pedestrian trails	2.22 (0.53)	0.41 (0.75)+	1.12 (0.77)	0.79 (0.50)+	4.02 (0.26)	0.79 (0.50)+
Traffic speed slow (<30mph)	4.68 (0.20)	0.54 (0.66)+	5.56 (0.14)	0.46 (0.71)+		
Traffic makes walking unpleasant	1.83 (0.61)	0.67 (0.57)+	1.24 (0.74)	0.32 (0.81)+		
Walk/cycle alone	0.35 (0.95)	1.14 (0.34)+	3.20 (0.36)	1.37 (0.26)+	0.63 (0.89)	1.37 (0.26)+
Walk/cycle with child	1.22 (0.75)	0.32 (0.81)+	2.44 (0.49)	1.70 (0.18)+	3.53 (0.32)	1.70 (0.18)+
Encourage child to walk/cycle to school	5.73 (0.13)	1.67 (0.18)+	**8.46 (0.04)***	0.36 (0.78)+	**8.16 (0.04)***	0.36 (0.78)+

** **Significant** at p<0.05 level*
+ F value

Table 55: All and A road length, intersection density, road safety score, all street length and quality associations with parent perceptions of the neighbourhood environment (H or F and (p values)) (n=67)

The majority of parents estimated they *usually* and *always* ‘Walk/ cycle in my local neighbourhood’, both ‘Alone’ and ‘With [their] child’, and that they ‘Encouraged their child to travel actively to school’ (58.2% n=39, 56.7% n=38 and 71.6% n=48).

Counter-intuitively *higher* ‘A road’ length was associated with *greater frequency* in parental ‘Encouragement of active travel to school’. Table 55 shows no other associations were significant.

Roads highlights:

- On average there were 2,084 metres of roads and 43 safety enhancing features per neighbourhood
- Better road safety scores were associated with poorer participant perceptions of ‘Places to walk or cycle’
- Parents were significantly more likely to report ‘Encouraging their child to travel actively to school’ when ‘A road’ length was longer

4.26 Streets

On average there were 6,037 metres of *all* streets per neighbourhood. Table 53 details street length by *type*; worthy of note is the wide range in street length between neighbourhoods. ‘Local streets’ were present in *all* neighbourhoods and ‘Alleys’ in 62% of neighbourhoods.

4.26.1 Street Quality

In line with section 4.25.1 and as explained in section 3.16.7 a 10% sample of street segments were audited (2,807 segments in total) for street quality. Table 56 outlines street quality scores by *grouping* which are expressed as a percentage for ease of interpretation.

Grouping	Mean	SD	Range
Total street quality	62	4	53–72
Pavement	79	3	72–83
Greenness	43	11	18–74
Cleanliness	88	7	64–100
Attractiveness	60	8	33–80
Pollution	54	11	27–76
Safety	45	14	20–79

Table 56: Mean (%), SD and range of street quality variables

4.26.2 Participant Perceptions

Participant *perceptions* of 'It is safe to play out near my house' and both *reported participating* and *estimated frequency* of 'Playing out on the streets' showed *no* associations with street *length* or *quality* (data not shown).

Positive perception of 'Lots of places to walk or cycle' showed statistically significant *negative* association with street *quality* score (H=11.94, p=0.02) but no association with street *length*.

4.26.3 Parent Perceptions

Street *length* showed statistically significantly *positive* associations with parent perception of 'I am happy for my child to be alone, or with friends unsupervised, in the neighbourhood' and 'I encourage my child to walk/ cycle to school'. Table 55 shows no other associations were significant.

There was *no* association between *pollution* street quality grouping and parent perceptions of 'There is so much traffic in my neighbourhood that it makes it difficult or unpleasant to walk'. Most parent's *agreed* 'My neighbourhood streets are well lit' (88.1%, n=59). Perceptions showed no association with objectively observed 'Streetlight presence'.

Streets highlights:

- Participants had on average 6,037 metres of streets per neighbourhood
- Better street quality scores were associated with poorer participant perceptions of ‘Places to walk or cycle’
- Street length was positively associated with parental ‘Happiness for child to be in the neighbourhood unsupervised’ and ‘Encouragement of child’s active travel to school’
- Parental perceptions of ‘Pollution’ and ‘Lighting’ showed no association with objectively measured reality

4.27 Cycling Facilities

In line with sections 4.25.1 and 4.26.1 a 10% sample of road and street segments were audited (2,807 segments in total). Cycling facilities were assessed as part of this audit.

‘Marked on-road cycle lanes’ (see Figure 43) and ‘Bike parking facilities’ were present in 2.2% (n=63) and 0.2% (n=5) of participant neighbourhood street segments, respectively. Mean facility counts per neighbourhood were 0.6 lanes (range 0–4) and 0.1 parking facilities (range 0–1).

In light of the small counts, cycling facility *types* were combined to create an overall ‘Cycling facilities’ variable. ‘Cycling facilities’ were present in 35.2% (n=38) of neighbourhoods with a mean 0.6 facilities (SD 1.0) per neighbourhood.

4.27.1 Parent Perceptions

Parental perceptions of ‘Cycle tracks and pedestrian trails *in* or *near* my neighbourhood are easy to get to’ showed *no* association with objectively measured cycling facility presence.

Figure 43: On-road cycle lanes

Cycling Facilities highlights:

- ‘Cycling facilities’ were observed in 35.2% participant neighbourhoods
- Parent perceptions of ‘Neighbourhood cycle tracks’ showed no association with cycling facility presence

This section explores neighbourhood environment influence on physical activity using binary logistic regression and case pairs. Neighbourhood environments are compared per regression assigned grouping with significant differences highlighted. Case study pairs for ‘high activity’ and ‘low activity’ reporter groupings are presented. Neighbourhood environment attributes are outlined descriptively then compared and contrasted with case and parent perceptions and self-reported activity behaviour.

Objectively measured neighbourhood environment data was used to explore effect on PA. Table 57 shows the binary logistic regression model explaining neighbourhood environment influence on PA. Binary response categories used were *‘High’* and *‘Low’* PA reporters.

High and *Low* reporter categories were yielded by dividing the CNES sample population into two equal groups according to time spent physically active rank. For *High reporters* 46.7–73.9% total time reported was spent being physically active and *Low reporters* 9.4–46.5%. There was 81.5% agreement between high/ low proportionate[31] active time reporting and high/ low absolute[32] time reporting (χ^2=42.82, p<0.01).

Gender and IMD were not controlled for in the model. Time reported physically active was not significantly different according to gender or IMD, and variables were consistently non-significant during model building (data not shown).

[31] Defined as time reported per activity intensity divided by total time reported.

[32]Defined as total time reported.

Neighbourhood variables	95% CI	B	Exp(B)
Amenity GS (n)	0.42–1.01	-0.43	**0.65***
Functional GS (n)	0.54–1.28	-0.18	0.83
Semi-Natural GS (n)	0.39–1.93	-0.14	0.87
Public leisure centre (n)	0.71–2.67	0.32	1.38
Private leisure centre (n)	0.27–5.18	0.16	1.18
Other sports facility (n)	0.21–1.42	-0.60	0.55
All shops and services (n)	1.00–1.04	0.02	**1.02****
Total road length (km)	0.28–1.05	-0.61	**0.54***
A road length (km)	0.75–3.61	0.50	1.65
Road safety (score)	0.36–2.80	0.01	1.01
Street length (km)	0.68–1.03	-0.17	**0.84***
Street quality (score)	0.90–1.15	0.02	1.02
Cycling facilities (presence/absence)	0.18–1.69	-0.60	0.55
-2 Log likelihood		132.35	
Nagelkereke R^2		0.20	
Hosmer and Lemeshow χ^2 (p)		5.21 (0.74)	

* ***Significant** at P<0.10 level*
** ***Significant** at P<0.05 level*

Table 57: Binary logistic regression model of neighbourhood environment on PA (n=108)

Other models were tested but this model was selected as it had fair variable significance (four environmental variables), comprised the majority of surveyed neighbourhood environment variables[33] which collectively explained approximately 20% of PA; and had a moderate classification success rate (63.9% correctly classified cases). Three outliers were identified by Standardised Residual deviance testing and therefore were excluded from further analysis[34].

[33] 'Road intersection' and 'Food advert' variables were excluded due to multicollinearity (high level correlation) with 'Total street length' and 'All shops and services' variables respectively.
[34] Outlying cases, identified by Standardised Residual testing, were not well explained by the model (i.e. were in some way deviant from the surveyed population).

In this model ‘All shops and services’[35] count was statistically significantly *positively* associated with the odds of being classified as a *Low* compared to *High activity reporter* (i.e. as ‘All shops and services’ counts increased the odds of being classified as a *Low activity reporter* increased). ‘Public’ and ‘Private’ leisure centre counts, ‘A road’ length, ‘Road safety’ and ‘Street quality’ scores were *non-significantly positively* associated with being classified as a *Low activity reporter*; relationship direction should be interpreted with caution in light of non-statistical significance and thus potential for chance.

‘Amenity GS’ count, Total ‘Road’ and ‘Street’ lengths were statistically significantly *negatively* associated with the odds of being classified as a *Low activity reporter*. ‘Functional GS’, ‘Semi-natural GS’, ‘Other sports facilities’ and absence of ‘Cycling facilities’ were *non-significantly negatively* associated with the odds of being classified as a *Low activity reporter*; again relationship direction should be interpreted cautiously.

The model was marginally better at classifying (i.e. defining according to binary response category) High activity (HA) reporters than Low activity (LA) reporters (69.2% (n=36) and 62.3% (n=33) and was better at correctly classifying male compared to female participants (71.1% and 61.7%).

4.28 Activity Case Overview

Figure 44 shows mean environment variable counts per binary response grouping overlaid with cases. Neighbourhood environment variable counts for HA and LA *typical* and *deviant* cases were not significantly different than mean counts for their respective grouping indicating that they were representative (data not shown).

Correctly assigned HA participants had *highest* mean counts of ‘Amenity’ and ‘Functional’ GSs (H=12.04, p=0.01 and H=12.75, p=0.01). *Correctly assigned* LA participants had *highest* mean counts of ‘All shops and services’ (H=14.39, p<0.01)

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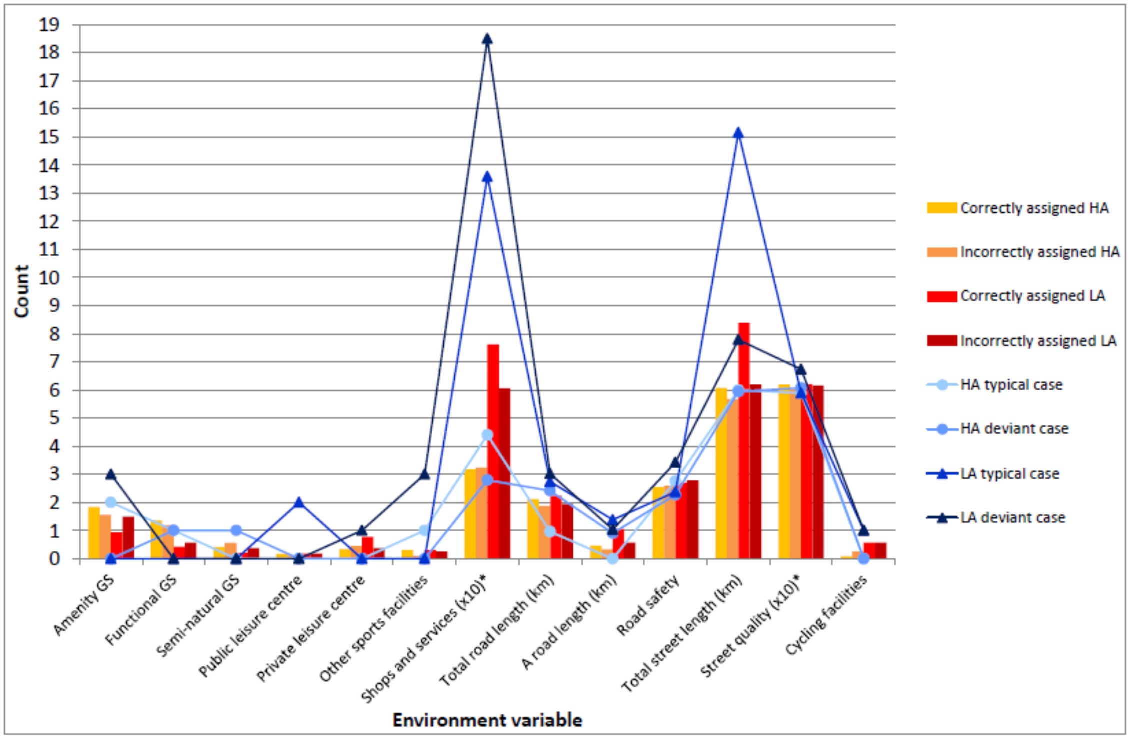
[35] All ‘shops and services’ variable comprised ‘Non-food shops and services’ and ‘Food outlets’.

and ‘Cycling facility’ (H=22.68, p=<0.01) and *longest* ‘A roads’ (H=12.26, p=0.01) and ‘Total streets’ (H=12.14, p=0.01). All other differences were non-significant.



** Counts divided by 10 for graphical purposes*

Figure 44: Mean neighbourhood environment variable counts per observed/ predicted PA grouping with overlying cases

4.29 High Activity Reporter Case Pair

The *correctly assigned* HA reporter case ‘HA *typical* case’ was participant #437, male, aged 11 years 1 month, reporting 55.3% of total time physically active. Case #425 was the most *deviant* HA predicted case, they reported just 10.1% of total time physically active. ‘Total road’ length for this case however was statistically significantly different from the HA *deviant* group (t=-2.34, p=0.03) thus the second most *deviant* HA case #450 was examined in case pairing. The *incorrectly assigned* HA case ‘HA *deviant* case’ was participant #450, female, aged 10 years 7 months, reporting 17% of total time physically active. Henceforth HA *typical* and *deviant* cases are referred to using the pseudonyms James and Ella.

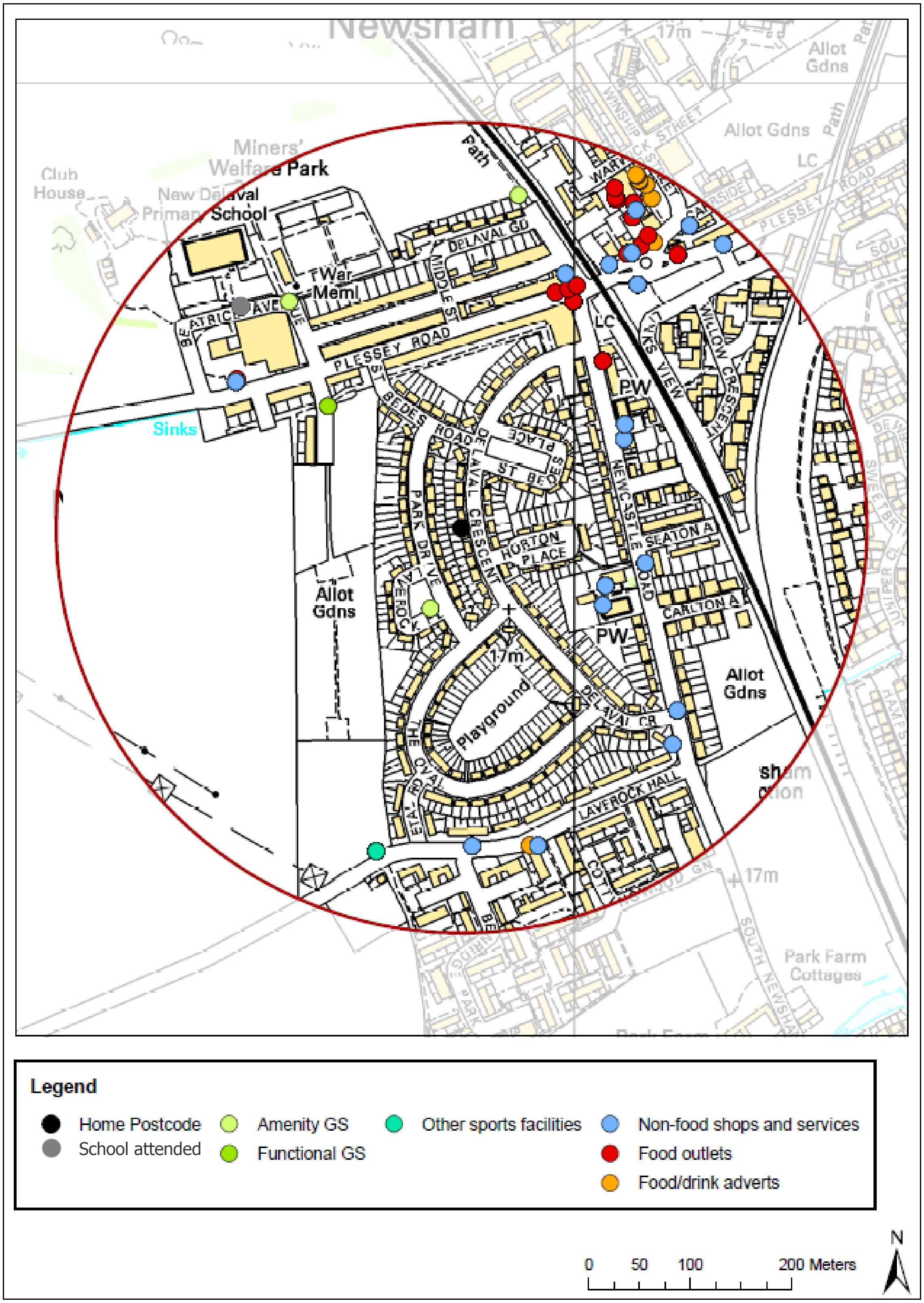


Figure 45: High activity reporter typical case James (participant #437) neighbourhood environment (from postcode centroid)

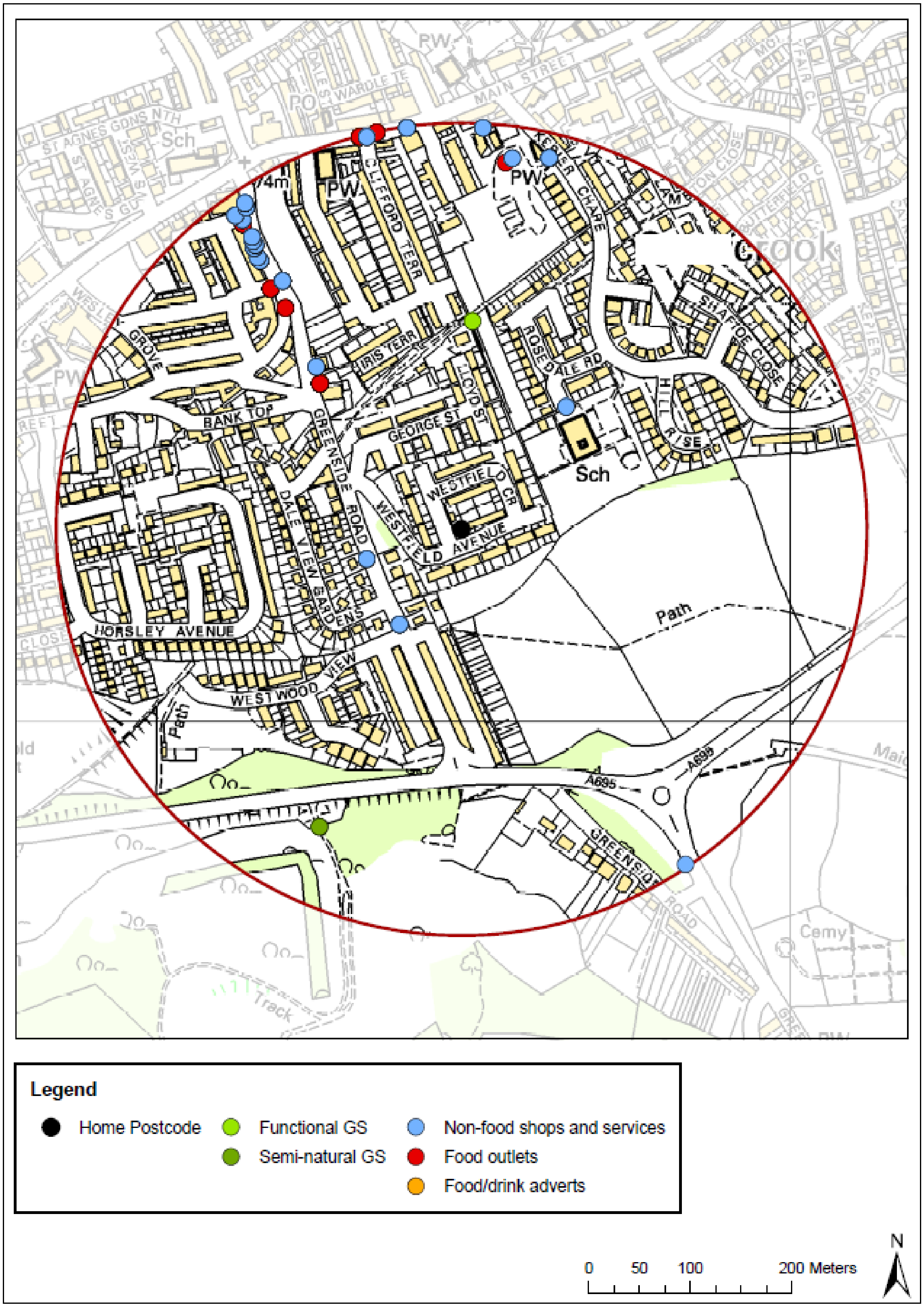


Figure 46: High activity reporter deviant case Ella (participant #450) neighbourhood environment (from postcode centroid)

Neighbourhood environment variables	James (HA typical) N (%)	Proximity	Ella (HA deviant) N (%)	Proximity
Parks and GSs:				
Amenity	2	85	0	
Semi-natural	0		1	205
Functional	1	178	1	325
Sports facilities:				
Private Leisure Centres	0		0	
Public Leisure Centres	0		0	
Other Sports facilities	1	330	0	
Non-food shops & services:				
Attractions & entertainment	1 (3)	358	0	
Community services	6 (18.2)	153	7 (31.8)	159
Employment services	17 (51.5)	265	6 (27.3)	344
Retail outlets	3 (9.1)	182	4 (18.2)	334
Transport services	6 (18.2)	279	5 (22.7)	98
Food outlets:				
Sit-down eateries	3 (27.3)	258	2 (33.3)	200
Takeaways	4 (36.3)	350	2 (33.3)	279
Grocers	2 (18.2)	249	1 (16.7)	399
Convenience & incidental outlets	2 (18.2)	216	1 (16.7)	364
Road length (metres):				
A roads	0		907	
B roads	845		57	
Minor roads	115		1,050	
Private roads (public access)	0		0	
Private roads (restricted access)	0		402	
Street length (metres):				
Local streets	5,250		5,818	
Alleys	748		126	

Table 58: High activity reporter case pair neighbourhood environment variable count (N), percentage (%), and proximity (in metres)

4.29.1 Physical Environment

Figure 45 and Figure 46 graphically illustrate case neighbourhoods and Table 58 enumerates neighbourhood facilities.

Parks and GSs

James (HA *typical*) had better access and proximity to Parks and GSs than Ella (HA *deviant*). Figure 47 shows the two 'Amenity' GSs in James' neighbourhood comprising: a well maintained medium sized park with three types of sports facilities all with high suitability for young people (top row images GS #3008). The researcher perceived this park to be high quality and have a good atmosphere. However, there was no on-looking supervision or lighting and sport facilities were set up for organised sports rather than informal play which may slightly impede utility for aged 10–11 years target users. Secondly a well-maintained small play area with highly age appropriate assault course and small grassed area (bottom row images GS #3022). Researcher perceived this play area to be good quality and highly safe owing to having on-looking supervision from the surrounding housing. The play equipment had no colour which may be less attractive for some young people.

Figure 47: James's neighbourhood Amenity GSs (GS #3008 and #3022)

Ella had one neighbourhood 'Semi-Natural' GS which was very large and environmentally diverse (see Figure 48), researcher perceived this to be an excellent facility for walking but poorly suited for sports or play.

Figure 48: Ella's neighbourhood Semi-Natural GS (GS #4249)

Sports Facilities

James had one neighbourhood Sports facility, Ella had none.

All Shops and Services

James had *more* 'Non-food shops and services' than Ella but *poorer* overall *proximity*. James had *more* 'Total food outlets' but a less *healthy* food environment than Ella (-1.7% MFE).

Roads

Ella had *longer* 'Total roads' than James but *lower* 'Road Safety' score. James's neighbourhood had *more* 'Traffic control devices' but *fewer* 'Pedestrian crossing aids' than Ella's (see Figure 49 bottom row left image).

Streets

James had marginally *longer* 'Total streets' but *lower* 'Street quality' score owing to having more 'Litter', 'Graffiti' and 'Foul', less 'Attractive buildings' and 'Street attractiveness' and poorer researcher perceived street 'Safety' than Ella. James's neighbourhood did however have better street 'Greenness' with more grassy verges and street trees (see Figure 50) and lower 'Pollution' scores than Ella's.

Figure 49: Ella's neighbourhood street segments sample

Figure 50: James's neighbourhood street segments sample

4.29.2 Case Perceptions

Both cases *agreed* they *liked* to be 'Active and keep fit', James (HA typical) was more *positive* than Ella (HA deviant) about 'Feeling better' and being 'Able to be' active.

Both cases *agreed* there were ‘Lots of things to do in the neighbourhood’. James was *positive* whilst Ella was *negative* about ‘Places to walk and cycle’ and ‘Neighbourhood safety’.

4.29.3 Parent Perceptions

Neighbourhood

Both cases’ parents had *positive* perceptions of neighbourhood ‘Shops and services’, ‘Walking and cycling routes’, ‘Public transport’, level of ‘Rubbish’, ‘Street lighting’, traffic ‘Speed’ and ‘Density’, and ‘Neighbourhood safety’. Both parents had *negative* perceptions of there being ‘Many places to go’ near home. James’s parent (HA typical) had more *positive* perceptions than Ella’s parent (HA deviant) about neighbourhood ‘Recreation and leisure services’, ‘Food outlets’ and were *happier* for James to be ‘Unsupervised in the neighbourhood’. Ella’s parent had more *positive* perceptions of street ‘Maintenance’ and ‘Attractiveness’ than James’s parent.

Physical Activity

James’s parent was more *positive* than Ella’s about ‘Role modelling PA’ to their child and ‘Personally enjoying PA’. Both parents *disagreed* they were ‘Physically active regularly’ but reported *frequently* ‘Walking/ cycling in the neighbourhood’ alone and with their child.

Both parents reported they *encouraged* and their child *did* ‘Travel actively to school’. James’s parent was marginally more *positive* about encouraging him to be ‘Active in the neighbourhood’ than Ella’s parent. James’s parent reported that they enrolled him in ‘Sports teams’, ‘Clubs and community programmes’, ‘Took [him] to places to be active’, ‘Watched [him] play sports/ do activities’, and limited time he spent ‘On the computer’ and ‘Watching TV’; Ella’s parent did not.

4.29.4 Case Behaviour

Ella (HA deviant) reported an additional 156 minutes activity time (all types) than James (HA typical), comparisons are expressed proportionally to enable meaningful comparison. James reported more time in ‘Moderate’ and ‘Intense’ activities than Ella but less time ‘Sedentary’ and in ‘Low’ intensity activity (+5.5%, +34.4%, -38.3% and -1.6%).

James reported 46.4% less time at ‘Home’, and 21.6%, 11%, 9.8% and 4% more time in ‘Parks and GSs’, ‘Other’, ‘School’ and ‘Neighbourhood’ locations, respectively.

Clubs and Classes

James reported attending two ‘Active clubs and classes’ at school and one outside-school. He reported 60 minutes at an active school club during the recording period. Ella reported she did not attend any ‘Clubs or classes’ and reported no time in this activity.

Recreation and Leisure Facilities

James estimated park use frequency ‘3–4 times weekly’. The facilities James described in the ‘Park you play in’ matched in part with both of the objectively observed proximal neighbourhood parks. James reported ‘Playing’ once and ‘Playing football’ twice with friends in parks or GSs on one weekend day (120, 60 and 60 minutes each).

Ella estimated park use ‘1–2 times weekly’. Ella’s description of the ‘Park [she] plays in’ matched that of GS #4249. Ella reported ‘Playing’ in a park with ‘Family’ one school day afternoon (10 minutes); incidentally this park was proximal to her school but not contained within her neighbourhood environment (see Figure 51).

Figure 51: Ella playing in Amenity GS (GS #4195)

Neither case reported any time in Sports facilities.

Neighbourhood Activity

James estimated he played on the street ‘Everyday’ and Ella ‘3–4 times weekly’. Neither participant reported any time active within the neighbourhood[36].

Neighbourhood Active Travel

James reported travelling actively in the neighbourhood[37] more *time* and an additional three *activity occasions* than Ella. James ‘Walked’ twice and ‘Cycled’ once to parks and GSs with friends on one weekend day (10, 4 and 4 minutes) he also ‘Scooted’ to and from school with friends on both school days (5 minutes each journey). Ella ‘Walked’ to and from school on both school days with family (two 8 minute and two 9 minute journeys).

High Activity Reporter Case Pair Key Differences:

- James (HA typical) had better access and proximity to Parks and GSs, he and his parent were more positive about their neighbourhood, and he reported more time in these spaces than Ella (HA deviant)
- James had better access to Sports facilities and his parents had better perceptions of these facilities than Ella’s, despite this neither case spent any time using these facilities
- James had better access to ‘All shops and services’ than Ella. This was reflected in more positive personal perceptions of neighbourhood ‘Things to do’ and parental perceptions of neighbourhood ‘Services’
- James had shorter ‘Total road’ and ‘A road’ but longer ‘Total street’ lengths, he had higher ‘Road safety’ but lower ‘Street quality’ scores than Ella.

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[36] Defined as all-time recorded playing, doing sports, athletics, dance, activity clubs, walking, jogging, running, cycling, skating, scooting, gardening or DIY within the neighbourhood.

[37] Defined as all-time recorded walking, jogging, running, cycling, skating or scooting for the purpose of travel within the neighbourhood.

James's parent was more positive about him being 'Unsupervised in the neighbourhood', Ella's parents had better perceptions of street 'Aesthetics'. James spent more time travelling actively in the neighbourhood than Ella

- James's parents reported enrolling him in 'Active clubs and classes' accordingly he reported attendance in the activities whereas Ella did not
- James had more positive attitudes towards PA and reported more time in 'Moderate' and 'Intense' activities than Ella

4.30 Low Activity Reporter Case Pair

The *correctly assigned* Low activity reporter case 'LA *typical* case' was participant #403, female, aged 10 years one month; reporting 35.6% of total time physically active. The *incorrectly assigned* LA case 'LA *deviant* case' was participant #515, male, aged 10 years 1 month, reporting 70.8% of total time physically active. Henceforth LA *typical* and *deviant* cases are referred to using the pseudonyms Chloe and Ben.

4.30.1 Physical Environment

Figure 52 and Figure 53 graphically illustrate case neighbourhoods and Table 59 enumerates neighbourhood facilities.

Parks and GSs

Ben (LA deviant) had three proximal 'Amenity' GSs all of which were 'Outdoor Sports Areas', the GSs contained in Ben's neighbourhood #8156, #8145 and #8148 are described in detail in Male Under and Healthy Weight Case Pair, Physical Environment in section 4.33.1 (Figure 59 on page 204) and Male Overweight and Obese Case Pair, Physical Environment section 4.34.1 (Figure 63 on page 212). In short these were all age appropriate, fit for purpose and generally well maintained facilities. They were contained within a housing estate which gave a safe, child-friendly atmosphere. Chloe (LA typical) had no neighbourhood Parks or GSs.

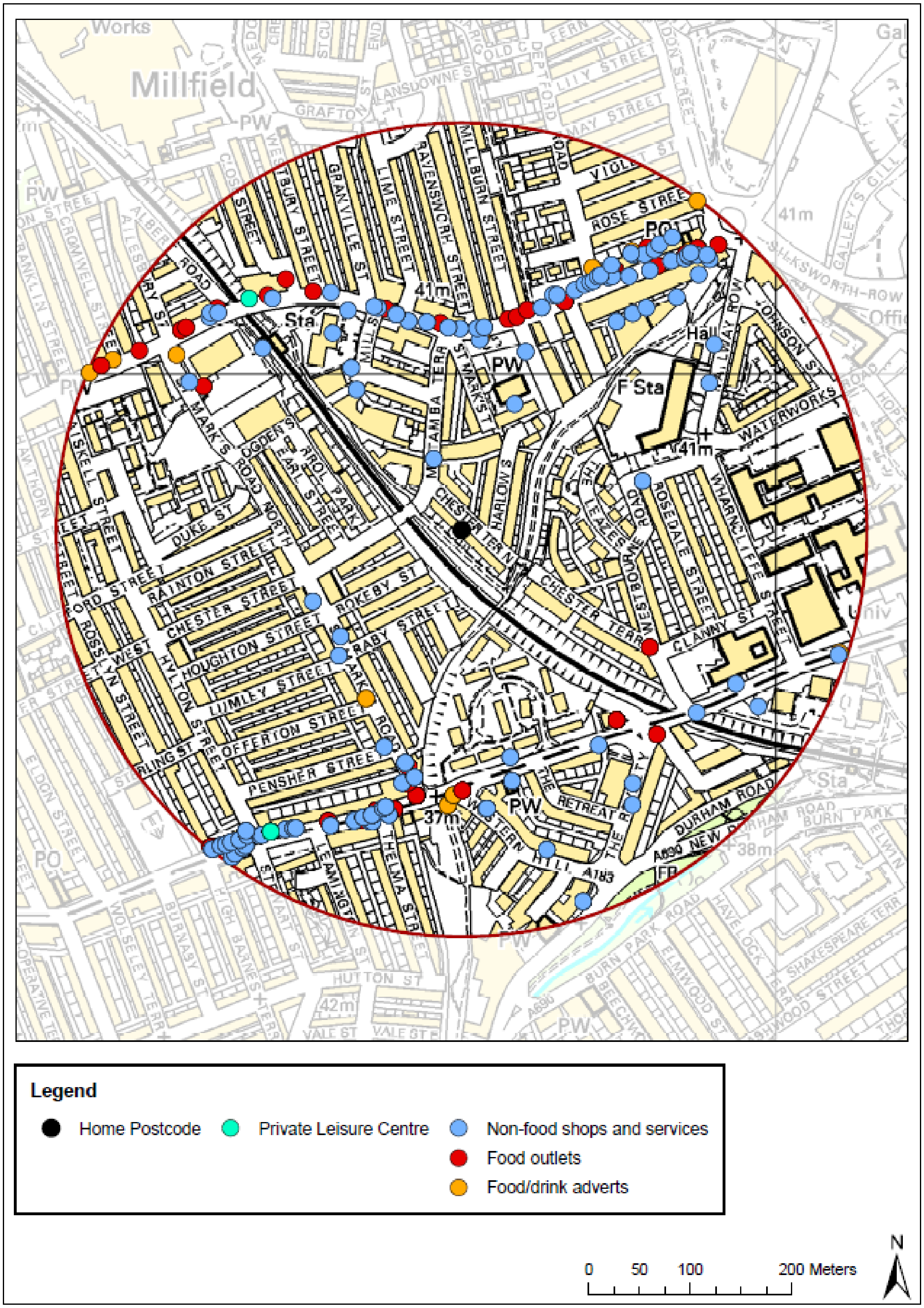


Figure 52: Low activity reporter typical case Chloe (participant #403) neighbourhood environment (from postcode centroid)

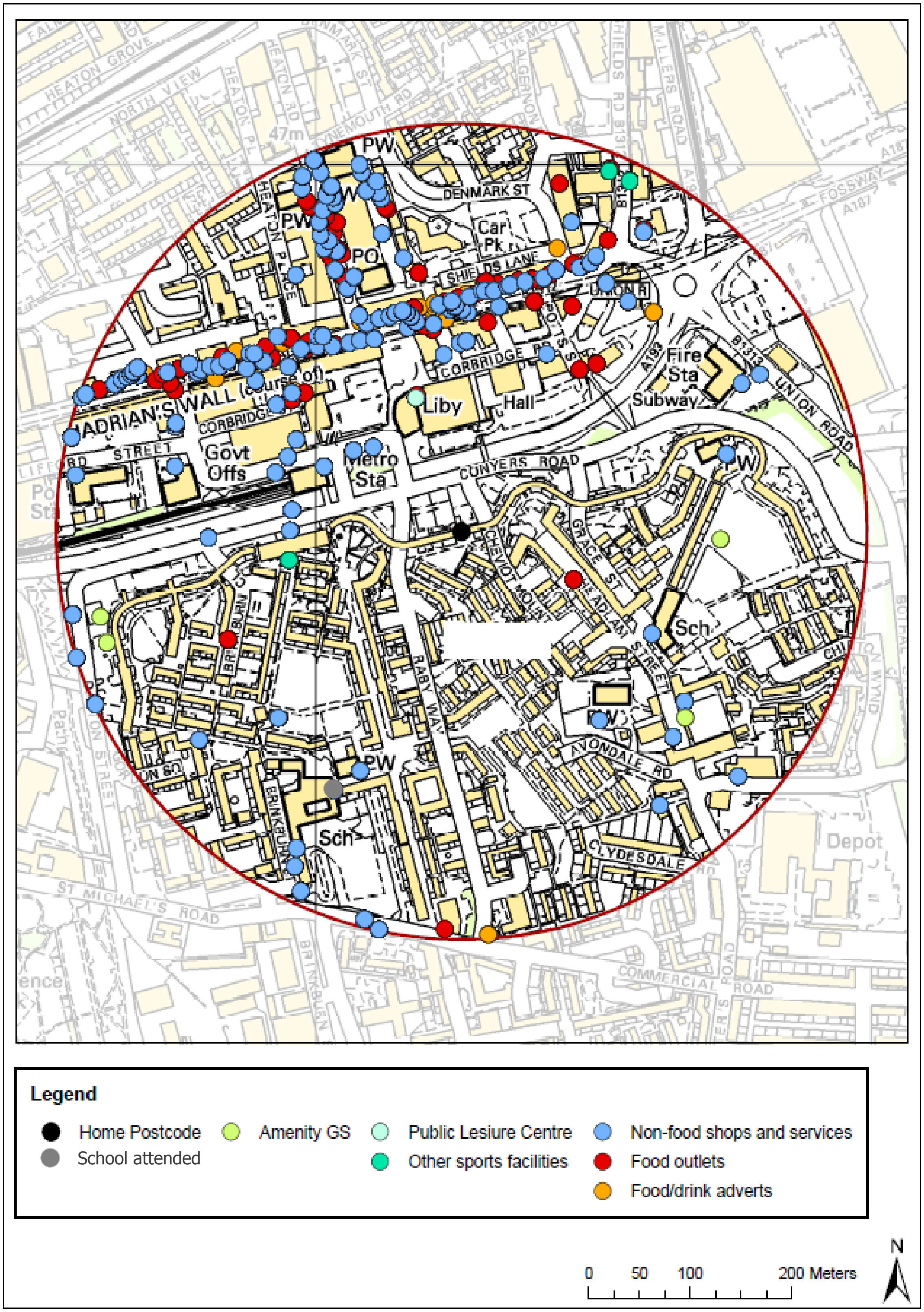


Figure 53: Low activity reporter deviant case Ben (participant #515) neighbourhood environment (from postcode centroid)

Neighbourhood environment variables	Chloe (LA typical)		Ben (LA deviant)	
	N (%)	Proximity	N (%)	Proximity
Parks and GSs:				
Amenity	0		3	255
Semi-natural	0		0	
Functional	0		0	
Sports facilities:				
Private Leisure Centres	2	309	0	
Public Leisure Centres	0		1	139
Other Sports facilities	0		3	172
Non-food shops & services:				
Attractions & entertainment	2 (1.9)	301	8 (5.8)	207
Community services	10 (9.4)	134	33 (23.9)	139
Employment services	50 (47.2)	75	47 (34.1)	175
Retail outlets	27 (25.2)	173	26 (18.8)	215
Transport services	17 (16.0)	159	24 (17.4)	120
Food outlets:				
Sit-down eateries	6 (20)	218	9 (19.1)	205
Takeaways	9 (30)	226	15 (32)	197
Grocers	4 (13.3)	256	9 (19.1)	230
Convenience & incidental outlets	11 (36.7)	204	14 (29.8)	141
Road length (metres):				
A roads	1,393		1,039	
B roads	0		1,053	
Minor roads	689		307	
Private roads (public access)	0		0	
Private roads (restricted access)	662		625	
Street length (metres):				
Local streets	9,510		7,770	
Alleys	5,651		22	

Table 59: Low activity reporter case pair neighbourhood environment variable count (N), percentage (%), and proximity in metres

Sports Facilities

Chloe had neighbourhood access to two ‘Private leisure centres’. Ben had access within his neighbourhood to one ‘Public leisure centre’, two climbing centres and one soft play facility. Ben had better proximal access to ‘All’ sports facilities than Chloe.

All Shops and Services

Ben had more ‘Non-food shops and services’ than Chloe but poorer overall proximity. Ben had better *access* and *proximity* to ‘All food outlet’ types than Chloe and had a *healthier* food environment (+3.2% MFE).

Roads

Ben had marginally *longer* ‘Total roads’ and *higher* ‘Road Safety’ score than Chloe. Ben had *more* ‘Traffic control devices’, ‘Cul-de-sacs’ and ‘Pedestrian crossing aids’ than Chloe (Figure 54).

Streets

Chloe had *longer* ‘Total streets’ but *lower* ‘Street quality’ score than Ben owing to having less street ‘Greenery’, more ‘Graffiti’ and ‘Foul’ and less ‘Attractive buildings’ and ‘Street attractiveness’ (Figure 55). Ben’s neighbourhood did however have *more* ‘Litter’, ‘Pollution’ and lower researcher perceived street ‘Safety’ than Chloe’s.

Cycling Facilities

Both cases had cycle lanes within their neighbourhoods.

4.30.2 Case Perceptions

Chloe (LA typical) was more *positive* about *liking* to be ‘Active and keep fit’, ‘Feeling better’ and being ‘Able to be’ active than Ben (LA deviant).

Both cases *agreed* it was ‘Safe to play out’ in the neighbourhood, Chloe was *positive* about neighbourhood ‘Things to do’ and ‘Places to walk and cycle’, Ben was *negative*.

Figure 54: Ben's neighbourhood street segments sample

Figure 55: Chloe's neighbourhood street segments sample

4.30.3 Parent Perceptions

Neighbourhood

Only Chloe's parent (LA typical) responded to the survey. Chloe's parent had *positive* perceptions of neighbourhood 'Recreation and leisure services', all 'Shops and services', 'Public transport', 'Places to go', 'Walking and cycling routes', levels of 'Lighting', 'Crime' and 'Traffic density'. But they had *negative* perceptions of neighbourhood 'Rubbish', 'Maintenance', 'Attractiveness' 'Safety' and 'Traffic speed', and they were *not* happy for Chloe to be 'Unsupervised in the neighbourhood'.

Physical Activity

Chloe's parent was wholly *positive* about their personal feelings towards and involvement with PA. They reported *sometimes* encouraging Chloe to and Chloe *sometimes* 'Traveling actively to school', *usually* encouraging her to be 'Active in the neighbourhood'. And *always* enrolling her in sports and activity 'Teams, clubs and classes', taking her to 'Places to be active', watching her 'Play sports/ do activities' and limiting time spent 'On the computer' and 'Watching TV'

4.30.4 Case Behaviour

Ben (LA deviant) reported an additional 340 minutes activity time (all types) than Chloe (LA typical) thus comparisons are expressed proportionally. Chloe reported *more* time 'Sedentary' and in 'Low' and 'Moderate' intensity activities than Ben but *less* time doing 'Intense' activity than Ben (+35.2%, +2.6%, +15.1% and -52.9%).

Chloe reported 57.3% and 11.4% *more* time in 'Other' locations and at 'Home' than Ben. Ben reported 26.3%, 21.5%, 12.7% and 8.2% *more* time in 'Neighbourhood', 'Sports facilities', 'School' and 'Garden' locations than Chloe.

Clubs and Classes

Chloe reported attending four 'Active clubs and classes' outside-school. No time was reported in this activity during recording period. Ben reported attending two 'Active clubs and classes' at school only. Despite reporting no outside-school class attendance during the recording period Ben reported one dance and one sports class in Leisure Centres on one weekend day each (180 and 240 minutes).

Garden

Ben estimated he played in the garden '1–2 times weekly', he reported 'Playing football' in the garden with 'Friends' and 'Alone' (150 and 10 minutes each). Chloe reported no time in her garden despite estimating she played in the garden '5–6 times weekly'.

Recreation and Leisure Facilities

Chloe and Ben estimated they 'Played in the park' '5–6 times weekly' and 'Everyday', respectively. Despite this neither case reported any time in parks and GSs during the recording period.

Ben reported 420 minutes in 'Sports Facilities' attending a dance and sports class as discussed in the 'Clubs and Classes' section above'. Chloe reported no time in 'Sports facilities'.

Neighbourhood Activity

Chloe reported she did not 'Play on the street' and reported no time active in the neighbourhood. Ben estimated he 'Played on the street' '5–6 times weekly' and reported 'Playing football' in the neighbourhood with 'Family' on one weekend day (300 minutes).

Neighbourhood Active Travel

Ben reported travelling actively in the neighbourhood an additional eight activity instance than Chloe. At the weekend Ben 'Walked' to football with 'Friends', to dance class with a 'Teacher' and to a friend's house 'Alone' (60, 10 and 10 minutes each), he also 'Cycled' to a friend's house 'Alone' (20 minutes). Ben 'Walked' to and from school with 'Friends' on both school days (10 minutes) and 'Alone' (an additional two 5 and one 10 minute journeys). He reported 'Walking' to and from school 'Alone' at lunchtime on one school day (two 10 minute journeys). Chloe 'Walked' home from school one school day with 'Family' (15 minutes).

Low Activity Reporter Case Pair Key Differences:

- Ben (LA deviant) had access to parks and GS, Chloe (LA typical) did not. Despite this Ben had more negative perceptions of 'Neighbourhood facilities' than Chloe. Neither case reported any time in these spaces
- Ben had better access and proximity to 'Open-access sports facilities' but had more negative perceptions of 'Neighbourhood facilities' than Chloe. Despite this Ben reported more time in 'Sports facilities' than Chloe

- Ben had better access to ‘All shops and services’ than Chloe. Chloe and her parent had positive perceptions about ‘Things to do’ and ‘Shops and services’ in the neighbourhood, respectively. Ben had negative perceptions
- Ben had longer ‘Total roads’, shorter ‘Total streets’ and higher ‘Road Safety’ and ‘Street quality’ scores than Chloe. Ben had negative and Chloe positive perceptions of neighbourhood ‘Places to walk and cycle’. Despite perceptions Ben reported more active time and active travel in the neighbourhood than Chloe
- Despite reporting attending more ‘Active clubs and classes’ than Ben, Chloe reported less time in this activity
- Chloe was more positive about PA than Ben. Her parent was also very positive about their personal and Chloe’s PA. Chloe reported proportionately more time ‘Moderately’ active but less time in ‘Intense’ activity than Ben

Neighbourhood Environmental Influence on Dietary Intake

This chapter explores neighbourhood environment influence on dietary intake using binary logistic regression.

Objectively measured neighbourhood environment data was used to explore effect on dietary intake. Table 60 shows the binary logistic regression model explaining neighbourhood environment influence on dietary intake. Binary response categories used were *'High'* and *'Low'* healthful food item reporters.

High and *Low* reporter categories were yielded by dividing the CNES sample population into two equal groups according to proportion of diet comprising healthful food item rank. For *High* reporters 65.1–87.9% of total dietary intake comprised healthful food items and for *Low* healthy food item reporters only 44.1–65%. There was 74.1% agreement between high/ low proportionate healthful diet reporting and high/ low 'more healthful' food item reporting (χ^2=25.07, p<0.01).

Gender and IMD were not controlled for in the model. Dietary intake was not significantly different according to gender or IMD, and variables were consistently non-significant during model building (data not shown).

Other models were tested but this model was selected as it comprised the majority of surveyed neighbourhood variables[38] which collectively explained approximately

[38] 'Food Outlet' and 'Food advert' variables were excluded due to multicollinearity (high level correlation). Food outlets and adverts (typically displayed on food outlets) tended to be concentrated in 'High Street' or 'Shopping District' locations. This meant that when counts of one food outlet or food advert type were high so were counts of other types. This was also true for counts of 'Non-food shops and services'. The combination of food outlet and advert counts included within the model ('Unhealthy food outlets' and 'HFS food/ drink adverts') was the only selection which did not have multicollinearity issues.

10% of dietary intake; and had a moderate classification success rate (61.1% correctly classified cases). One outlier was identified by Standardised Residual deviance testing.

Neighbourhood variables	95% CI	B	Exp(B)
Unhealthy food outlets (n)	0.82–1.10	-0.06	0.95
HFS food/ drink adverts (n)	0.91–1.02	-0.03	0.97
Non-food shops and services (n)	0.99–1.05	0.02	1.02
Park and GS (n)	0.78–1.23	-0.03	0.98
Sports facility (n)	0.78–2.11	0.25	1.28
Total road length (km)	0.51–1.30	-0.20	0.82
Street length (km)	0.96–1.37	0.14	1.15
-2 Log likelihood		141.06	
Nagelkereke R^2		0.10	
Hosmer and Lemeshow χ^2 (p)		3.68 (0.89)	

Table 60: Binary logistic regression model of neighbourhood environment on dietary intake (n=108)

In this model 'Non-food shops and services' and 'Sports facility' counts, and 'Street length' were *non-significantly positively* associated with the odds of being classified as a *Low* compared to *High* healthful diet reporter (i.e. as 'All shops and services' counts increased the odds of being classified as a *Low* healthful diet reporter increased). Relationship direction should be interpreted with caution in light of non-statistical significance and thus potential for chance.

'Unhealthy food outlet'[39], 'HFS food/ drink advert' and 'Park and GS' counts and 'Total road' length were *non-significantly negatively* associated with being classified as a *Low* healthful diet reporter; again relationship direction should be interpreted cautiously.

[39] Unhealthy outlets comprised: Takeaway eateries and Convenience and incidental outlets.

4.31 Dietary Intake Cases

Full case study analysis was not undertaken for dietary intake in light of a number of factors. Firstly, the binary logistic regression model had low-level predictive power for explaining dietary intake by neighbourhood environment variables (approximately 10%). Furthermore neighbourhood environmental variables were consistently non-significant in the model meaning the direction of association with dietary intake was unclear. Secondly, the multifaceted and interconnected relationship of food outlet *type* and its influence on dietary intake could not be fully explored in the model due to issues of multicollinearity. Thirdly, the imperfect measurement tools employed: self-reported dietary intake by food item count (i.e. not accurate portion) impedes robustness of binary response classification and data exploration. Finally, the CNES population sourced food from ‘Food outlets’ on only 9.4% (n=171) of eating occasions thus the importance of these facilities on influencing total dietary intake is questionable (see section 4.14.3 on page 138).

Neighbourhood Environmental Influence on BMI

This section explores neighbourhood environment influence on BMI using binary logistic regression and case pairs. Neighbourhood environments are compared per regression assigned grouping with significant differences highlighted. Case study pairs for ‘under and healthy weight’ and ‘overweight and obese’ groupings are presented – male and female participants separately. Neighbourhood environment attributes are outlined descriptively then compared and contrasted with case and parent perceptions and self-reported activity behaviour and dietary intake.

Objectively measured neighbourhood environment data was used to explore effect on BMI. Table 61 shows the logistic regression model explaining neighbourhood environment influence on BMI, controlling for IMD and gender. Binary response categories used were ‘Under and healthy weight’ (UHW) and ‘Overweight and obese’ (OWOB).

Other models were tested (data not shown) but this model was selected as it: had some variable significance (two environmental variables and gender); comprised the majority of surveyed neighbourhood environment variables which collectively explained approximately 21% of BMI; and had a robust classification success rate (76.9% correctly classified cases). Five outliers were identified by Standardised Residual deviance testing and therefore were excluded from further analysis.

‘All shops and services’ count and absence of ‘Cycling facilities’ were statistically significantly *positively* associated with the odds of being classified as *OWOB* compared to UHW (i.e. as ‘All shops and services’ counts increased the odds of being OWOB increased). ‘Parks and GS’ count, ‘A road’ and ‘Total street’ lengths and ‘Road safety’ were non-significantly *positively* associated with being classified as OWOB; relationship direction should be interpreted with caution in light of non-statistical significance and thus potential for chance.

Being ‘Male’ was significantly *negatively* associated with the odds of being classified as OWOB. ‘Sports facility’ count, ‘Total road’ length, ‘Street quality’ and ‘IMD’ were non-significantly *negatively* associated with the odds of being classified as OWOB; again relationship direction should be interpreted cautiously.

Neighbourhood variables	**95% CI**	**B**	**Exp(B)**
Parks and GSs (n)	0.76–1.47	0.06	1.06
Sports facilities (n)	0.33–1.16	-0.49	0.61
All shops and services (n)	1.00–1.04	0.02	**1.02****
Total road length (km)	0.40–2.13	-0.08	0.92
A road length (km)	0.59–3.46	0.36	1.43
Road safety (score)	0.48–5.62	0.50	1.64
Total street length (km)	0.86–1.24	0.03	1.03
Street quality (score)	0.79–1.08	-0.08	0.92
Cycling facilities (presence/ absence)	0.92–15.00	1.31	**3.72***
Gender	0.11–0.97	-1.12	**0.33****
IMD (score)	0.95–1.03	-0.01	0.99
-2 Log likelihood	107.32		
Nagelkereke R^2	0.21		
Hosmer and Lemeshow χ^2 (p)	9.06 (0.38)		

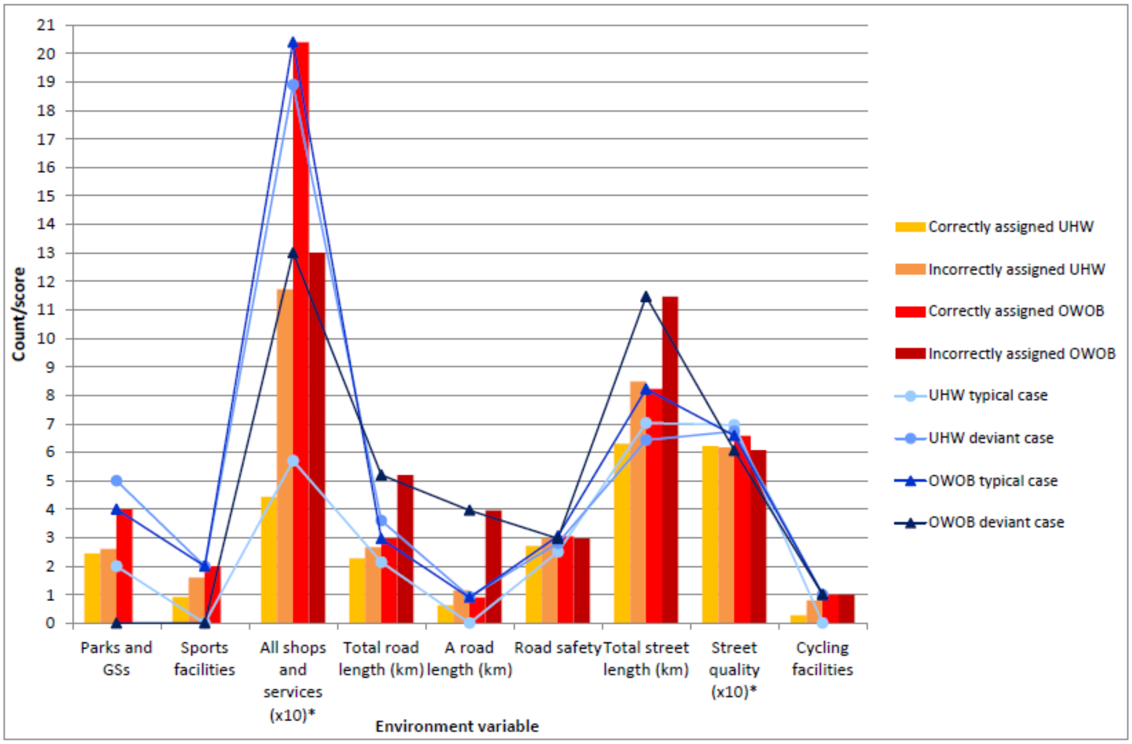
* ***Significant*** *at P<0.10 level*
** ***Significant*** *at P<0.05 level*

Table 61: Binary logistic regression model of neighbourhood environment influence on BMI (n=108)

The model was better at correctly classifying UHW than OWOB cases: 96.3% (n=77) and 26.1% (n=6) respectively. And was marginally better at correctly classifying ‘Male’ than ‘Female’ participants: 86% and 76.7% correctly classified. Because gender was a significant predictor of BMI subsequent cases analyse male and female participants separately.

4.32 Male BMI Case Overview

Figure 56 shows mean environment variable counts per binary response grouping overlaid with cases. Neighbourhood environment variable counts for UHW and OWOB *‘typical’* and *‘deviant’* cases were not significantly different than mean counts for their respective grouping indicating that they were representative (data not shown).



** Counts divided by 10 for graphical purposes*

Figure 56: Mean neighbourhood environment variable counts per observed/ predicted BMI grouping with overlying cases for male participants

Correctly assigned OWOB participants had the *highest* mean counts of ‘All shops and services’ (H=10.0, p=0.02), *Incorrectly assigned* OWOB participants had on average the *longest* ‘Total roads’ (F=3.13, p=0.04), and *Correctly* and *Incorrectly* assigned OWOB participants had the *highest* mean ‘Cycling facility’ counts (H=8.46, p=0.03). All other differences were non-significant.

4.33 Male Under and Healthy Weight Case Pair

The *correctly assigned* UHW case ‘UHW *typical* case’ was participant #511, aged 11 years one month, BMI 17 (healthy weight). The *incorrectly assigned* UHW case ‘UHW *deviant* case’ was participant #507, aged 11 years 1 month, BMI 25.2 (overweight). Henceforth UHW *typical* and *deviant* cases are referred to using the pseudonyms Tom and Chris.

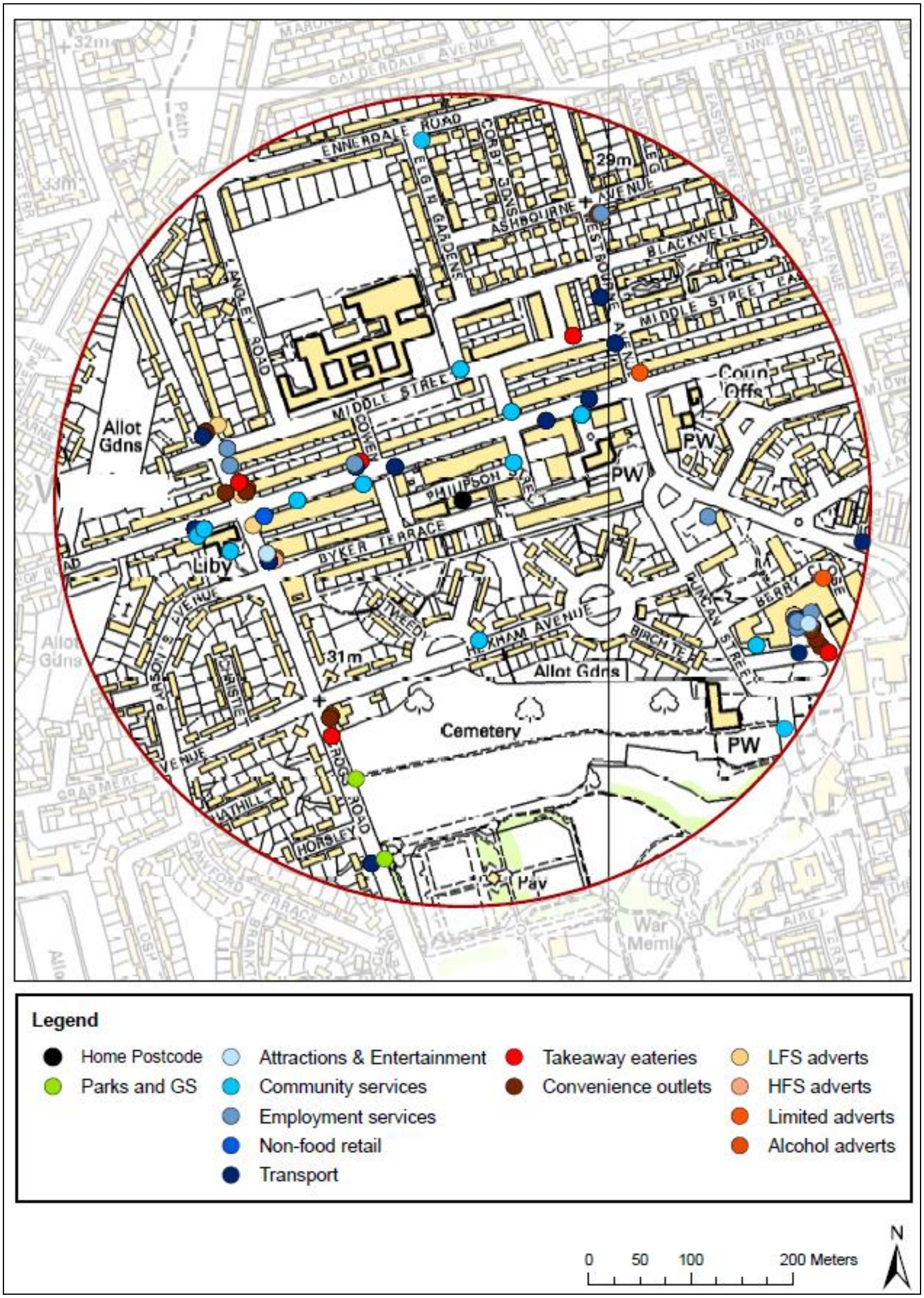


Figure 57: Under and healthy weight typical male case Tom (participant #511) neighbourhood environment (from postcode centroid)

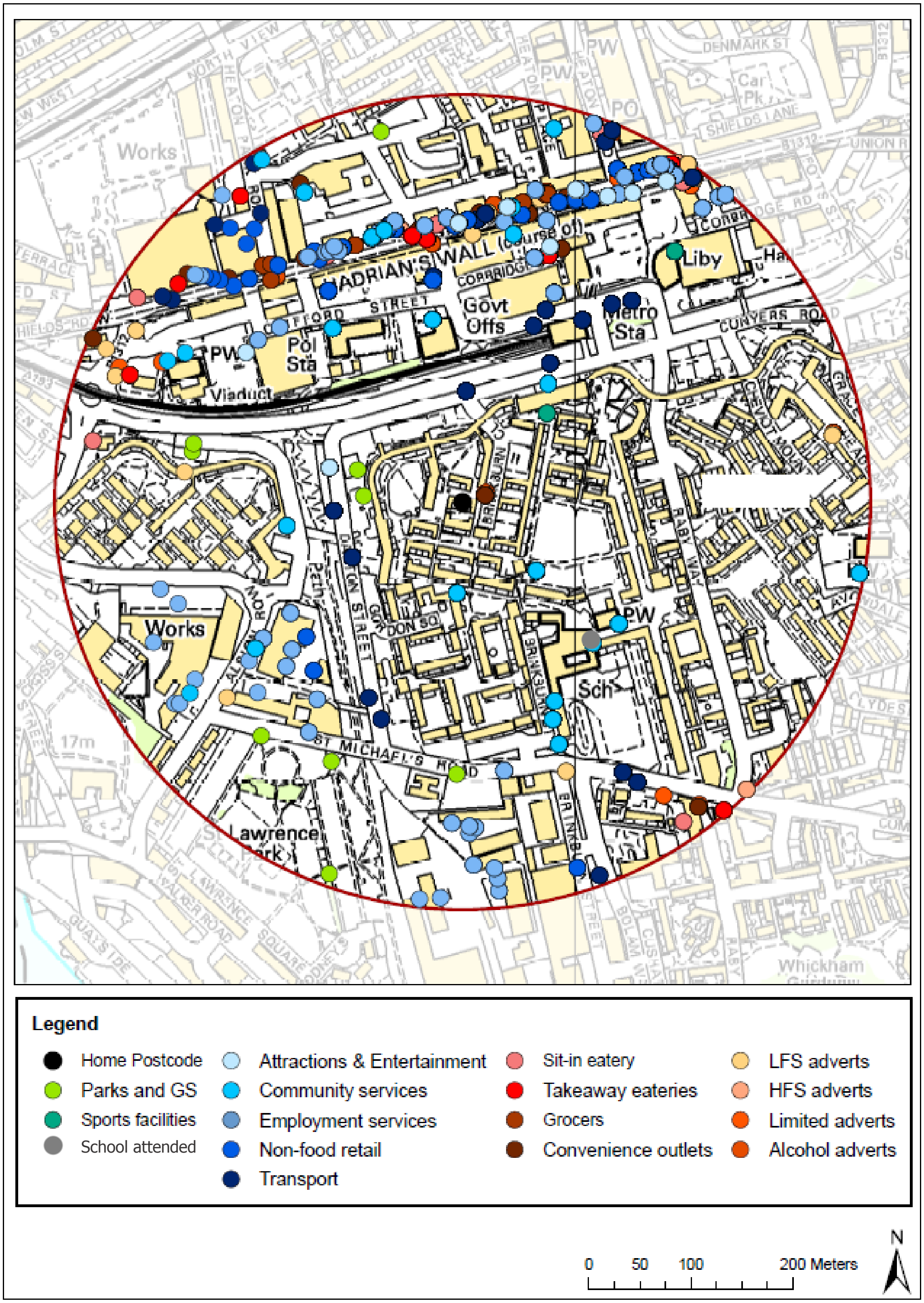


Figure 58: Under and healthy weight deviant male case Chris (participant #507) neighbourhood environment (from postcode centroid)

Neighbourhood environment variables	Tom (UHW typical) N (%)	Proximity	Chris (UHW deviant) N (%)	Proximity
Parks and GSs:				
Amenity	1	361	4	97
Semi-natural	1	294	1	267
Functional	0		0	
Sports facilities:				
Leisure Centres	0		1	120
Other Sports facilities	0		1	322
Non-food shops and services:				
Attractions and entertainment	2 (5.1)	199	9 (6)	135
Community services	15 (38.5)	62	24 (16.1)	89
Employment services	8 (20.5)	112	58 (38.9)	201
Retail outlets	2 (5.1)	195	30 (20.1)	201
Transport services	12 (30.8)	74	28 (18.8)	109
Food outlets:				
Sit-down eateries	2 (11.1)	206	9 (22.5)	276
Takeaways	6 (33.3)	108	9 (22.5)	258
Grocers	1 (5.6)	344	7 (17.5)	275
Convenience and incidental outlets	9 (50)	212	15 (37.5)	25
Food & Drink adverts:				
Low fat and/ or sugar (LFS)	37 (43.5)	198	85 (36.6)	25
High fat and/ or sugar (HFS)	26 (30.6)	192	68 (29.4)	25
Alcohol	12 (14.1)	192	24 (10.3)	25
Limited	10 (11.8)	108	55 (23.7)	25
Road length (metres):				
A roads	0		928	
B roads	794		869	
Minor roads	1,312		1,205	
Private roads (public access)	0		0	
Private roads (restricted access)	36		596	
Street length (metres):				
Local streets	7,025		6,430	
Alleys	0		0	

Table 62: Under and healthy weight male case pair neighbourhood environment variable count (N), percentage (%), and proximity (in metres)

4.33.1 Physical Environment

Figure 57 and Figure 58 graphically illustrate case neighbourhoods and Table 62 enumerates neighbourhood facilities.

Parks and GSs

Chris (UHW *deviant*) had better *access* and *proximity* to 'Parks and GSs' than Tom (UHW *typical*). Chris had four neighbourhood 'Amenity' GSs (Figure 59). A medium sized park with age-appropriate playground, hard surface court and playing field facilities (top row images GS #8001). This park was perceived to be a pleasant enclosed green environment with good facilities for young people. There was some evidence of alcohol debris and lighting was limited which detracted from overall pleasantness. Secondly, a small park with small playground targeted at younger children (bottom centre and right images GS #8343). This park had an unpleasant atmosphere owing to lack of greenery and colour and a sense of confinement and 'being-watched' due to the walled, overlooked boundary. There were also two hard surface 'Outdoor Sports Area' courts which were fit for purpose, had a good atmosphere and fairly good maintenance (bottom left image GS #8127 and #8156). Their location juxtaposition housing and busy roads did however detract from facility 'sense of destination'.

Figure 59: Chris's neighbourhood Amenity GSs (GSs #8001, #8127, #8156 and #8343)

Tom had one large 'Amenity' GS which contained multiple, age-appropriate sports and play facilities. Objective researcher perceptions of this park were generally positive, the atmosphere and environment were pleasant, and during the time of audit the park was busy with families. There was however some broken glass and alcohol debris and the park had a number of concealed entrances and pathways which lessened perceptions of safety (see concealed entrance in bottom right image Figure 60).

Figure 60: Tom’s neighbourhood Amenity GS (GS #8455)

Sports Facilities

Chris had two neighbourhood Sports facilities, Tom had none.

All Shops and Services

Chris had *more* ‘Non-food shops and services’ than Tom, proportionally *more* ‘Attractions and Entertainment’ and ‘Employment’ services and ‘Retail outlets’. Chris had on average better *proximal access* to ‘Non-food shops and services’ than Tom.

Chris had *more* and *closer* overall proximity to ‘Food outlets’ than Tom. He had proportionally *more* ‘Sit-down eateries’ and ‘Grocers’ but *fewer* ‘Takeaways’ and ‘Convenience and incidental outlets’. Outlet *healthfulness*, according to MFE, *favoured* Chris for ‘All food outlet’ types: ‘Sit-down eateries’ +0.8%, ‘Takeaways’ +4.2%, ‘Grocers’ +6.9% and ‘Convenience and incidental outlets’ +0.3%.

Outdoor Food and Drink Advertising

Proportionally Tom had *more* ‘LFS’, ‘HFS’ and ‘Alcohol’ adverts than Chris but *fewer* ‘Limited’ adverts. All food adverts in Tom’s neighbourhood were on ‘Food outlets'. For Chris, 79.6% of food adverts were on 'Food outlets', 7.4% on 'Closed food outlets' and 13% in 'Other' locations.

Roads

Chris had *longer* 'Total roads' and *higher* 'Road safety' score than Tom. Chris's neighbourhood had *more* 'Traffic control devices' and 'Pedestrian crossing aids' than Tom's but *fewer* 'Cul-de-sacs' (for example see Figure 61 middle and bottom row left images) and slightly *fewer* average 'Car lane' count.

Streets

Tom had *longer* 'Total streets' and *higher* 'Street quality' score than Chris. Tom's neighbourhood had *less* 'Graffiti', 'Foul', 'Noise' and 'Air' pollution and *higher* perceived 'Safety' predominately owing to surveillance from nearby buildings (Figure 61). Chris had *better* neighbourhood 'Greenness' owing to grassy verges (Figure 62), marginally *less* neighbourhood 'Litter', and better 'Building' and 'Overall street' attractiveness.

Cycling Facilities

Tom had no neighbourhood 'Cycling facilities'; Chris had cycle lanes present in two street segments (see Figure 62 second row centre image).

4.33.2 Case Perceptions

Chris (UHW deviant) was *positive* about neighbourhood 'Things to do' and 'Places to walk and cycle' whilst Tom (UHW typical) was *negative*. Chris was slightly more *positive* about it being 'Safe to play out in the neighbourhood' than Tom. Both cases *agreed* they 'Liked', 'Felt better' and were 'Able to be' active and keep fit.

Both cases *agreed* they 'Liked fruit and vegetables' and they were 'Able to eat well'. Tom *really disagreed* and Chris felt *neutral* that they ate 'Five pieces of fruit and vegetables most days' (5-a-day). Tom *agreed* and Chris *disagreed* that they 'Felt better when they ate well'. Both cases *agreed* they were 'Happy with [their] body shape'.

Figure 61: Tom’s neighbourhood street segments sample

Figure 62: Chris’s neighbourhood street segments sample

4.33.3 Parent Perceptions

Neighbourhood

Only Chris’s parent (UHW deviant) responded to the survey. They were *positive* about neighbourhood ‘Recreation and leisure services’, ‘All shops and services’, ‘Walking and cycle routes’, ‘Street maintenance’, ‘Lighting’, traffic ‘Speed’ and ‘Density’ and were happy for Chris to ‘Unsupervised in the neighbourhood’. But they were *negative* about neighbourhood ‘Attractiveness’, ‘Rubbish’ and ‘Crime’ levels.

Physical Activity

Chris’s parent was wholly *negative* about their ‘Personal involvement with’ and ‘Enjoyment of’ PA, and *disagreed* that they enrolled Chris in ‘Out-of-school sports teams and community programmes’. They were *positive* about ‘Encouraging [Chris] to be active’ and reported playing an active role in his activity ‘Enrolling him in after-school clubs’ and ‘Taking him to places to be active’. They also reported *limiting* time Chris spent on the ‘Computer’ but *not* ‘Watching TV’.

Home Food Environment

Chris’s parent reported *positive* ‘Meal time practices’, healthy food ‘Access’ and ‘Encouragement’, and being *non-permissive* with Chris’s ‘Eating’. Despite this they did report Chris *usually* ‘Ate snacks without permission’ and they *usually* ‘Substituted food [Chris] didn’t like or want’.

4.33.4 Case Behaviour

Tom (UHW *typical*) reported *less* absolute[40] and proportionate[41] time ‘Sedentary’ and in ‘Moderate’ intensity activity than Chris (UHW *deviant*) by 88 minutes 3%, and 99 minutes 6.4%, respectively. But *more* time in ‘Intense’ activity by 94 minutes or 9.3%.

Tom spent *more* time in the ‘Neighbourhood’, at ‘School’ and in ‘Other’ locations (+16.4%, +4.9% and +3%) but *less* time in ‘Parks and GSs’, ‘Sports venues’ and at ‘Home’ than Chris (-13.8%, -6.9% and -3.7%).

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[40]Defined as total time reported.

[41] Defined as time reported per activity intensity divided by total time reported.

Clubs and Classes

Tom reported attending two 'Active clubs and classes' outside-school, Chris only one. This was reflected in an additional 30 minutes reported in this activity by Tom than Chris (120 compared 90 minutes).

Recreation and Leisure Facilities

Tom estimated park use frequency 'Monthly'. He reported no time during the recording period in 'Parks or GSs'. Chris estimated 'Twice weekly' park usage and 180 minutes within parks and GSs during the reporting period; 'Playing football' with 'Friends' one weekend day morning and afternoon (120 and 60 minutes).

Both case's description of the sports and play facilities within the park 'They play in' matched researcher observations, Tom as per GS #8455 and Chris GS #8001. Though information about the park they reported on was not ascertained.

Chris reported 'Swimming' at the Leisure Centre with 'Friends' one weekend afternoon (90 minutes); Tom reported no time in these spaces.

Neighbourhood Activity

Both cases estimated playing on the street '5–6 times weekly'. Tom's favourite activity within this space was classified as 'Very active' and Chris 'Moderately active'. Tom reported both more *time* and *activity occasions* being active within the neighbourhood[42] than Chris. Tom reported 'Playing' on the street with 'Friends' one weekend afternoon (120 minutes). And four activity instances 'playing football': 'Alone' one weekend afternoon (60 minutes) and evening (3 minutes), and with 'Friends' one weekend evening (26 minutes) and school day evening (90 minutes). Chris reported 'Playing outside on the street' with 'Friends' one weekend afternoon only (120 minutes).

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[42] Defined as all-time recorded playing, doing sports, athletics, dance, activity clubs, walking, jogging, running, cycling, skating, scooting, gardening or DIY within the neighbourhood.

Neighbourhood Active Travel

Chris reported travelling actively in the neighbourhood[43] an additional 27 minutes and five activity occasions than Tom. Chris reported 'Walking' to and from school on both school days (3 minutes per journey); Tom did not travel actively to school. Chris 'Walked' to the 'Swimming pool' and 'Takeaway' one weekend afternoon (10 and 20 minutes), to 'Football' one weekend evening (5 minutes) and to 'Youth club' one school day evening (5 minutes). Tom walked to a 'Friends house' twice one weekend morning (2 minutes each) and one weekend afternoon (1 minute), and to the 'Shops' one weekend afternoon (20 minutes). Neither participant reported any time cycling in the neighbourhood.

Dietary Intake

Tom ate on average one *less* food item per day than Chris. Less 'Carbohydrates' (by 0.75 food items), 'Protein' (0.25), 'Sauces and spreads' (0.25), 'Puddings, deserts, cakes and biscuits' (1.25) and 'Low calorie drinks' (0.75), and more 'Fruit and vegetables' (0.75), 'Dairy' (0.75), 'Fried/ high fat snacks' (0.25) and 'Sweets and chocolate' (0.5).

Both cases fell well short of '5-a-day' recommendations with Tom reporting an average 2 fruit and vegetables items per day and Chris only 1.3 items.

Food Sourcing and Eating Location

Tom *sourced* and *ate* food from 'House' on 13 eating occasions and from 'School' on two occasions. He *sourced* food from a 'Food outlet' *eating* at 'School' on one occasion (school day morning snack, food item biscuit). Chris *sourced* and *ate* food from 'House' on 14 eating occasions and from 'School' on two occasions. He *sourced* food from a 'Food outlet' *eating* in the 'Neighbourhood' on two occasions (weekend lunch, food items: chips and butter sandwich, chocolate biscuit and low calorie drink; and school day afternoon snack, food item: sweets).

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[43] Defined as all-time recorded walking, jogging, running, cycling, skating or scooting for the purpose of travel within the neighbourhood.

Under and Healthy Weight Male Case Pair Key Differences:

- Chris (UHW deviant case) had better access to Parks, GSs and Sports facilities and had more positive perceptions of 'Things to do' in the neighbourhood than Tom (UHW typical case). Chris's parent had positive perceptions of neighbourhood recreation and leisure services. Chris reported more time in Parks, GSs and Sports facilities than Tom
- Chris had better access and proximity to 'Non-food shops and services' and more positive perceptions of 'Things to do' in the neighbourhood than Tom. His parent also had positive perceptions of neighbourhood 'Shops and services'
- Chris had better access, proximity and 'All food outlet' healthfulness and reported greater use of these facilities than Tom (by eating occasion). Both cases reported majority 'HFS' food items sourced from food outlets
- Chris had longer 'Total roads' and better 'Road safety' but shorter 'Total streets' and poorer 'Street quality' than Tom. Chris had more positive perceptions of 'Places to walk and cycle in the neighbourhood' and was marginally more positive about neighbourhood 'Safety' than Tom. Tom spent more time *active* but less time *travelling actively* in the neighbourhood than Chris
- Tom spent proportionally more time in 'Intense' activity and less time 'Sedentary' and in 'Moderate' intensity activity than Chris
- Tom reported attending more 'Active clubs and classes' than Chris and reported more time in this activity
- Chris had slightly more negative perceptions of his diet and ate more food items, more frequently and less 'Fruit and vegetable items' than Tom

4.34 Male Overweight and Obese Case Pair

Correctly assigned OWOB case 'OWOB *typical* case' was participant #514, aged 11 years eight months, BMI 25.3 (obese). *Incorrectly assigned* OWOB case 'OWOB *deviant* case' was participant #401, aged 10 years 7 months, BMI 14.4

(underweight). Henceforth OWOB *typical* and *deviant* cases are referred to using the pseudonyms Josh and Luke.

4.34.1 Physical Environment

Figure 64 and Figure 65 graphically illustrate case neighbourhoods and Table 63 enumerates neighbourhood facilities.

Parks and GSs

Josh (OWOB typical) had four 'Amenity' GSs, GSs #8156 and #8343 are described in detail in Male Under and Healthy Weight Case Pair, Physical Environment in section 4.33.1 (Figure 59 on page 204). The 'Outdoor Sports Areas' in Figure 63 were good, well maintained, fit for purpose facilities. Being contained in a housing estate they were deemed to be safe and have a child-friendly atmosphere. Luke (OWOB deviant) had no neighbourhood parks and GSs.

Figure 63: Josh's neighbourhood Amenity GSs (GSs #8145 and #8148)

Sports Facilities

Josh had two neighbourhood 'Sports facilities', Luke had none.

All Shops and Services

Josh had better *access* and closer overall *proximity* to all 'Non-food shops and services'. Proportionally Josh had *more* 'Attractions and Entertainment' and 'Community services' than Luke.

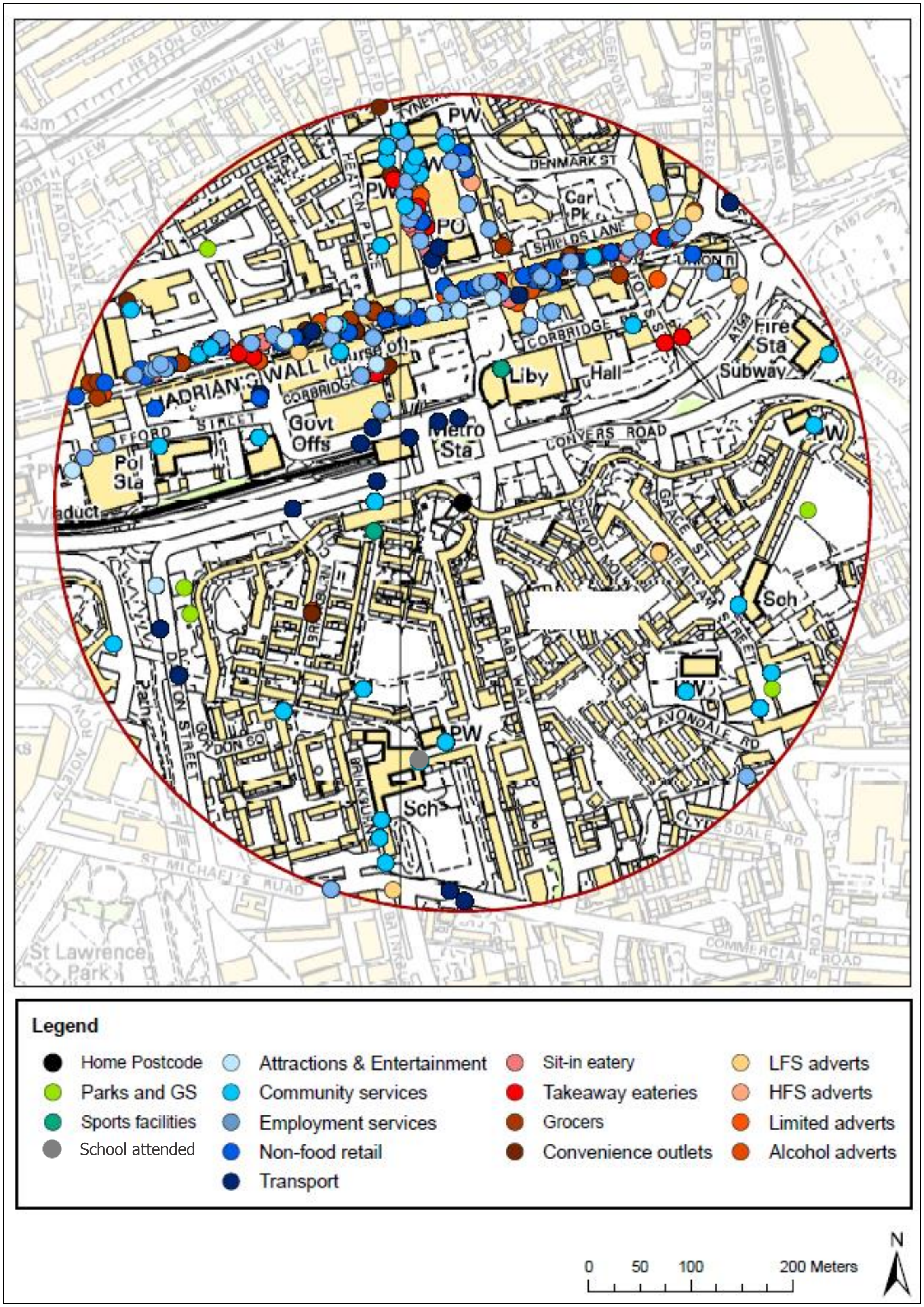


Figure 64: Overweight and obese typical male case Josh (participant #514) neighbourhood environment (from postcode centroid)

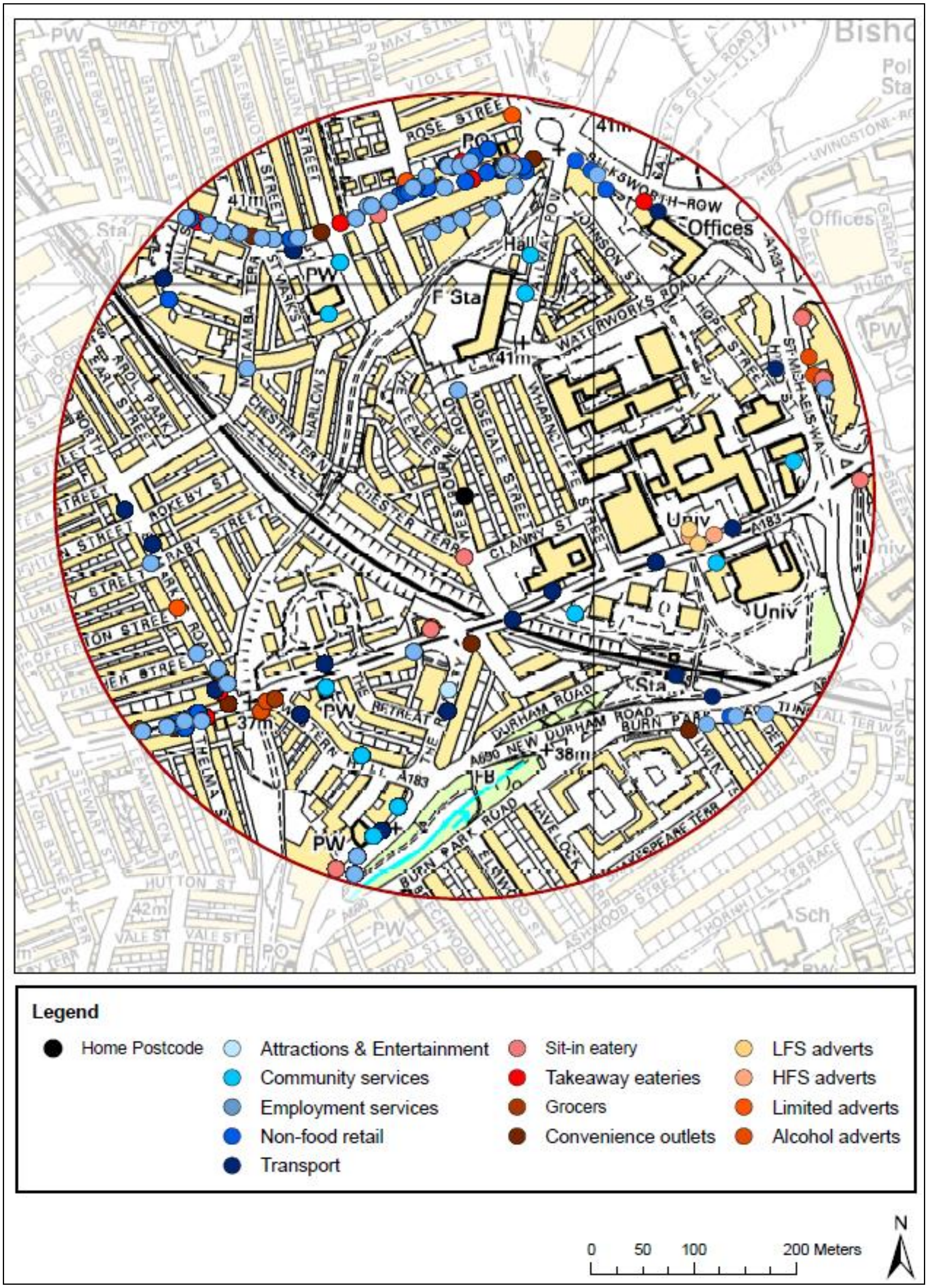


Figure 65: Overweight and obese deviant male case Luke (participant #401) neighbourhood environment (from postcode centroid)

Neighbourhood environment variables	Josh (OWOB typical) N (%)	Proximity	Luke (OWOB deviant) N (%)	Proximity
Parks and GSs:				
Amenity	4	285	0	
Semi-natural	0		0	
Functional	0		0	
Sports facilities:				
Leisure Centres	1	137	0	
Other Sports facilities	1	93	0	
Non-food shops and services:				
Attractions and entertainment	9 (6)	160	1 (1)	193
Community services	35 (23.3)	86	11 (11)	159
Employment services	53 (35.4)	121	43 (43)	105
Retail outlets	30 (20)	187	26 (26)	305
Transport services	23 (15.3)	83	19 (19)	127
Food outlets:				
Sit-down eateries	11 (20.4)	189	9 (30)	58
Takeaways	15 (27.8)	155	8 (26.7)	299
Grocers	12 (22.2)	208	2 (6.7)	271
Convenience and incidental outlets	16 (29.6)	139	11 (36.7)	144
Food & Drink adverts:				
Low fat and/ or sugar (LFS)	138 (40.6)	155	45 (34.4)	58
High fat and/ or sugar (HFS)	90 (26.5)	155	20 (15.3)	224
Alcohol	26 (7.5)	181	26 (19.8)	134
Limited	86 (25.3)	25	40 (30.5)	134
Road length (metres):				
A roads	903		3,956	
B roads	923		0	
Minor roads	414		518	
Private roads (public access)	0		19	
Private roads (restricted access)	723		707	
Street length (metres):				
Local streets	8,222		7,713	
Alleys	0		3,753	

Table 63: Overweight and obese male case pair neighbourhood environment variable count (N), percentage (%), and proximity (in metres)

Josh had *more* ‘Food outlets’ than Luke but *poorer* overall *proximity*. Proportionally Josh had *more* ‘Grocers’ and marginally *more* ‘Takeaways’. Josh had a *healthier* food environment, according to MFE, for all outlet types. The biggest difference in outlet healthfulness by outlet grouping *type* was ‘Grocers’ (5% MFE). Josh had 12 ‘Grocers’: one supermarket and 11 specialist suppliers (see Figure 66); Luke had two specialist suppliers. ‘World Food’ suppliers in Josh’s neighbourhood were less healthy than those in Luke’s (average -7.5% MFE) but the ‘Supermarket’, ‘Butcher’, ‘Fishmonger’ and ‘Greengrocers’ were all healthier, resulting in an overall healthier score. The second biggest difference by outlet grouping type was for ‘Sit-down eateries’ (4.2% MFE). All ‘Sit-down eatery’ outlet types in Josh’s neighbourhood were healthier: ‘Restaurants’, ‘Traditional Cafes’, and ‘Greasy spoon type Cafes’ (+7.3%, +12.5% and +7% MFE scores) (see Figure 67 and Figure 68).

Figure 66: Sample of Grocers in Josh’s neighbourhood

Figure 67: Sample of Sit-down eateries in Josh’s neighbourhood

Figure 68: Sample of Sit-down eateries in Luke’s neighbourhood

Outdoor Food and Drink Advertising

Josh had *more* food adverts than Luke, proportionally more 'LFS' and 'HFS' adverts but *fewer* 'Alcohol' and 'Limited' adverts. Josh had proportionally *more* adverts on 'Food', 'Retail' and 'Gambling' outlets (3.4%, 1.3% and 0.3%) and by the 'Road' (0.9%), but *fewer* in 'Residential areas' (0.2%) and at 'Library's and Education services' (5.7%) than Luke. The university campus contained within Luke's neighbourhood (see Figure 65) had a public access 'Café' and 'Coffee shop' which explains the higher advertisement count at 'Library's and Education services'.

Roads

Luke had *longer* 'Total roads' but marginally *lower* 'Road safety' score owing to having *fewer* 'Traffic control devices' and 'Cul-de-sacs' than Josh. Luke's neighbourhood did however have marginally *more* 'Pedestrian crossing aids' than Josh's.

Streets

Luke had *longer* 'Total streets' than Josh but *lower* 'Street quality' score. Josh's neighbourhood had *better* street 'Greenness' and perceived 'Safety' than Luke's (see Figure 69). *Lower* perceptions of safety in Luke's neighbourhood were predominately owing to presence of alleys with no pavements which were perceived as very unsafe (for example see Figure 70 third row left image and fourth row centre image). Luke's neighbourhood had *better* 'Street cleanliness' having *less* graffiti and litter, and was *more* 'Attractive' owing to having *more* attractive buildings and *lower* pollution scores than Josh's neighbourhood.

Cycling Facilities

Both cases had 'Cycling facilities' (lanes) available in two street segments (for example see Figure 70 second row right hand image). Josh was attributed as having *marginally better* cycling facility provision owing to having a *higher* average facility count per neighbourhood.

Figure 69: Josh’s neighbourhood street segments sample

Figure 70: Luke’s neighbourhood street segments sample

4.34.2 Case Perceptions

Josh (OWOB *typical*) *really disagreed* there were ‘Lots of things to do’ and there were ‘Places to walk and cycle’ in the neighbourhood, Luke (OWOB *deviant*) felt *neutral* and *agreed* with statements respectively. Luke was more *positive* about ‘Neighbourhood safety’ than Josh. Josh was *negative* and Luke *positive* about ‘Liking’, ‘Feeling better’ and their ‘Ability to be’ active and keep fit.

Josh was *negative* and Luke *neutral* about ‘Liking fruit and vegetables’ and ‘Eating 5-a-day’. Josh was *negative* and Luke *positive* about feeling ‘Better’ and ‘Able’ to eat well and about their ‘Body shape[s]’.

4.34.3 Parent Perceptions

Neighbourhood

Only Josh’s parent (OWOB *typical*) responded to the survey. They were *positive* about neighbourhood ‘Recreation and leisure services’, ‘Walking and cycling routes’, level of ‘Traffic density’, and ‘Non-food shops and services’. But they were *negative* about street ‘Maintenance’, amount of ‘Rubbish’ and ‘Lighting’ levels.

Physical Activity

Josh’s parent was wholly *positive* about their personal ‘Involvement with’ and ‘Enjoyment of’ PA and reported playing a *positive* active role in Josh’s activity ‘Encouraging him to be active’, ‘Enrolling him in teams and clubs’, ‘Taking him to places to be active’ and *limiting* time he spent ‘Using the computer’ and ‘Watching TV’.

Home Food Environment

Josh’s parent reported moderately *positive* ‘Meal time practices’, *positive* food ‘Access’ and ‘Encouragement’ and *non-permissiveness* with Josh’s ‘Eating’.

4.34.4 Case Behaviour

Josh (OWOB *typical*) reported an additional 1,086 minutes activity (all types) than Luke (OWOB *deviant*) thus proportionate comparison of reported time follows to facilitate meaningful comparison. Josh reported *more* time in ‘Moderate’ intensity activity than Luke but *less* time ‘Sedentary’ and in ‘Low’ and ‘Intense’ activities (+36.3%, -11.4%, -2.9% and -22%).

Josh reported *more* time in the 'Neighbourhood' and 'Other' locations but less time at 'Home' and 'School' than Luke (+27.2%, +10.1%, -29% and -8.3%).

Garden

Josh estimated he played in the garden 'Daily', Luke '3–4 times weekly'. Despite this Josh reported no time in his garden whilst Luke reported 'Playing sports' in the garden with 'Family' twice (20 and 30 minutes). Luke's description of his garden did not match the photographic evidence provided. Figure 71 shows no grass or plants but presence of bins which conflicted with self-report.

Figure 71: Luke's garden

Recreation and Leisure Facilities

Josh estimated park use frequency 'Once–twice weekly' and Luke 'Monthly'. Neither participant reported any time in Parks and GSs or Sports facilities during the recording period.

Neighbourhood Activity

Josh estimated playing on the street 'Everyday', Luke 'Once–twice weekly'. Both case's favourite street activity was classified as 'Moderately active'. Josh reported 'Playing outside on the street' with 'Family' at the weekend on three activity occasions (60, 60 and 120 minutes) and on both school day afternoons (120 and 240 minutes). Luke reported one activity instance 'Playing football' 'Alone' in the neighbourhood on one weekend afternoon (30 minutes).

Neighbourhood Active Travel

Josh reported 51 minutes travelling actively in the neighbourhood; Luke reported no active travel time. Josh 'Walked' with 'Family' to the library one weekend morning, afternoon and evening (10, 20 and 10 minutes each) and to and from school on both school days (one 5 minutes and three 2 minute journeys).

Dietary Intake

Josh ate on average two *more* food items per day and on nine additional eating occasions over four days than Luke. He ate *less* 'Low calorie drinks' (by 1.5 food items), 'Sauces and spreads' (0.25), 'High calorie drinks' (1), and *more* 'Fruits and vegetables' (1.25), 'Protein' (0.75), 'Dairy' (1.75), 'Fried/ high fat snacks' (0.75) and 'Puddings, deserts, cakes and biscuits' (0.25).

Both cases ate well below recommended fruit and vegetable intakes reporting only 1.75 and 0.5 food items per day respectively.

Food Sourcing and Eating Location

Josh sourced and ate food from 'House' on 17 eating occasions and from 'School' on two eating occasions. Luke sourced and ate food from 'House' on seven eating occasions. He sourced food from 'House' and ate at 'School' on two occasions; and sourced food from a 'Food outlet' eating at 'House' on one occasion (school day evening meal, food: item meat pizza).

Overweight and Obese Male Case Pair Key Differences:

- Josh (OWOB typical) had access to Parks, GSs and Sorts facilities Luke (OWOB deviant) did not. Josh had negative and Luke positive perceptions of their neighbourhood environments and PA. Josh's parent however had positive perceptions of 'Neighbourhood recreation and leisure services'. Neither case reported any time in these spaces
- Josh had better access and proximity to 'Non-food shops and services' than Luke but less positive perceptions of 'Things to do' in the neighbourhood. His parent had positive perceptions of all neighbourhood 'Non-food shops and

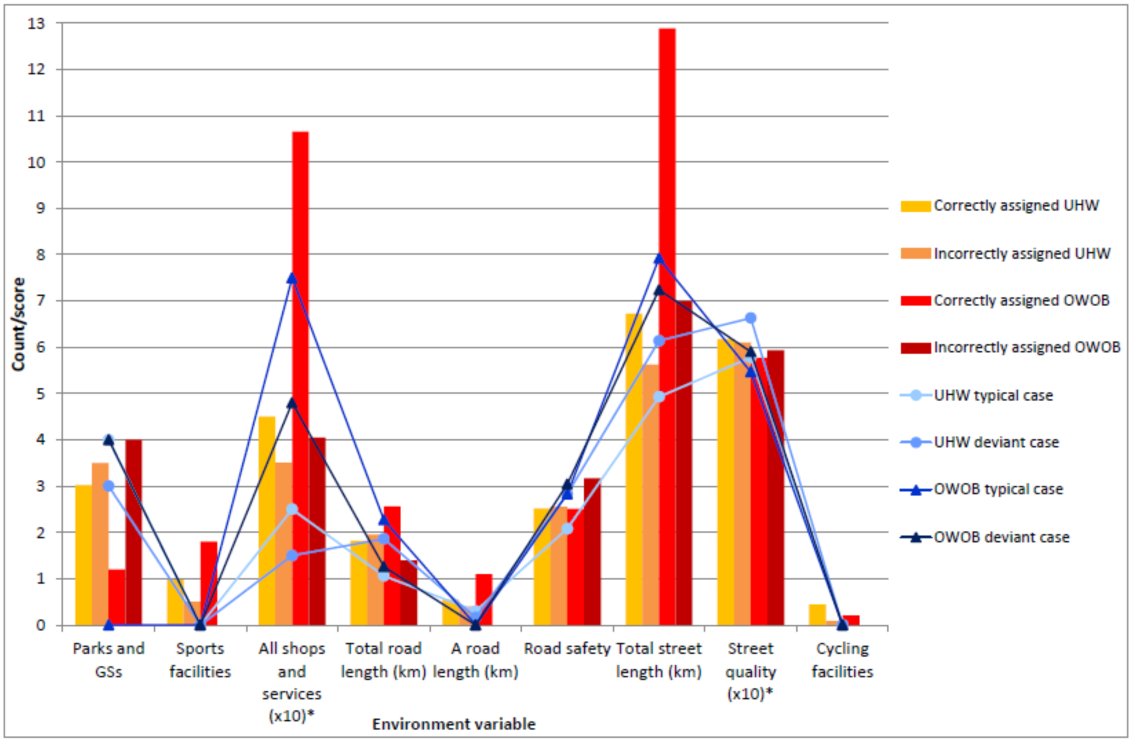
services’

- Josh had better ‘All food outlet’ access and healthfulness but lower proximity than Luke. Josh had higher access and proximity to ‘Food and drink adverts’ than Luke. Josh reported no food outlet use compared to one eating occasion by Luke
- Josh had shorter total ‘Roads’ and ‘Streets’ than Luke but higher ‘Road safety’ and ‘Street quality’ scores. He reported more time *active time* and *active travel time* within the neighbourhood than Luke
- Josh had marginally more ‘Cycling facilities’ than Luke; neither case reported any time cycling
- Josh spent proportionally more time in ‘Moderate’ intensity activity and less time being ‘Sedentary’ and in ‘Low’ and intensity activities than Luke
- Luke reported lower frequency of playing in the garden but reported more time in this activity
- Luke had more positive perceptions of eating well, his diet and body shape. He ate fewer food items and less frequently than Josh

4.35 Female BMI Case Overview

Figure 72 shows mean environment variable counts per binary response grouping overlaid with cases. Neighbourhood environment variable counts for UHW and OWOB *typical* and *deviant* cases were not significantly different than mean counts for their respective grouping indicating that they were representative (data not shown).

Correctly assigned OWOB participants had the *highest* mean counts of ‘All shops and services’ (H=9.88, p=0.02) and *longest* ‘Total streets’ (H=10.64, p=0.01). All other differences were non-significant.



** Counts divided by 10 for graphical purposes*

Figure 72: Mean neighbourhood environment variable counts per observed/ predicted BMI grouping with overlying cases for female participants

4.36 Female Under and Healthy Weight Case Pair

Correctly assigned UHW case 'UHW *typical* case' was participant #448 aged 10 years seven months, BMI 16.8 (healthy weight). *Incorrectly assigned* UHW case 'UHW *deviant* case' was participant #491, aged 11 years, BMI 28.2 (obese). Henceforth UHW *typical* and *deviant* cases are referred to using pseudonyms the Lucy and Sara.

4.36.1 Physical Environment

Figure 73 and Figure 74 graphically illustrate case neighbourhoods and Table 64 enumerates neighbourhood facilities.

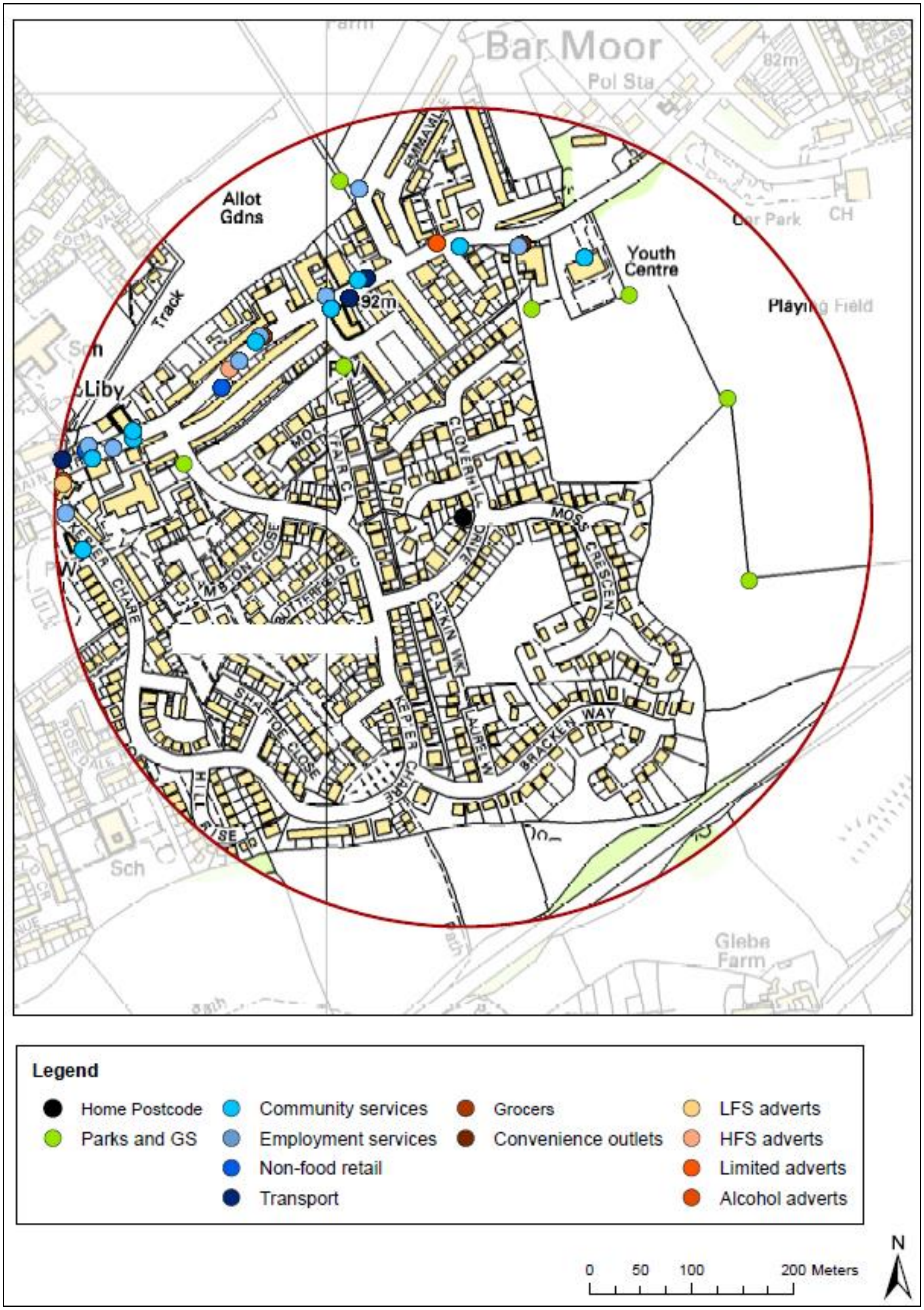


Figure 73: Healthy weight typical female case Lucy (participant #448) neighbourhood environment (from postcode centroid)

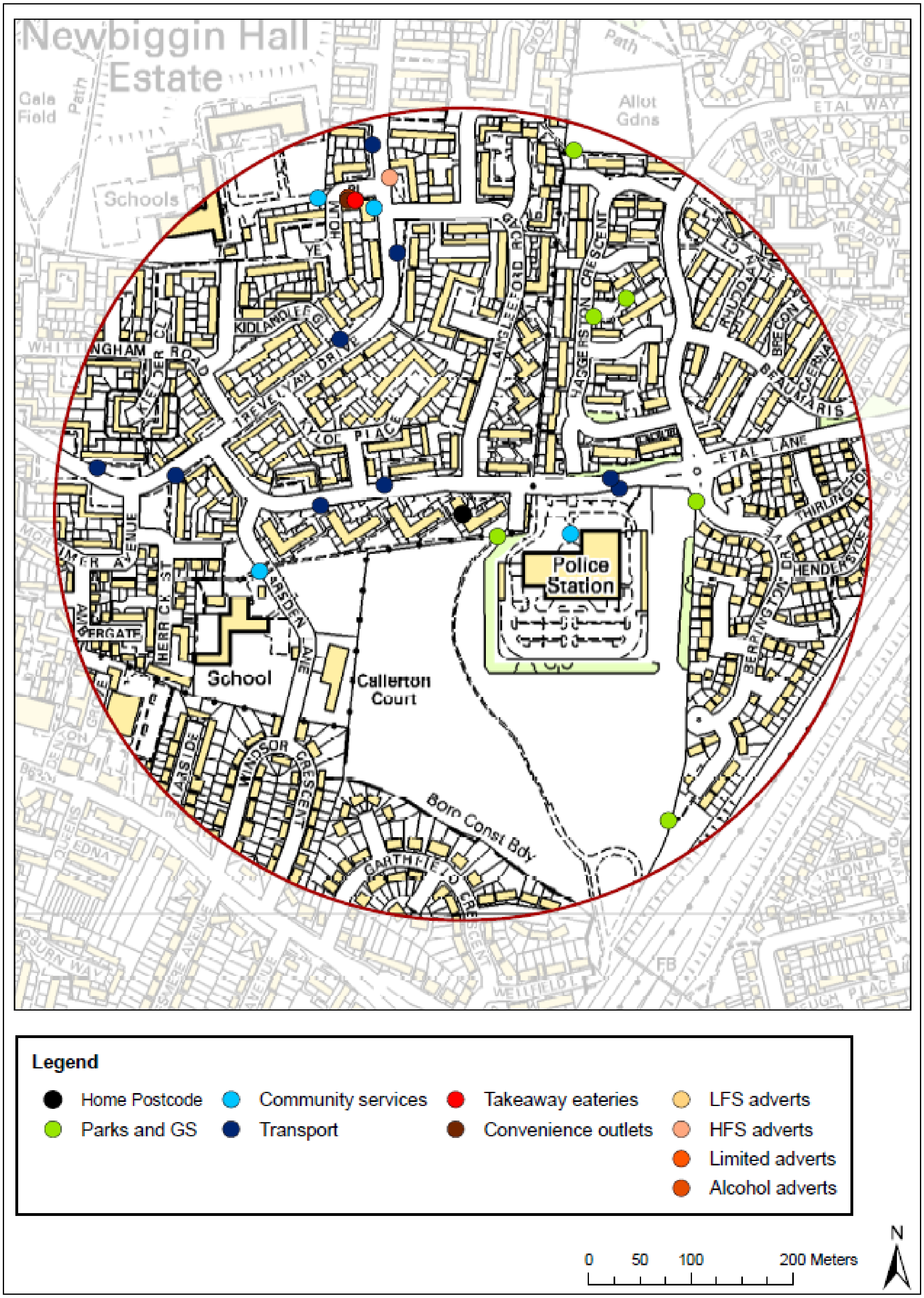


Figure 74: Healthy weight deviant female case Sara (participant #491) neighbourhood environment (from postcode centroid)

Neighbourhood environment variables	Lucy (UHW typical) N (%)	Proximity	Sara (UHW deviant) N (%)	Proximity
Parks and GSs:				
Amenity	1	214	2	40
Semi-natural	3	188	1	374
Functional	0		0	
Sports facilities:				
Leisure Centres	0		0	
Other Sports facilities	0		0	
Non-food shops and services:				
Attractions and entertainment	0		0	
Community services	9 (39.1)	242	4 (30.8)	108
Employment services	9 (39.1)	255	0	
Retail outlets	2 (8.7)	269	0	
Transport services	3 (13)	241	9 (69.2)	82
Food outlets:				
Sit-down eateries	0		0	
Takeaways	0		1 (50)	329
Grocers	1 (50)	265	0	
Convenience and incidental outlets	1 (50)	276	1 (50)	331
Food & Drink adverts:				
Low fat and/ or sugar (LFS)	2 (10.6)	276	1 (8.3)	331
High fat and/ or sugar (HFS)	7 (36.8)	265	2 (16.7)	331
Alcohol	3 (15.8)	393	7 (58.3)	331
Limited	7 (36.8)	265	2 (16.7)	329
Road length (metres):				
A roads	299		157	
B roads	673		0	
Minor roads	0		1,375	
Private roads (public access)	0		167	
Private roads (restricted access)	92		159	
Street length (metres):				
Local streets	4,934		6,102	
Alleys	0		41	

Table 64: Under and healthy weight female case pair neighbourhood environment variable count (N), percentage (%), and proximity (in metres)

Parks and GSs

Sara (UHW *deviant*) had *better access* and *proximity* to ‘Amenity’ GSs but *poorer access* and *proximity* to ‘Semi-natural’ GSs than Lucy (UHW *typical*). Lucy had one ‘Amenity’ GS a large ‘Outdoor Sports Area’ with playing fields and full sized sports pitches (Figure 75). Objective researcher perceptions of this park were positive it had good sports facilities highly suitable for young people. There was a good, and perceived safe, atmosphere owing to presence of lighting on paths, on-site rugby club and youth centre, and presence of park users (predominately dog walkers).

Figure 76 shows the two ‘Amenity’ GSs in Sara’s neighbourhood comprising a large GS with well-maintained age-appropriate grassed areas and sports pitches (top row images GS #7224). This park was perceived to be excellent for organised sports and good for unstructured play. The large size, absence of ‘on-looking’ supervision, and multiple entrance points (some concealed) diminished slightly the perception of safety. GS #7228 was small fairly well maintained play area with one play structure (poor age appropriateness); small grassed and hard surface play areas (bottom row images). This park was perceived to be poor; there were very limited play options, high levels of rubbish and a feeling of bleakness.

Sports Facilities

Neither case had any proximal neighbourhood Sports facilities.

All Shops and Services

Lucy had *better access* but *poorer* overall *proximity* to ‘Non-food shops and services’ than Sara. Proportionally she had *more* ‘Community’ and ‘Employment’ services and ‘Retail outlets’ but *fewer* ‘Transport services’.

Both cases had two ‘ All food outlets’ in their neighbourhoods. Lucy was on average *more proximal* to food outlets (mean 60 metres). Lucy had on average a *healthier* food environment (+2.5% MFE).

Figure 75: Lucy's neighbourhood Amenity GS (GS #4122)

Figure 76: Sara's neighbourhood Amenity GSs (GS #7224 and #7228)

Outdoor Food and Drink Advertising

Lucy had *more* 'Food and drink adverts' than Sara; proportionally *more* 'LFS', 'HFS' and 'Limited' adverts but *fewer* 'Alcohol' adverts. For Lucy all adverts were on 'Food outlets', for Sara 91.7% were on 'Food outlets' and 8.3% in 'Other' locations.

Roads

Sara had *longer* ‘Total roads’ and slightly *higher* ‘Road safety’ score than Lucy. Sara’s neighbourhood had more street segments containing ‘Traffic control devices’ but slightly fewer ‘Cul-de-sacs’ than Sara’s.

Streets

Sara had *longer* ‘Total streets’ and *better overall* ‘Street quality’ score than Lucy. Sara’s neighbourhood had *better* street ‘Greenness’ and ‘Cleanliness’ (see Figure 78). Despite having *lower* ‘Street quality’ scores, Lucy’s neighbourhood had *more* ‘Attractive buildings’ and overall ‘Street attractiveness’ predominately owing to more open and expansive views (see Figure 77 top row right and second row centre images), *better* perceived ‘Safety’ and *lower* ‘Air pollution’.

Cycling Facilities

Neither case had any neighbourhood Cycling facilities.

4.36.2 Case Perceptions

Lucy (UHW *typical*) had *positive* perceptions of neighbourhood ‘Things to do’ and ‘Safety’ whilst Sara (UHW *deviant*) was *neutral* towards statements. Lucy had more *positive* perceptions than Sara of ‘Places to walk and cycle’ in the neighbourhood. Both cases *really agreed* they ‘Liked to be active and keep fit’ Lucy was more *positive* than Sara about ‘Being able to be active’ and vice versa for ‘Feeling better when active’.

Sara was more *positive* than Lucy about ‘Liking fruit and vegetables’, ‘Eating 5-a-day’, ‘Feeling better’ and ‘Being able’ to eat well. Lucy *really agreed* she was ‘Happy with [her] body shape’ whilst Sara *disagreed*.

Figure 77: Lucy's neighbourhood street segments sample

Figure 78: Sara's neighbourhood street segments sample

4.36.3 Parent Perceptions

Neighbourhood

Both case's parents responded to the survey. Both parents *agreed* their 'Neighbourhood was well maintained', and 'Crime rates', traffic 'Speed' and 'Density' were low. Lucy's parent (UHW *typical*) was *more positive* about 'Shops and services' and 'Walking and cycling routes' and *less negative* about neighbourhood 'Recreation and leisure services' than Sara's parent (UHW *deviant*). Lucy's parent was *positive* whilst Sara's was *negative* about neighbourhood 'Places to go', 'Rubbish' and 'Attractiveness'. Sara's parent was *more positive* about neighbourhood 'Food outlets' than Lucy's parent. Sara's parent was *positive* whilst Lucy's was *negative* about 'Public transport options', 'Street lighting' and 'Happiness for their child to be unsupervised' in the neighbourhood.

Physical Activity

Lucy's parent was *positive* about their 'Personal involvement with' and 'Attitude towards' PA, Sara's parent was *negative*. Both parents 'Encouraged their child to travel actively to school' and 'Took their child to places to be active'. Sara's parent reported 'Enrolling [her] in teams, clubs and community programmes' and 'Watching her participate in PA', Lucy's parent did not. Lucy's parent reported 'Encouraging her to be active in the neighbourhood', Sara's did not. Lucy's parent was more *positive* than Sara's about 'Enrolling [Lucy] in within-school clubs and classes' and 'Limiting time spent using the computer'.

Home Food Environment

Both parents reported *positive* 'Food access'. Lucy's parent reported slightly more *positive* 'Meal time practices' than Sara's. Both parents reported *some permissiveness* around their child's eating, Sara's parent marginally more.

4.36.4 Case Behaviour

Lucy (UHW *typical*) reported 579 fewer minutes' activity (all types) than Sara (UHW deviant). Proportionately *more* time 'Sedentary' and in 'Low' intensity activity but *less* time in 'Moderate' and 'Intense' activities than Sara (+8.1%, +1.8%, -5.3% and -4.5%).

Lucy spent *more* time in 'Other' locations, at 'School', 'Home' and in the 'Neighbourhood' than Sara, but *less* time in 'Parks and GSs' and 'Sports venues' (+16.3, +8%, +6.4%, +0.4%, -25.7% and -5.4%, respectively).

Clubs and Classes

Lucy reported attending one ‘Sedentary club’ in-school and two outside-school, and one ‘Active club’ outside-school. Accordingly she reported playing the ‘steel pans’ and the ‘harp’ at a music venue one on each weekend day each (120 and 30 minutes), ‘Choir practice’ and ‘Athletics’ after school on one day each (45 and 90 minutes). Sara reported attending four ‘Sedentary clubs’ in-school, but no time in this activity.

Recreation and Leisure Facilities

Lucy estimated park use frequency ‘Once–twice’ weekly but no time in these spaces during the recording period. Sara estimated park use ‘5–6 times’ weekly and 660 minutes in parks she: ‘Cycled’ with ‘Friends’ one weekend morning (10 minutes), ‘Played’ with ‘Friends’ both weekend afternoons (180 and 290 minutes) and ‘Played’ with friends on both school day afternoons (90 minutes each). Sara’s description of the play facilities within the park she ‘Played in’ matched researcher observations of park #7228.

Sara reported ‘Rock climbing’, ‘Trampolining’ and ‘Archery’ in a Leisure Centre with her ‘Teacher and friends’ as part of a school trip (140 minutes) (see Figure 79). Lucy reported no time in Sports facilities.

Figure 79: Sample of Sara’s school trip sports facility images

Neighbourhood Activity

Lucy estimated she played on the street ‘3–4 times’ weekly. During the reporting period she ‘Played out’ with ‘Friends’ one weekend afternoon (60 minutes). Sara reported she did not play on the street, but she reported ‘Walking’ ‘Alone’ one weekend morning (10 minutes) and ‘Cycling’ with ‘Friends’ one weekend afternoon (3 minutes).

Neighbourhood Active Travel

Sara travelled actively in the neighbourhood *more* than Lucy. Sara ‘Walked’ to the shops one weekend afternoon with ‘Friends’ (10 minutes), to and from the park ‘Alone’ one school day afternoon (40 minutes). She also ‘Cycled’ to the park with ‘Friends’ on both weekend afternoons (10 and 20 minutes), to the shops with ‘Friends’ one school day afternoon (20 minutes), and to and from school on one school day (15 and 25 minutes). Lucy ‘Walked’ to school on both school days with ‘Family’ (2 minutes both days) and then ‘Alone’ (3 minutes both days) and home from school on both school days with ‘Family’ (5 and 15 minutes each).

Dietary Intake

Lucy ate on average 8.25 *more* food items per day than Sara. More ‘Carbohydrates’ (by 1 food item), ‘Fruit and vegetables’ (2), ‘Dairy’ (3.25), ‘Fried/ high fat snacks’ (1.25), ‘Sweets and chocolate’ (1), ‘Puddings, deserts, cakes and biscuits’ (1.75) and ‘High calorie drinks’ (1); and less ‘Protein’ (1.25), ‘Sauces and spreads’ (0.25) and ‘Low calorie drinks’ (1.5).

Both cases fell well below 5-a-day recommendations reporting on average 3 (Lucy) and 1 (Sara) fruit and vegetables item daily.

Food Sourcing and Eating Location

Lucy sourced and ate food from ‘House’ on 12 eating occasions and from a ‘Food outlet’ on one occasion (school day lunch, food items: tuna mayonnaise sandwich, crisps and high calorie drink). She sourced food from ‘House’ eating at ‘School’ on three occasions and ‘Other’ location once. Food was sourced from a ‘Food outlet’ and eaten at ‘House’ on one occasion (weekend lunch, food items: cheese and tomato pizza, chocolate and high calorie drink).

Sara sourced and ate food from ‘House’ on 12 eating occasions and from ‘School’ on one occasion. She sourced food ‘House’ eating at ‘School’ and ‘Food outlet’ on one occasion each (latter school day morning snack, food item water). Food was sourced from a ‘Food outlet’ and eaten at ‘House’ on two occasions (weekend afternoon snack, food item low calorie drink; and weekend dinner, food items: cheese and tomato pizza, and two low calorie drinks).

Under and Healthy Weight Female Case Pair Key Differences:

- Sara (UHW deviant) had better access and proximity to 'Amenity' GSs than Lucy (UHW typical). Sara had less positive perceptions of neighbourhood 'Things to do' and her parent more negative perceptions of 'Neighbourhood recreation services' than Lucy and her parent. Sara spent more time in parks and GSs than Lucy
- Despite having no proximal neighbourhood Sports facilities (nor did Lucy) and her parents having negative perceptions of 'Neighbourhood recreation and leisure services' Sara spent more time in Sport facilities than Lucy (time was reported as part of a school trip)
- Lucy had better access but poorer proximity to 'All non-food shops and services' than Sara. She had more positive perceptions of 'Things to do' in the neighbourhood and her parent had more positive perceptions of 'Neighbourhood shops and services' than Sara and her parent
- Lucy had better proximal access to 'All food outlets' than Sara, but her parent had less positive perceptions of 'Neighbourhood food outlets'. Lucy used these facilities less often (by eating occasion)
- Lucy had marginally higher 'All food outlet' healthfulness but reported slightly less healthful food outlet usage than Sara (by food item)
- Sara had longer total 'Roads' and 'Streets' and better 'Road safety' and 'Street quality' scores than Lucy. She and her parent had worse perceptions of 'Places to walk and cycle in the neighbourhood'. Sara had more negative perceptions of 'Neighbourhood safety' but her parent more positive perceptions than Lucy and her parent. Lucy spent more time being active but Sara more time travelling actively in the neighbourhood
- Sara reported some time cycling despite having no neighbourhood Cycling facilities
- Lucy's parent was more positive than Sara's about enrolling Lucy in 'Within-school activity clubs', Lucy reported attending more of these clubs and spent

more time in this activity than Sara

- Lucy had slightly less positive attitudes towards activity and spent proportionally less time in ‘Moderate’ and ‘Intense’ activities than Sara
- Sara had more positive perceptions of her diet than Lucy but her parent reported less positive ‘Meal time practices’. Sara ate less ‘Total food items’ and ‘Fruit and vegetable’ items than Lucy

4.37 Female Overweight and Obese Case Pair

Correctly assigned OWOB case ‘OWOB *typical* case’ was case #405 aged 10 years nine months, BMI 24.3 (overweight). *Incorrectly assigned* OWOB case ‘OWOB *deviant* case’ was case #432, aged 10 years and 11 months, BMI 14.6 (underweight). Henceforth OWOB *typical* and *deviant* cases are referred to using the pseudonyms Ruth and Freya.

4.37.1 Physical Environment

Figure 80 and Figure 81 graphically illustrate case neighbourhoods and Table 65 enumerates neighbourhood facilities.

Parks and GSs

Freya (OWOB *deviant*) had *access* to Parks and GSs, Ruth (OWOB typical) did not. The ‘Amenity’ GSs contained in Freya’s neighbourhood #3008 and #3022 are described in detail in High Activity Reporter Case Pair, Physical Environment section 4.29.1 (Figure 47 on page 180). In short GSs contained high quality play and sports facilities and were perceived by researcher to be high quality, highly suitable for use by young people and with good atmospheres.

Sports Facilities

Neither case had any proximal neighbourhood Sports facilities.

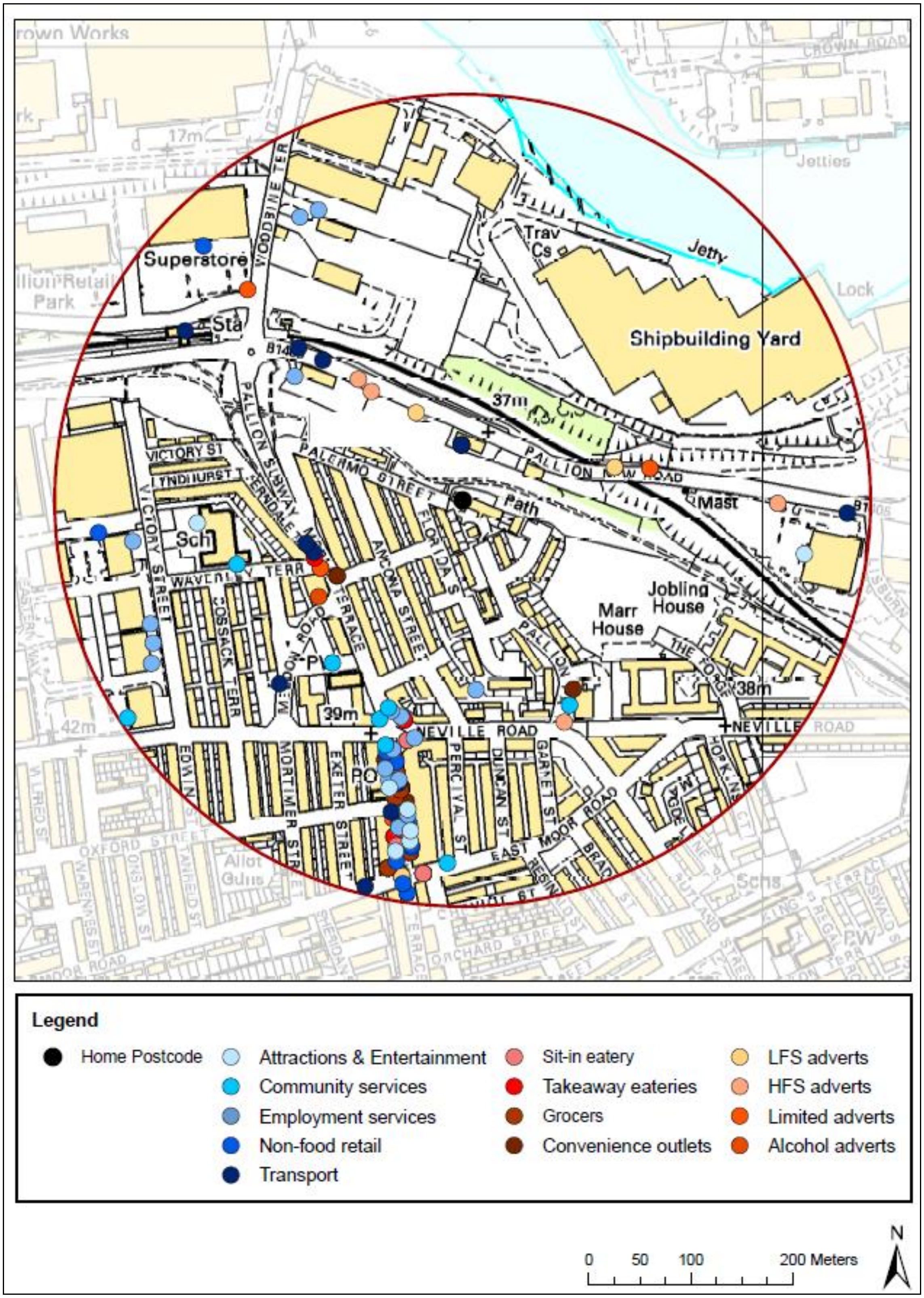


Figure 80: Overweight and obese typical female case Ruth (participant #405) neighbourhood environment (from postcode centroid)

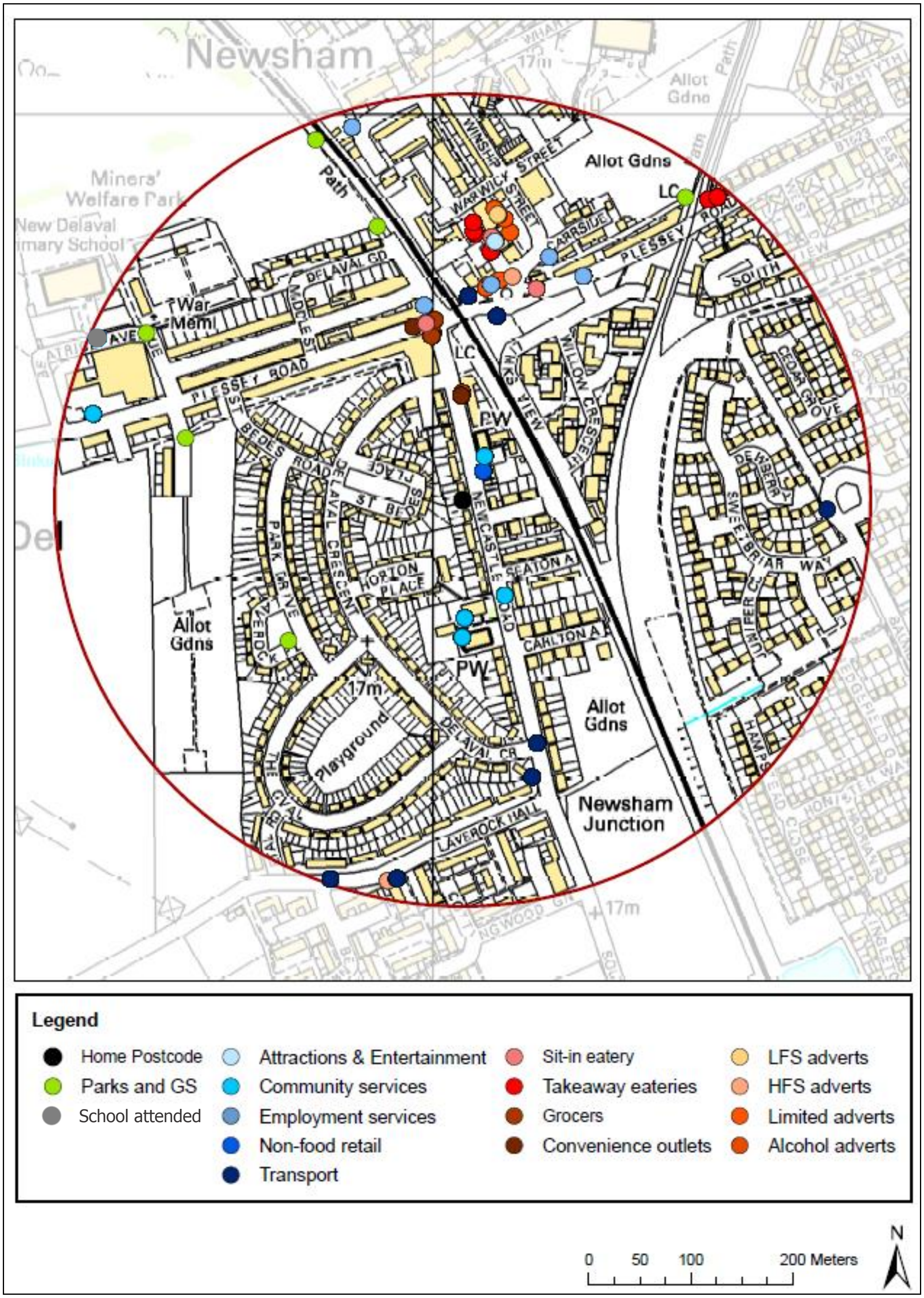


Figure 81: Overweight and obese deviant female case Freya (participant #432) neighbourhood environment (from postcode centroid)

Neighbourhood environment variables	Ruth (OWOB typical) N (%)	Proximity	Freya (OWOB deviant) N (%)	Proximity
Parks and GSs:				
Amenity	0		2	220
Semi-natural	0		2	279
Functional	0		0	
Sports facilities:				
Leisure Centres	0		0	
Other Sports facilities	0		0	
Non-food shops and services:				
Attractions and entertainment	7 (12.7)	261	1 (2.9)	257
Community services	8 (14.6)	205	6 (17.1)	48
Employment services	18 (32.7)	187	18 (51.4)	196
Retail outlets	11 (20)	259	3 (8.6)	35
Transport services	11 (20)	55	7 (20)	184
Food outlets:				
Sit-down eateries	2 (10)	344	3 (23.1)	180
Takeaways	6 (30)	154	6 (46.1)	249
Grocers	6 (30)	274	2 (15.4)	167
Convenience and incidental outlets	6 (30)	57	2 (15.4)	106
Food & Drink adverts:				
Low fat and/ or sugar (LFS)	55 (44)	99	21 (27.3)	167
High fat and/ or sugar (HFS)	40 (32)	57	17 (22.1)	106
Alcohol	18 (14.4)	170	10 (13)	106
Limited	12 (9.6)	153	29 (37.7)	10
Road length (metres):				
A roads	0		0	
B roads	914		1,007	
Minor roads	1,088		248	
Private roads (public access)	0		0	
Private roads (restricted access)	265		0	
Street length (metres):				
Local streets	5,390		6,383	
Alleys	2,526		853	

Table 65: Overweight and obese female case pair neighbourhood environment variable count (N), percentage (%), and proximity (in metres)

All Shops and Services

Ruth had *better access* but *worse* overall *proximity* than Freya to ‘Non-food shops and services’. Ruth had proportionately *more* ‘Attractions and Entertainment’ services and ‘Retail outlets’.

Ruth had *more* ‘Total food outlets’ and *closer* overall *proximity* than Freya. Ruth had proportionately *more* ‘Grocers’ and ‘Convenience and incidental outlets’ and on average a marginally *healthier* food environment (MFE +0.4%). The biggest difference in MFE by outlet grouping was ‘Sit-down eateries’ (8.4%). Within this category Ruth’s neighbourhood ‘Sit-in sandwich shop’ scored MFE 51.7% (‘Fast-casual pub’ was not audited). Freya’s neighbourhood outlets (‘Traditional restaurant’, ‘Fast-casual pub’ and ‘Café with deli’) scored an average MFE 43.3%. The second biggest difference was for ‘Takeaway eateries’ (6.2% MFE). Ruth had one ‘Greasy spoon type café’, ‘Takeaway sandwich shop’, ‘Retail baker’, ‘Traditional takeaway’ and ‘Takeaway with delivery option’ (first three outlets audited, see Figure 82). Freya had four ‘Takeaways with delivery option’ and two ‘Instant fast food outlets’ (one and both audited, see Figure 83). Though Ruth’s neighbourhood ‘Retail baker’ had the lowest MFE score Freya’s neighbourhood takeaways were consistently low scoring.

Figure 82: Sample of Takeaway eateries in Ruth’s neighbourhood

Figure 83: Sample of Takeaway eateries in Freya’s neighbourhood

Outdoor Food and Drink Advertising

Ruth had *more* food and drink adverts than Freya, proportionately more ‘LFS’, ‘HFS’ and ‘Alcohol’ adverts but fewer ‘Limited’ adverts. For Ruth 92.8% of adverts were on ‘Food outlets’, 5.6% by the ‘Road’, 0.8% in ‘Residential’ and ‘Retail’ areas each. For Freya 98.7% were on ‘Food outlets’ the rest in ‘Residential’ areas.

Roads

Ruth had *longer* ‘Total roads’ but *lower* ‘Road safety’ score than Freya. Freya’s neighbourhood had more ‘Traffic control devices’ and ‘Cul-de-sacs’ but fewer ‘Pedestrian crossing aids’ than Ruth’s.

Streets

Ruth had *longer* ‘Total streets’ than Freya but *lower* overall ‘Street quality’ score. Freya’s neighbourhood had *better* ‘Street greenness’ (see Figure 85), *less* ‘Graffiti’ and ‘Rubbish’ and *better* overall ‘Street attractiveness’, the latter owing mostly to having fewer ‘Alleys’. Ruth’s neighbourhood had on average *more* ‘Attractive buildings’ and *lower* levels of ‘Foul’ and ‘Air pollution’ (Figure 84).

Cycling Facilities

Neither case had any neighbourhood Cycling facilities.

4.37.2 Case Perceptions

Both cases *disagreed* there were ‘Lots of things to do’ and *agreed* there were ‘Many places to walk and cycle’ in their neighbourhoods. Ruth (OWOB *typical*) was *positive* about ‘Neighbourhood safety’ whilst was Freya (OWOB *deviant*) had *negative* perceptions. Both cases *agreed* they ‘Felt better when active’, Ruth was *more positive* than Freya about ‘Liking to be active and keep fit’ and vice versa for ‘Ability to be active and keep fit’.

Ruth was *more positive* than Freya about ‘Liking fruit and vegetables’ and was *neutral* compared to *negative* about ‘Eating 5-a-day’. Both cases *really agreed* they were ‘Able to eat well’, Ruth was more *positive* about ‘Feeling better’ when eating well. Ruth was more *positive* than Freya about her ‘Body shape satisfaction’.

Figure 84: Ruth’s neighbourhood street segments sample

Figure 85: Freya’s neighbourhood street segments sample

4.37.3 Parent Perceptions

Neighbourhood

Only Ruth's parent (OWOB *typical*) responded to the survey. They were *positive* about neighbourhood 'Shops and services', 'Public transport', 'Rubbish', 'Maintenance', 'Attractiveness' and 'Traffic speed'. But were *negative* about 'Recreation and leisure services', 'Places to go', 'Walking and cycling routes', 'Crime rates' and happiness for Ruth to be 'Unsupervised in the neighbourhood'.

Physical Activity

Ruth's parent reported *usually* 'Walking in the neighbourhood' and 'Exercising/ being physically active on a regular basis' but only *sometimes* 'Role modelling being active' and 'Enjoying exercise and PA'. They reported encouraging Ruth to 'Travel actively to school' and be 'Active in the neighbourhood', 'Enrolling her in clubs and classes', and limiting time she spent on the 'Computer' and watching 'TV'. But they didn't play an active role in Ruth's PA not 'Enrolling her in community programmes' or 'Within-school clubs', not 'Taking her to places to be active' or 'Watching her do PA'.

Home Food Environment

Ruth's parent reported *positive* 'Meal time practices', *healthy* 'Food access', and *non-permissive* around Ruth's 'Eating'. However, they did report *usually* 'Using food to reward Ruth' and *always* 'Substituting food according to Ruth's likes'.

4.37.4 Case Behaviour

Freya (OWOB *deviant*) reported an additional 15 minutes activity (all types) than Ruth (OWOB *typical*). Proportionately Freya spent *more* time 'Sedentary' and in 'Low' and 'Moderate' intensity activities and *less* time in 'Intense' activity than Ruth (+0.7%, +0.3%, +7.7% and -8.7%).

Freya spent proportionately *more* time at 'Home' and in 'Other' locations but *less* time in 'Parks and GSs', at 'School' and in the 'Neighbourhood' than Ruth (+6.9%, +0.3%, -3.5%, -2.9% and -0.1%).

Garden

Ruth reported she did not play in her garden, despite this she 'Played with her dogs' one weekend day with 'Family' (120 minutes). Freya estimated 'Playing in the garden' 'Once–twice' weekly and reported 'Running' 'Alone' on one weekend day (5 minutes). Freya reported having sports and play facilities in her garden (Figure 86); Ruth none.

Figure 86: Freya's garden

Recreation and Leisure Facilities

Ruth reported she did not play in Parks and GSs but she recorded 'Playing' in the park with 'Family' one weekend afternoon (60 minutes). Freya estimated park use 'Once–twice' weekly and reported 'Walking' in the park with 'Family' one weekend morning (10 minutes).

Freya's description of the park she 'Played in' did not match researcher's observation of proximal neighbourhood parks.

Neighbourhood Activity

Ruth and Freya estimated they played on the street '3–4' and '1–2' times weekly respectively. Freya reported 'Playing' in the neighbourhood with 'Friends' one weekend and school day afternoon (25 and 60 minutes each) and 'Walking' one weekend day afternoon with ‘Friends’ (20 minutes) and ‘Alone’ (10 minutes). Ruth reported no time active in the neighbourhood.

Neighbourhood Active Travel

Ruth ‘Walked’ with ‘Family’ to school on both days and home from school on one day (30 minutes each). Freya ‘Walked’ to and from school on both school days ‘Alone’ (10 minutes each).

Dietary Intake

Ruth ate on average 7.75 *fewer* food items per day than Freya. *Less* ‘Carbohydrates’ (by 1.5 food items), ‘Fruit and vegetables’ (0.75), ‘Protein’ (1.75), ‘Dairy’ (0.25), ‘Fried/ high fat snacks’ (0.75), ‘Sweets and chocolate’ (0.25), ‘Sauces and spreads’ (1) and ‘Puddings, deserts, cakes and biscuits’ (2); and *more* ‘High calorie drinks’ (0.5).

Both cases fell well below 5-a-day recommendations reporting on average 2.25 and 3 fruit and vegetables item daily, respectively.

Food Sourcing and Eating Location

Ruth *sourced* and *ate* food from ‘House’ on 15 eating occasions and from a ‘Food outlet’ on one occasion (weekend lunch, food items: burger, chips, ketchup and low calorie drink). She *sourced* food from ‘House’ *eating* at ‘School’ on one occasion and from a ‘Food outlet’ *eating* in the ‘Neighbourhood’ on one occasion (school day morning snack, food item high calorie drink).

Freya *sourced* and *ate* food from ‘House’ on 11 eating occasions and from ‘School’ on four occasions. She *sourced* from a ‘Food outlet’ *eating* at ‘House’ on two occasions (weekend dinner, food items: meat kebab in pita bread with salad, chips and garlic sauce and a high calorie drink; and school day dinner, food items: chicken pizza, chicken burger and low calorie drink).

Overweight and Obese Female Case Pair Key Differences:

- Freya (OWOB typical) had access to Parks and GSs, Ruth (OWOB deviant) did not. Both cases disagreed there were lots of ‘Things to do’ in the neighbourhood and Ruth’s parent had negative perceptions of ‘Neighbourhood recreation and leisure facilities’. Despite this Ruth spent more time in the parks than Freya
- Neither case had any proximal neighbourhood Sports facilities or reported any time in these spaces
- Ruth had better access but worse proximity to ‘All non-food shops and services’ than Freya. Both cases had comparable perceptions of ‘Things to do’ in the neighbourhood and Ruth’s parent had positive perceptions of ‘Neighbourhood shops and services’
- Ruth had better access, proximity and food outlet healthfulness than Freya. Freya reported greater frequency (by eating occasion) and less healthy food outlet usage (by food items) than Ruth
- Ruth had longer total ‘Roads’ and ‘Streets’ but poorer ‘Road safety’ and ‘Street quality’ than Freya. Ruth’s parent was unhappy for her to be ‘Unsupervised in the neighbourhood’. Freya spent more time *being active* but less time *travelling actively* in the neighbourhood than Ruth
- Freya reported having Sports and Play facilities in her garden, Ruth did not. Despite this Ruth reported more time playing in her garden
- Ruth spent proportionally more time in ‘Intense’ activity and less time ‘Sedentary’ and in ‘Low’ and ‘Moderate’ intensity activities than Freya
- On average Ruth ate fewer food items per day than Freya; she had more positive perceptions of her ‘Diet’ and ‘Body shape’

Chapter 5: Discussion and Conclusion

Key finding from CNES are discussed in this chapter. This section is sub-divided into the following four sections:

- CNES Population Characteristics are outlined and compared to the wider UK context;
- The Neighbourhood Environment section discourses environmental influence on health behaviours (PA and dietary intake) and outcome (BMI) according to environment variables;
- Strengths and Limitations of research approach, sample, methods and analysis are outlined;
- Finally Overarching Conclusions are presented.

Where appropriate throughout this chapter results, themes and critiques have been grouped to offer a balanced and insightful discussion.

CNES Population Characteristics

This chapter discusses CNES population characteristics comprising active and sedentary time, dietary intake and BMI in relation to published studies with preferential focus on nationally representative UK data.

CNES population characteristics are discussed sequentially in relation to health behaviour and health outcomes: PA, dietary intake and BMI.

5.1 Physical Activity

CNES participants reported active and sedentary time was compared to national (preferentially) and international datasets in this section.

5.1.1 Active Time

The Health Survey for England (HSE) state 25.8% of young people aged 10–11 years self-reported 60 minutes of at least moderate intensity physical activity daily (Pickup and Gunning, 2009). In the CNES sample 91.7% participants self-reported meeting this level of PA over a four day average. CNES participants self-reported *walking* and participating in *formal sports* more than national average rates for males +25.7%, +39% and females +27.5%, +21.1% respectively.

In accordance with HSE data and literature from the UK, male CNES participants reported more time in intense (or vigorous) PA than female participants (Riddoch *et al.*, 2007; Coombes *et al.*, 2013). Time self-reported by CNES participants at intense activity was notably higher than objectively measured data from Coombes *et al.* (2013)[44] and Esliger and Hall (2009)[45] +59 and +75 minutes per day for CNES males participants and +32 and +43 minutes for CNES female participants.

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[44] Sample: 100 children aged 9–10 years from Norfolk, UK.

[45] Sample: 770 children aged 4–15 years from the UK, focus participants aged 8–11 years.

CNES female participants self-reported significantly more time in low and moderate intensity activity than male participants. This was contrary to objectively measured evidence from Coombes *et al.* (2013) and Esliger and Hall (2009) which found males reported more time at all activity intensities. This discrepancy may be attributable to mismatch between accelerometer and CNES MET assigned activity intensity cut-off points.

The largest differences in time spent active (by intensity categorisation) and companion was between males and females at higher intensity activities. Male CNES participants spent proportionately more time (as a percentage of total time) in intense activity with friends than females (+5.5%); female participants spent more time in moderate intensity activity with friends (+4.1%). In their qualitative study on UK 10–11 year olds Jago *et al.* (2009a) reported *sporting prowess* was a key status symbol for males but not females in this age group. It is reasonable to assume that this finding from CNES echoes this finding. This was echoed in a follow-up paper by Brockman *et al.* (2011) which reported a preference for males to participate in PA with friends and females with family.

5.1.2 Sedentary Time

In the CNES sample mean sedentary time was 4 hours 17 minutes per day for male participants and 3 hours 31 minutes for female participants (over a four day average). For both genders this was higher than self-reported weekday UK national average time (3.4 hours), similar for males on weekend days (4.1 hours) and lower for females on weekend days (4.2 hours) (Pickup and Gunning, 2009).

CNES participant's self-reported sedentary time was notably lower than objectively measured (accelerometer) data from Vissers *et al.* (2013)[46] and Esliger and Hall (2009) -209 and -167 minutes per day for CNES male participants and -262 and -238 minutes for CNES female participants. It was also lower than objectively measured data for young people aged 10–14 years from New Zealand – average

[46] Sample: 1,317 children aged 9–10 years from Norfolk, UK.

170 minutes (Foley *et al.*, 2011) and aged 11 years from Australia – average 107 minutes male and 165 minutes female participants (Telford *et al.*, 2013).

Over estimation of activity and underestimation of sedentary time is a common place critique of activity self-report measures and is discussed in Methodology and Methods Chapter 3 sections 3.10 and 3.11.

5.2 Dietary Intake

Socioeconomic patterning in weight status and dietary intake is well established both nationally and across Europe (Buttriss, 2002; Nelson *et al.*, 2007; Marmot, 2010; Knai *et al.*, 2012). Consistent with findings from Nelson *et al.* (2007) and Buttriss (2002), fruit and vegetable consumption was lower in more deprived CNES participants compared to their more affluent peers. As socioeconomic status was used as a control factor rather than an outcome/ interest variable full interrogation of this was beyond the scope of this study. Literature broadly suggests socioeconomic status affects: food outlet access, food spend, knowledge of nutrition and is linked to food preparation/ cooking proficiency at the family-level (Winkler and Turrell, 2009; Fismen *et al.*, 2012; Hough and Sosa, 2014).

In CNES participants BMI was not associated with intakes of any single food group, this is noteworthy when considered alongside the Eatwell guidance (Food Standards Agency, 2007) which outlines the need for a balanced diet to maintain health and a healthy weight. The public health message here is that consumption of any single food groups outside the proposed ‘balance’ is to be avoided. This finding points to a need to consider energy intake in its entirety in accordance with the energy balance equation to fully predict or associate BMI. Nevertheless it is useful to compare CNES dietary intake by food group to national datasets for comparison.

CNES participant’s dietary intake is compared to the National Diet and Nutrition Survey (Department of Health and Food Standards Agency, 2012b); this section should be interpreted cautiously in light of previously acknowledged self-report and portion size biases (Methodology and Methods Chapter 3 sections 3.10 and 3.11).

5.2.1 Carbohydrate

In the CNES population carbohydrates represented 17.4% of total diet (by food item intake); this is markedly lower than the Dietary Reference Value for carbohydrates: 50% of food energy (Department of Health and Committee on Medical Aspects of Food Policy, 1994) and NDNS findings for children aged 4 to 10 years reported at 51.9%.

5.2.2 Fruit and Vegetables

In contrast to findings from the NDNS, female CNES participants reported higher fruit and vegetable intakes than male participants. Male and female CNES participants ate on average 0.9 and 0.1 fewer portions of fruit and vegetables than national averages for young people aged 11–18 years (Department of Health and Food Standards Agency, 2012b).

The HSE found 3.5% males and 2.5% females aged 10–11 years reported less than one portion of fruit and vegetables per day (Jotangia, 2009); these figures were lower than those reported by the CNES population by -7.6% and -0.7%, respectively. For male CNES participants, a notably higher proportion of the study sample ate 1–2 daily portions (+21%) and notably fewer ate higher intakes: 4–5 daily portions (-6.6%) and 5+ daily portions (-17.8%) than HSE males aged 10–11 years. For female CNES participants notably more ate 2–3 daily portions (+22.5%) and fewer ate higher intakes: 4–5 (-5%) and 5+ portions per day (-14.2%) than HSE females aged 10–11 years.

5.2.3 Protein

CNES male participants ate on average more protein than female participants; this is in accordance with NDNS gendered findings. NDNS report males ate 115 grams (g) and female’s 83g of meat per day (Department of Health and Food Standards Agency, 2012b); CNES found male participants ate 1.7 portions and females 1.5 portions. If a portion is assumed as 80g then CNES participants reported more meat than the average 11–18 year old (+21g and +37g). A similar pattern was observed for fish (+13g and +6g).

5.2.4 Foods and Drinks High in Fat and/ or Sugar

Less healthful foods[47] comprised 21.9% males and 20.5% female's aged 11–18 years total dietary intake in the NDNS sample (Department of Health and Food Standards Agency, 2012b). This is notably lower than CNES male +15.9% and female participants +14.3%. This may be because the CNES sample ate considerably more of these foodstuff or it may be a consequence of the broad ranging definition of this food group.

5.3 BMI

Figure 87 shows CNES participants (n=108) had higher than *national* and *regional* average rates of underweight and higher than *national* and *regional* average rates of obesity (Department of Health *et al.*, 2012). Male CNES participants (n=52) had higher than *national* and *regional* average rates of under (+7.8% and +9.7%) and healthy weight (+8.2% and +11%); and lower than *national* and *regional* average rates of overweight (-3.6% and -3.8%) and obesity (-14% and -15.4%). Female CNES participants (n=56) had higher than *national* and *regional* average rates of under (+12.7% and +13.6%) and over weight (+10.7% and +10.5%); and lower than *national* and *regional* average rates of healthy weight (-12.2% and -8.3%) and obesity (-11.4% and -15.8%). As per *national* average female CNES participants had higher average BMIs than male participants.

High levels of underweight and low levels of obesity may have been attributable to recruitment bias. Selection of low obesity prevalence rate schools may be the reason for high levels of low weight participants (see section 3.5.3 on page 46). If this was the case however, it could be expected that the same would follow for obesity rates which was not the case. Teachers dictating the recruitment of pupils may have favoured lower weight participants, alternately it is postulated that obese

[47] Comprising: Fried/high fat snacks, Puddings, deserts, cakes and biscuits, Sauces and spreads, Sweets and chocolate and High calorie drinks.

pupils may have opted-out of participation at the stage of study not seen by the researcher i.e. at the teacher led pre-researcher stage. As anthropometric data was only collected on the students included in CNES (i.e. not the full class) comparison cannot be made consequently this conjecture cannot be verified.

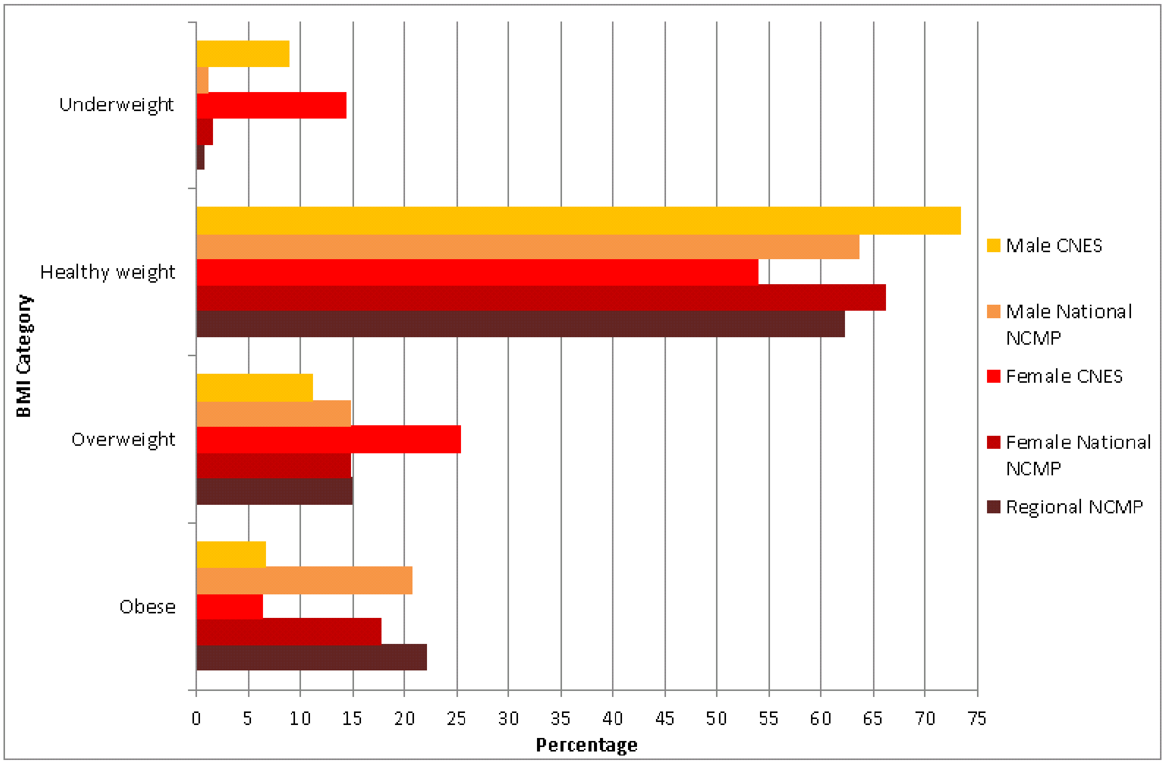

Figure 87: BMI category prevalence rates for CNES, National and Regional NCMP, by gender

CNES population characteristics summary:

The CNES population was poorly representative of UK national average 10–11 year olds when compared to NDNS national dataset; this was likely due to the targeted case study site location: high and low school-level obesity prevalence and high and low area-level affluence. CNES participants were: lighter (according to BMI), more active, and had less favourable dietary intake (lower fruit and vegetable intake and higher less healthful food intakes).

Neighbourhood Environment Influences on Physical Activity, Dietary Intake and BMI

This chapter discusses neighbourhood environment influences on PA, dietary intake and BMI according to binary logistic regression associations. How young people interact with their neighbourhoods is first discussed then the section is sub-divided thematically according to neighbourhood environment facilities/ amenities/ resources: Parks and GSs, Sport Facilities, Land Use Mix (comprising non-food shops and services and food outlets), Outdoor Food and Drink Advertising, Roads, Streets and Cycling Facilities. Neighbourhood environment sub-section influences on health behaviours (PA and dietary intake) and outcome (BMI) are discussed in turn.

This chapter is sub-divided into seven sections according to neighbourhood environment facilities/ amenities/ resources; neighbourhood attributes are discussed in turn. Results are summarised in Table 66.

5.4 The Neighbourhood

CNES results indicate that the neighbourhood (400 metre peripheral home postcode buffer) is an important resource for young people aged 10–11 years (n=108), with approximately 15% of overall time recorded within this space. This is broadly consistent with objectively measured findings from Coombes *et al.* (2013) and Wheeler *et al.* (2010). These authors reported 10.9% time (of which was outside home) in British children aged 9–10 years old and 9% total time in British children aged 10–11 year olds, respectively. The substantial amount of time reported in the neighbourhood signposts that it has considerable potential to influence behaviour.

Neighbourhood amenity	PA	Dietary intake	BMI
Parks and GSs		+	–
- *Amenity*	**+***		
- *Functional*	–		
- *Semi-natural*	–		
Sports facilities		–	+
- *Public*	–		
- *Private*	–		
- *Other*	+		
High land use mix	**–***		**– ***
- *Non-food shops and services*		–	
- *Less healthful food outlets*		+	
Food advertising (less healthful)	N/A	+	N/A
Walkability			
- *A road length*			–
- *Road length*	**+***	+	+
- *Road safety*	–		–
- *Street length*	**+***	–	–
- *Street quality*	–		+
Cyclability	–	N/A	**+***

+ Favourable / – Unfavourable health outcome (i.e. high PA, healthful dietary intake, low BMI)
**** Significant** p<0.05 level*

Table 66: Summary of neighbourhood environment amenities and health outcome associations

In the Focus Group, young people asserted the neighbourhood was used predominately for PA. CNES participants reported the majority of their time in the neighbourhood being moderately active, approximately 50% time, active travel was the most common activity in the neighbourhood. This is broadly consistent with Coombes *et al.* (2013) assertion that *"roads and pavements also appear supportive of bouts of MVPA [moderate to vigorous PA], possibly reflecting the fact that children use them for walking trips"* (p.64). Proportion of time spent in intense activity (i.e. PA/ sports) was approximately 33% and sedentary 17%.

Neighbourhood environment facilities/ amenities/ resources and their association with health behaviours and outcomes in young people shall now be discussed in turn in relation to UK literature. Where UK literature is absent international studies are used for comparison.

5.5 Parks and GSs

Within the CNES population access to parks and GSs was high, 82.4% participants had at least one accessible facility within their neighbourhood. The UK National Planning Policy Framework (NPPF) states that *"access to high quality open spaces and opportunities for sport and recreation can make an important contribution to the health and well-being of communities… assessments should identify specific needs and quantitative or qualitative deficits or surpluses of open space, sports and recreational facilities in the local area. Information gained from the assessments should be used to determine what open space, sports and recreational provision is required"* (Communities and Local Government, 2012 Article 8, Section 73). Though this policy does not set out clear guidelines on access and proximity it highlights the role of GS in facilitating public health and the need for planners to provide this within developments.

The, slightly outdated, Natural England Report (1995) recommended 280m was a reasonable straight-line distance to access on foot between home and natural spaces for able-bodies adults and children (Harrison *et al.*). Though the majority of CNES participants' access fell within this criterion, 17.6% had no proximal parks or GSs within 400 meters and 13.9% had access beyond 280m. Likewise the Natural England Accessible Natural Greenspace Standard (ANGSt) recommends within 300m from home proximity to accessible Natural GS (>2 hectares) (Natural England, 2010). Using the CNES Semi-natural GS definition (consistent with ANGSt Natural GS definition) only 22% (n=24) CNES participants met this criteria. Both of these standards, and the diminutive proportion of CNES participants meeting the recommended standards, indicate a need for assessment of guidance adherence to ensure good and equal access to parks and GSs for all.

5.5.1 *Physical Activity*

Access[48] to all types of park and GS was *positively* associated with participant PA in the CNES population. Access to *Amenity* GSs, which refers to traditional parks (e.g. spaces containing open GS and playground facilities), had statistically significant positive association with PA whereas *Functional* and *Semi-natural* GSs had non-statically significant associations.

The stronger association with Amenity GS detected in CNES results aligns with qualitative findings from Pearce *et al.* (2009) in their research with UK 9–11 year olds; authors reported knowledge of available resources (e.g. skate parks, and basketball courts) were key correlates of park usage. Such resources would more commonly be found in Amenity than Semi-Natural and Functional GSs. Interestingly CNES' findings are inconsistent with those from Ward Thompson *et al.* (2006) in their Natural England report where the value of wild adventure space (broadly consistent with Semi-natural GS) was esteemed above that of formalised Amenity GS. In this report authors discuss the attraction to risky and adventurous activity, especially for adolescent boys, within environments that offer physical challenge. Though this report was focussed on young people older than CNES participants (12–18 years) this disparity is worthy of note. CNES Amenity and Semi-Natural GSs were consistently found to be high quality mixed environment spaces, in the main containing both formalised playgrounds and exercise/ play areas (see Figure 39, on page 151). Mixed environment types are enabling of both structured and unstructured play. Amenity GSs in CNES tended to have a wider variety of playground structures and exercise/ play areas which may explain greater appeal, resultant use and consequent stronger association with PA.

The positive association between park access and PA is the expected direction; the statistical significance of the result is surprising when considered alongside the proportionately low duration of time spent in parks and GSs by CNES participants:

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[48] Access refers to facility/ amenity count as per regression analysis variables; this is the case throughout this section of the thesis.

males 5.8% and females 4.1% total reported time. Interestingly this result was notably higher than objective measurement of the same variable in the large scale (n=1,307) UK based study on children aged 10–11 years by Wheeler *et al.* (2010): +3.7% males and +2.2% females. This may be indicative of over-estimation of time in these spaces by CNES participants and therefore skewed association. Despite the proportionately low level of total time reported in parks and GSs activity intensity reported within these spaces was almost exclusively moderate and intense. Furthermore for males and female CNES participants respectively 16.2% and 13.3% of total moderate activity and 13.1% and 2.4% of total intense activity was reported within these spaces. Parks and GSs therefore appear to be important PA resources for young people. This finding is consistent with UK literature: time spent by young people outdoors and specifically within parks and GS is consistently positively associated with moderate–vigorous activity (GreenSpace, 2007; Jones *et al.*, 2009; Wheeler *et al.*, 2010; Gallo *et al.*, 2014a).

The greater proportion of total time reported in parks and GSs by male CNES participants is consistent with findings from Gallo *et al.* (2014a) which found majority young male park users in a small scale study of urban parks within the North East. And is consistent with qualitative investigation of young people 10–11 years (n=77) by Brockman *et al.* (2011). In a focus group of UK young people aged 10–14 years Tucker and Matthews (2001) found that females believed that parks were predominately for boys and that they were not welcome in these spaces. This *gendered use* of space may in part explain the disparity in total moderate and intense PA between male and female CNES participants.

Male CNES participants reported more time in intense activity in parks and GSs than female participants (+29.2%); females reported majority moderate activity in these spaces. This behavioural outcome aligns with CNES participant surveyed preference of favourite activity to do within parks and GS; 17.6% more and 12.2% fewer male than female participants reported preference for vigorous and moderate intensity activity in these spaces respectively. This skewing towards male intense activity participation may be explained by the previous discussion on sporting prowess being a status symbol in male but not female young people (Jago *et al.*, 2009a). Or may be a consequence of females being driven out of play spaces by males; this was particularly highlighted by Tucker and Matthews (2001) in the context of playing fields and recreation grounds which are key sites for intense (sporting) activity.

CNES participant and parent/ guardian perceptions of park and GS access and proximity and things to do within the neighbourhood were not linked to objective measurement. This is disparity, and the complexity in the relationship, between *provision* and *perception* is well illustrated across the detailed case studies, here are four illustrative examples: in the under and healthy weight (UHW) male case pair Chris showed better access, perception and parent perception of parks and GSs than Tom, this resulted in greater usage i.e. access, proximity and perception all aligned. In the UHW female case pair Sara had better access and proximity, less positive perceptions, and her parents more negative perceptions of parks and GS than Lucy, this resulted in greater usage i.e. proximity was the overriding factor. In the overweight and obese (OWOB) female case pair Ruth had poorer access, poor personal and parent perceptions of parks and GSs but reported more time in these spaces than Freya, i.e. there appeared to be an influencing factor beyond that of access and perception. In the high activity (HA) case pair James had better access and proximity, his parent had more positive perceptions of parks and GSs than Chloe but neither case reported any time in these spaces i.e. access and perception do not always result in usage. Lachowycz and Jones (2013) included park and GS access, proximity, perception and awareness within the multiple influencers on park use in their theoretical framework of GS and health. Within this framework, and across literature, factors influencing perception are widely debated to include: socioeconomic position, social disorder, gender, race, age, prejudice etc. There is little clarity amidst this complexity and CNES results do little to further explain any mediating effects.

In a national satisfaction survey of Britain's parks and GSs, the Park Life Report, over a third of children (aged under 16 years) reported that they travelled for ten minutes or more to visit a park that they consider met their needs (GreenSpace, 2007). This is notable in light of CNES 400 metres buffer definition of neighbourhood. If CNES participants' definition of perceived *access* corresponded with the 10+ minutes travel, as per the Park Life Report, then access *perception* would not necessarily align with *objective measurement* in CNES, i.e. 10 minutes' walk/ cycle is beyond the 400 metre scope of CNES study. This raises a significant challenge to CNES methods and may render perception data, within this context, null. Findings from the CNES focus group add further weight to this challenge, here young people reported use of neighbourhood facilities as acceptable if they were: across a road, a mile away or 5–30 minutes away. This highlights the inconsistency in young peoples' understanding on access.

To conclude, the ubiquity of parks and GSs, and their free cost, make them a valuable resource for promoting youth PA. There is significant opportunity to increase the amount of time children spend in these spaces and with that the opportunity to improve time spent physically active by this population group, due to their inherent use of these spaces for moderate and vigorous activity. Access to parks and GSs was shown to be not equal, in light of emphasis in the NPPF to promote healthy communities, urban planners and developers need greater understanding of the role that parks and GSs play in public health to ensure the health benefits of these spaces are able to be enjoyed by all. More work is needed to better understand the relationship between park access, proximity, perception and usage – clearer understanding of this would best enable targeted interventions within and public health guidance for these spaces.

5.5.2 Dietary Intake

Healthful dietary intake and neighbourhood park and GS access showed a non-significant *positive* trend in CNES participants. To authors knowledge only one other study has studied and observed this association: Carroll-Scott *et al.* (2013) in their study of 9–11 year olds from the US. In their discussion, authors postulated that the mechanism for this association was two-fold: firstly, accessible parks and GSs provide an overarching positive health experience which impacts behaviour beyond that associated with activity within these spaces; secondly parks and GSs provide an alternative to loitering at convenience stores or fast food outlets which would viably lead to food purchase from these outlets. An alternate mechanism is that of positive healthy environment selection i.e. those who take an active interest in health (both PA and diet) preferentially live close to parks and GSs. This was beyond the scope of study and therefore cannot be validated; it is nonetheless worthy of further investigation.

In their detailed case study of two urban parks within the North East Gallo *et al.* (2014a) profiled the *types* of food outlets surrounding two parks within the North East (400m peripheral buffer). Authors found that the majority of peripheral park food outlets were Convenience and Incidental outlets or Takeaway eateries. Though Gallo *et al.'s* work did not associate access, to parks and food outlets, with dietary intake this provides a question about the observed positive association in CNES. The role of the peripheral park food environment was also discussed in the CNES focus group – young people talked about eating sweets and fast food from shops proximal to parks and the temptation these food outlets affected when near to recreational spaces. CNES participants reported a very low proportion of total dietary intake within parks and GSs: 0.8% and 0.2% in male and female participants respectively which indicates limited potential of this potential negative influence. To fully explore this greater interrogation of the peripheral food environment to parks and GSs in CNES would be required which was beyond the scope of study.

The exact mechanism for the association between park and GS access and healthful dietary intake is not fully understood and there is a need to complete further investigation of direction and causality. Greater understanding of these links may enable urban planners to intervene and help e.g. by preventing the proliferation of unhealthy food outlets near parks. Nevertheless parks and GSs are shown to have health behaviour impacts beyond those of PA alone which further asserts the value of these spaces for health promotion.

5.5.3 BMI

Counter-intuitively park and GS access showed a non-significant *positive* trend with higher BMI in CNES participants. This finding is particularly surprising when considered alongside the positive health behaviour associations discussed in sections 5.5.1 and 5.5.2. In their systematic review of GS and obesity Lachowycz and Jones (2011) reported just 66 papers pertaining to this field and very few investigating association in young people, studies from outside the UK will therefore necessarily be used for comparison with CNES results.

Results from studies associating parks, GS and BMI are decidedly inconsistent. In the only UK study to authors knowledge Cetateanua and Jones (2014) reported *negative* association between MSOA greenness and prevalence of overweight and obesity in young people aged 4–5 and 10–11 years. *Positive* association between neighbourhood GS and BMI was also reported by three studies from the US: Ohri-Vachaspati *et al.* (2013) reported positive association between BMI and presence of large neighbourhoods parks (800m buffer) in 702 young people aged 3–18 years. In their large-scale longitudinal study of youth aged 9–10 years (n=3,173) Wolch *et al.* (2011) reported neighbourhood access to parkland (within 500m) and recreation programs (within 10km) were significantly positively associated with healthy BMI outcomes attained at age 18. And Bell *et al.* (2008) reported significant negative association between neighbourhood greenness and increase in BMI over two years in their large-scale longitudinal study of deprived young people aged 3–16 years from the US (n=3,831). Conversely in their study of 108 Canadian young people, aged 2–17 years, Potwarka *et al.* (2008) reported *no* association with park access, proximity or park size and the odds of being classified as healthy weight.

Mixed results are not well understood or debated and there is a clear need for more research in this field. Broadly the assumed mechanism for *positive* association between GS and BMI is the role of GS in facilitating PA. The mechanism for *negative* association is not well understood and is not explained by CNES results. Potwarka *et al.* (2008) attribute *their* counter-intuitive results to a flawed research design relying heavily on a small sample size and self-reported behaviours, this is consistent with CNES methods and may in part explain the negative result reported. Potwarka *et al.* also indicated that young people will travel to preferred parks and GSs, based on social and amenity preferences, this limits the role of *local* parks in young people's PA and consequent BMI. This may be a contributing factor to the CNES result especially in light of the small geographical scale used. Previous discussion of the Park Life Report (section 5.5.1) is also relevant to this argument (GreenSpace, 2007).

In conclusion park and GS access showed a non-significant trend for positive association with higher BMI in CNES participants. The mechanism for this result is not well understood and there is wide ranging inconsistency in findings from literature. The association between PA and GS is well established and is in the expected direction – park access and proximity facilities PA in young people (section 5.5.1). As discussed in section 5.5.2 however the association between parks, GS and diet is scantly studied and therefore poorly understood. With limited understanding of park and GS influence on energy intake the well-established findings on energy expenditure appear to not fully predict energy balance, or BMI. More investigation of direction and causality is needed on park and GS association with BMI, and the role of energy intake within this field.

Park and GS influence on PA, dietary intake and BMI summary:
Parks and GS showed statistically significantly positive association with PA in the CNES population. Amenity GS was shown to be the most important GS type in the facilitation of PA feasibly owing to the high quality mixed facility and environments observed within this GS typology. Activity within parks and GSs was predominately moderate and intense; this indicates parks and GSs are important locations for PA in young people. Male CNES participants reported more time in parks and GSs and within these spaces they were more likely to undertake intense PA than female

participants. This was hypothesised to be linked to preference, social desirability and perceived permission to be within these spaces. Park and GS provision and young people's or parent's perceptions of this provision did not align; this was not well explained in CNES but may in part be owning to a flawed CNES research design of access measurement.

Access to neighbourhood parks and GSs were positively, but not statistically significantly, associated with healthful dietary intake in the CNES population. The mechanism for this association was not fully explicated but authors propose that access to natural spaces is linked to a holistic positive health experience; parks and GS offer an attractive alternative to hanging around in shopping areas which feasibly lead to purchase and consumption of convenience and fast foods; and those with an active interest in health may preferentially live close to parks and GSs. The proportion of total diet consumed within parks and GSs was limited therefore the role of the peripheral park food environment, though discussed in the focus group as being influential, may be of limited importance when taken in the context of total diet. Nevertheless this is an area of study worthy of more investigation.

BMI association with park and GS access showed negative association in the CNES population, the association was not statistically significant. This was poorly explained by the CNES results and wide inconsistency in the wider literature further confused interpretation. Authors proposed that poor understanding of the association between parks, GSs and the role of energy intake in the energy balance equation within these spaces was the cause of inconsistent results; more study was recommended.

5.6 Sports Facilities

Sports facilities were present in 53.9% CNES participant's neighbourhoods. The NPPF (2012), as quoted in section 5.5, highlights the importance of access to sports and recreation facilities to facilitate health and well-being. There is no requirement in this policy framework for neighbourhood-level access to these facilities.

5.6.1 Physical Activity

Access to neighbourhood *public* and *private* sports facilities were *negatively* associated with CNES participant PA whilst access to *other* sports facilities showed *positive* association. No associations were statistically significant and therefore represent directional trend only. To authors knowledge sports facility access has not been investigated in relation to young people's PA within the UK, international studies are consequently used for comparison.

CNES is the first study to author's knowledge to report *negative* association (non-significant) between neighbourhood sports facilities and PA. Seven studies employing objective measurement of neighbourhood sports facilities reported *null* association with PA in young people. In their cross-sectional analysis of 852 adolescents aged 12-13 years from the Netherlands Prins *et al.* (2012) reported no association between access to sports facilities and parks (within 1600m neighbourhood buffer) and self-reported leisure time sports participation. In an earlier study from the Netherlands Prins *et al.* (2009) similarly reported no association between self-reported PA and access to parks and public sports facilities (n=654, age 12–15 years) within a 1500m neighbourhood buffer. In their cross-sectional multi-site neighbourhood-level scale of 422 children aged 6–11 years from the Netherlands de Vries *et al.* (2007) reported no association with objectively measured sports facility access and PA. In a sample of 209 Australian young people aged 10–12 years Prins *et al.* (2011) reported no associations between sports facility access and objectively measured PA at three neighbourhood buffer sizes: 400, 800 and 2000 metres. In their study of 192 adolescents aged 14 years from the US Graham *et al.* (2011) reported neighbourhood access (800m buffer) to PA resources (including sports facilities, parks and GSs) showed no association with either objective or subjective measures of PA. Patnode *et al.* (2010) reported null association between proximity to recreational centres, within a 1600m neighbourhood buffer, and objectively measured PA in male but not female adolescents from the US (n=349, 10–17 years). In their study of 799 young people aged 11–15 years from the US Norman *et al.* (2006) similarly reported null association between proximity to recreational centres and objectively measured PA in male but not female adolescents (1600m neighbourhood buffer).

Conversely six studies from the US reported *positive* association between Sports facilities and PA in young people. Two studies employing objective measurement of sports facilities and objective measurement of PA: in females aged 10–17 years by Patnode *et al.* (2010) and 11–15 years by Norman *et al.* (2006). Four studies employing objective measurement of sports facilities and subjective measurement of PA: Gordon-Larsen et al., in their large-scale study of 17,766 adolescents aged 12–17 years using a 5 mile neighbourhood buffer, reported use of a community recreation centre was positively associated with PA (2000), and reported positive association between PA and having a single neighbourhood PA facility and a higher number of facilities (facilities included public, private, parks and GSs) (2006). Slater *et al.* (2010) reported similar findings, at the school postcode level, in their large-scale sample of 36,929 adolescents aged 14–16 years: the presence of commercial PA outlets was significantly positively associated with PA. In their large-scale sample of 101,693 adolescents aged 14–18 years Powell *et al.* (2007) reported a statistically significant, but very small (0.22%) association between availability of commercial PA-related facilities at the postcode level and youth PA. Lin and Yu (2011) also reported positive perceptions of neighbourhood leisure facility access were positively related to leisure trip generation in Chinese children aged 6–14 years.

Notably all studies reporting exclusively *positive* association between sports facility access and PA used very large neighbourhood scales: 5 miles and postcode levels. It is well established that the larger the buffer size the greater the opportunity for confounding by loss of sensitivity (i.e. higher likelihood that in a larger buffer area there would be at least one facility suitable for adolescents' needs) and bias from *other*, un-controlled for, neighbourhood environment factors.

Definitions of sports facilities included parks and GSs in four of the studies asserting *null* association and one which reported *positive* association with PA. Following the fairly conclusive discussion in section 5.5.1 – positively associating parks and GSs and youth PA, it is reasonable to postulate that *negative* association may have been reported in the four *null* association studies separated parks and GSs from sports facilities i.e. inclusion of parks and GS produced a false *null* rather than *negative* association.

The mechanism for *positive* association between sports facilities and PA is clear; the reasons for *null* and *negative* associations however are less obvious. Deterrence of PA by neighbourhood sports facilities reported in CNES is problematic especially when taken in conjunction with CNES findings showing the majority of time reported in sports facilities was intensely active: 91.8% and 94.2% time reported by male and female participants, respectively. Moreover 30.4% and 26.7% of total intense PA was reported in sports facilities by male and female participants, respectively. Inherently flawed self-report research methods for reporting PA may, in part, be the cause of this result.

Another possible explanation is that individuals motivated to be physically active in sports facilities do not see neighbourhood access, or lack thereof, as a defining factor for use. They may be willing to travel to these facilities or may preferentially use alternate neighbourhood resources for PA. Alternately, sports facilities within environments surrounding school, friend's houses or parent's workplaces may be more important influences on PA and use than resources within young people's own neighbourhood environments conceivably owing to convenience factors.

Perception rather than objective *provision* of neighbourhood sports facilities may be of greater importance to PA in young people. Consistent with this argument studies on young people's perceptions of sports facility access from Belgium (Deforche *et al.*, 2010), the US (Mota *et al.*, 2005; Evenson *et al.*, 2006; Heitzler *et al.*, 2006; Rosenberg *et al.*, 2010; Carroll-Scott *et al.*, 2013), the Netherlands (Prins *et al.*, 2009), and New Zealand (Utter *et al.*, 2006) all reported *positive* association with PA. A study of Portuguese adolescents found positive association in females but no association in males (Santos *et al.*, 2009); and one study from Australia found no association (Hume *et al.*, 2005). This is incoherent with CNES findings showing participant perceptions of 'ability to be active' and reported attendance at 'out-of-school activity clubs' showing *no* association with sports facility access or proximity. However, this is an imperfect measurement metric of this association.

Finally, the proportion of total time reported in sports facilities by CNES participants was relatively low especially in females (males 6.7% and females 3.8%). With proportionality low time reported in these spaces their role in young people's PA facilitation may be less important than other neighbourhood resources.

Negative association between neighbourhood sports facilities and PA in the CNES population is not well explained by the CNES results; this may in part explain the non-statistical significance. There is implicit bias in CNES research methods which is assumed in part to be causative of this unintuitive negative association. Despite reported negative association sports facilities are shown in CNES to be important, but relatively poorly used, sites for intense activity in young people. There is consequently a need to better understand the function of neighbourhood sports facility location and its influence on facility usage to enable targeted public health policy and urban planning recommendations to maximise use by young people. Qualitative investigation of this is recommended for clarity of the complex associations uncovered in literature.

5.6.2 Dietary Intake

Neighbourhood access to sports facilities and healthful dietary report in the CNES population showed a non-significant *negative* trend. As discussed in section 5.5.2, to author's knowledge only one other study has studied access to sports facilities (composite with parks and GSs) and dietary outcome. Carroll-Scott *et al.* (2013) in their study of North American 9–11 year olds reported *positive* association whilst CNES found *negative* association. The proposed mechanism for the observed *negative* association is the unhealthy food environments within sports facilities which function to encourage unhealthful dietary choices within these spaces and indirectly encourage or promote less healthful dietary choices outside of these environments, see Table 50 on page 160. This proposition is guided by the study of 67 sports facilities in London by Nowak *et al.* (2012) where authors documented poor availability of healthy foodstuffs in these spaces and the dominance of less healthy snack food vending. These findings are consistent with the British Heart Foundation report (2009) which criticized leisure centres for the dominance of unhealthy snack options and the indirect promotion of unhealthy products in UK leisure centres (Food Commission, 2009).

In short the unhealthy food environments within UK sports centres are indicated to be negatively influencing dietary intake in young people. This may feasible function to offset the PA health behaviour outcomes associated with young people's use of these spaces. There is significant opportunity, and need, for regulation of the foodstuffs within sports facilities, potentially akin to the School Foods regulations on school dinners (School Food Trust, 2007).

5.6.3 BMI

Neighbourhood access to sports facilities and higher BMI showed a non-significant *negative* trend with higher in the CNES population. This is consistent with findings from two UK studies; both employed perception rather than objective measurement nevertheless the association was in the same direction. In their study of 33,594 English children aged 3–13 years Edwards *et al.* (2010) reported perceived difficulty accessing leisure facilities increased the risk of childhood obesity. Likewise, in their study of 2,535 Irish adolescents (15–17 years) Nelson and Woods (2009) found adolescents classified as overweight or obese perceived fewer convenient facilities for physical activity within a 5–10 min walk of their homes than healthy weight adolescents. Consistent positive association was reported in one study from the US and from Australia (Gordon-Larsen *et al.*, 2006; Timperio *et al.*, 2010); conversely two studies from the US reported no association (Norman *et al.*, 2006; Slater *et al.*, 2010).

In all studies reporting association between sports facilities and BMI, both positive and negative, PA is cited as the facilitating influence. With associations between CNES population PA (5.6.1) and healthful dietary intake (5.6.2) being contradictory to the direction of BMI association mechanisms CNES results do little to add clarity to this. Despite this it is reasonable to conclude that PA is an important facilitator of this association.

Sports Facility influence on PA, dietary intake and BMI summary:
Neighbourhood access to sports facilities and CNES population PA showed a non-significant *negative* trend. CNES is the first study in literature to report negative association though authors postulated that the inclusion of parks and GS into previous study's definitions of sports facilities may have skewed negative findings to be reported as null. Confounding by subjective PA measurement and small geographical scale in CNES; assumed willingness for UK residents to travel to sports facilities; and positive skewing of perceived availability of these facilities are discussed as being causative of this unintuitive negative association.

Neighbourhood sports facilities access and healthful dietary report in the CNES population showed a non-significant negative trend, the assumed mechanism for this was the characteristically unhealthy food environments within sports facilities. It was postulated that these environments functioned to encouraged unhealthful dietary intake whilst within them and indirectly influenced dietary intake by through unhealthful food advertising.

Healthy BMI outcome showed a non-significant positive trend with neighbourhood sports facilities in the CNES population. This finding is consistent with UK and international literature. The assumed mechanism of association is facilitation of PA.

5.7 Land Use Mix

Neighbourhood land use mix broadly pertains to the mix of residential, commercial and leisure building and open space uses within a given neighbourhood parameter. For the purpose of this discussion chapter, and in accordance with the CNES definition, land use mix refers only to neighbourhood shops and services and does not include residential density; the latter of which was beyond the scope of study. The NPPF states *“where practical, particularly within large-scale developments, key facilities such as primary schools and local shops should be located within walking distance of most properties”* (Communities and Local Government, 2012, Article 4, Section 38). Within the policy framework preference is also given for designated spatially restricted Retail Areas in urban planning (Article 2, Section 13). This national policy was reflected in local-level plans within the North East. The Newcastle and Gateshead Council Urban Core Plan (2014) outlines Primary (i.e. main city centre), District (i.e. neighbourhood high streets comprising *“a wide range of retail and related services”* (p. 63)) and Local Centres (i.e. smaller neighbourhood clusters of shops and services which *“support the daily needs of a smaller catchment area”* (p. 63)) as well as Community Facilities and small Shopping Parades which *“provide an important service to the local community”* (p. 59). Both Sunderland and North Tyneside Council Unitary Development Plans preference City Centre and Primary Shopping Area development, stating that community retail development was pertinent to address the needs of residents with low or restricted mobility (North Tyneside Council, 2002 Section 3.41; Sunderland City Council, 2007 Section 6.21).

On average 38 non-food shops and services and 15 food outlets were observed within CNES participant’s neighbourhoods (n=108) this is indicative of neighbourhood-level access to shops and services consistent with NPPF guidance.

5.7.1 Physical Activity

High neighbourhood land use mix (measured by access to shops and services) was statistically significantly *negatively* associated with PA in CNES participants. Within the UK there are no studies associating land use mix and youth PA, international studies are therefore necessarily used for comparison. Studies employing objective land use mix measurement are discussed first and findings are compared with CNES result; then studies which measured perceived neighbourhood land use mix are outlined.

Of the studies employing objective land use mix measurement one study reported *positive* association: Kerr *et al.* (2007) reported walking was positively associated with mixed and commercial neighbourhood land uses (1000m buffer) in young people from the US, aged 5–18 years (n=3,161). Conversely two studies reported *no* association: Norman *et al.* (2006) reported neighbourhood land use mix (1600m buffer) was not associated with PA in adolescents from the US aged 11–15 years (n=799). Similarly Aarts *et al.* (2012) reported neighbourhood land use mix, at the neighbourhood-level scale, and outdoor play were not associated in young people aged 10–12 years from the Netherlands (n=1,046). Conversely again Leung *et al.* (2010) reported a crude *inverse* association between neighbourhood (400m buffer) mixed residential and commercial destinations and PA in girls aged 6–8 years (n=207) from the US. Notably all studies reporting *null* and *negative* associations encompassed residential density as a factor within land mix; only Kerr *et al.* (2007), in the one study reporting *positive* association, dichotomised land use (including residential density) and commercial land uses. With this in mind, presence of commercial land uses (i.e. shops and services) within the neighbourhood are shown to consistently encourage PA in young people.

The mechanism for *positive* association between neighbourhood land use mix and PA is generally assumed to be the encouragement of active travel *to* and *between* local, and therefore accessible, shops and services (and as a continuation the wider neighbourhood). This is consistent with UK findings from Rainham *et al.* (2012) which report the majority of activity, reported by adolescents aged 12–16 years, was whilst commuting to school or other leisure locations (e.g. shopping centres and GSs). Authors also highlighted residential (i.e. within neighbourhood) and shopping locales as important sites for activity. Both *actual* and *perceived* neighbourhood walkability, is inextricably linked to active travel and is therefore a biasing factor in the association between land use mix and PA. Walkability factors are discussed later in the chapter in section 5.9. *Proximity* to land uses (i.e. destinations) is similarly inextricably linked to active travel. Greater travel distance has the potential to result in more activity but there is a tipping point at which active travel is no longer discerned to be possible. This is illustrated in the study by Panter *et al.* (2010a) which reported distance between home and school as a moderating influence on attitude and active travel behaviour in a UK-based study on commuting to school in 9–10 year olds. Better understanding of acceptable travel distances, and moderating factors of this, is needed to better inform youth PA literature conclusions on land use association with PA. Conversely, a proposed mechanism for *negative* association in the CNES population is the reduced need for active travel in neighbourhoods which are highly mixed (i.e. all amenities are proximal therefore active travel is limited). This discrepancy with the wider literature further highlights the need for qualitative analysis on the mediating influence of proximity. As an alternative explanation, there may be a relationship between low levels of open and green space, consistently associated with youth PA, in neighbourhoods where mixed residential and commercial land uses dominate (i.e. it is not unreasonable to assume that to accommodate mixed land uses open and green spaces may be built upon). As a caveat the latter wasn't substantiated with correlational analysis but is perhaps worthy of further interrogation.

Interrogating the detailed case study analyses of neighbourhood active travel behaviour[49] active travel within the neighbourhood was undertaken predominately for commuting to school, equating to 60.3% as a proportion of total time reported by all cases. There was proportionality more limited engagement of participants travelling actively to shops and services, equating to 22.1% total time but by only 36.4% cases. This indicates the potential for weighted importance of some land use amenities above others. It is acknowledged that this is a very small sample and therefore results are poorly generalizable, nonetheless this example effectively

[49] See sections 4.29.4, 4.30.4, 4.33.4, 4.34.4, 4.36.4 and 4.37.4.

illustrates another potential mechanism for negative association (i.e. CNES participants did not report high levels of active travel with the purpose of engaging with neighbourhood amenities).

Asides encouraging active travel *to* amenities, mixed land use may encourage PA *within* amenities i.e. walking within a retail outlet. Male and female CNES participants reported 8.7% and 11.5% of total time in ‘Other’ locations; the definition of ‘other’ locations was broadly consistent with the amenities comprising mixed land use. Within these spaces males and female CNES participants reported on average 25% and 50.7% total time in low intensity activity and 23.6% and 22.2% in moderate–intense activity, respectively. Activity *within* these amenities is thus indicated to be meaningful within the CNES population.

Of the studies measuring neighbourhood land use mix by young people’s perception three studies reported *positive* association: Deforche *et al.* (2010) reported more active transportation in adolescents from Belgium (16–18 years, n=1,445) in those with higher perceived land use mix diversity. Rosenberg *et al.* (2010) reported positive association between perceived neighbourhood land use mix and walking to shops, walking to school and being active in a park in adolescents from the US aged 12–18 years (n=171). Mota *et al.* (2005) further reported positive association between positive perceptions of access to neighbourhood shops and PA in adolescents from the US aged 12–18 years (n=1,250). Correspondingly positive parental perceptions of neighbourhood land use mix showed consistent positive associated with youth activity in studies from Australia (Timperio *et al.*, 2004a), Belgium (De Meester *et al.*, 2014) and the US (Rosenberg *et al.*, 2010). Conversely three studies reported *no* association: in their study of active and non-active obese girls aged 12–16 years from Portugal (n=162) Mota *et al.* (2009) reported no significant differences in perceptions of access to neighbourhood shops or public transport by PA status i.e. inferring that land use mix is not a mediating factor in activity behaviour within obese adolescent girls. In another study of Portuguese adolescents (12–18 years, n=1,124) Santos *et al.*

(2009) reported no association with PA and participant's perceptions of neighbourhood access to shops, public transport or places to go. De Meester *et al.* (2013) likewise reported no association between neighbourhood land use and active travel during leisure time but significant *negative* association with active travel to school in their study of adolescents aged 13–15 years from Belgium (n=637).

The mechanism of *perceived* neighbourhood land use mix, and its role as an effecting factor on activity behaviour, is not well understood. As an illustrative example of this: it is reasonable to project that young people perceive shopping areas as desirable areas to hang-out with friends, this may feasibly promote active travel *to* these spaces, and low–moderate intensity activity whilst *within* these spaces. However, it is similarly reasonable to project that some young people may be put-off visiting shopping areas, and therefore engaging in low intensity activity, due to gangs of young people congregating in these areas. The CNES results do little to illuminate this association. For example in the low activity (LA) case pair Ben had better access to shops and services than Chloe, reported more time travelling actively in the neighbourhood but had worse perceptions of 'things to do' in the neighbourhood. Conversely in the HA case pair James had better access to shops and services, spent more time travelling actively in the neighbourhood and had better perceptions of neighbourhood 'things to do'. Further qualitative work is required to better understand this mechanism.

To conclude, there is a need to more consistently define neighbourhood land use to better enable cross-study comparison and to further investigate the mechanisms of association. Whilst diverse, and therefore engaging, neighbourhoods are assumed to be linked to PA by encouraging active travel *around* and *within* these spaces the literature on young people is far from conclusive. It is not unreasonable to propose that the stronger association commonly reported in adult populations is linked to this age group's greater engagement with shops and services (Sugiyama *et al.*, 2014). In consideration of the heterogeneous findings in literature there is a need for greater clarity about the mechanism of association between land use and PA and a better understanding of which facets of land use are enabling or disabling of PA. Only informed by this can urban planners ensure there are no unintentional detrimental impacts of the NPPF guidance which recommends shops and services are located within walking distance of homes.

5.7.2 Dietary Intake

High neighbourhood land use mix and healthful dietary report in the CNES population showed a non-significant *negative* trend. The proposed mechanism of this trend was the co-location of food outlets in mixed land use areas i.e. in high street and retail areas (refer to Footnote 38 on page 195). To author's knowledge only one study on young people addresses neighbourhood land use mix in association with dietary intake. In their study of 207 girls aged 6–8 years from the US Leung *et al.* (2010) objectively assessed neighbourhood environments (400m buffer) correlating self-reported total energy intake with 'mixed residential and commercial'[50] and 'food and retail'[51] scales – results for both scales are reported as both include the CNES definition of neighbourhood land use i.e. incorporating shops and services. Total energy intake was *not* associated with the 'mixed residential and commercial' scale but was *inversely* associated with the 'food and retail' scale (i.e. the higher the prevalence of neighbourhood retail destinations the lower the total energy intake). In their discussion Leung *et al.* propose that children may be only very modestly influenced by the neighbourhood land use environment, particularly the food environment, due to low level ability to purchase from these outlets. It is postulated that the disparity with CNES results may be attributable to

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[50] Mixed residential and commercial scale comprised: residential (house size and type), walkability (pavements, road safety factors and neighbourhood incivilities), commercial outlets (food outlets and employment services) and community services (places of worship, community centres and pre-schools).

[51] Food and retail scale comprised: food outlets (takeaways, supermarkets, restaurants and coffee shops), non-food retail outlets (pharmacies, shopping centres, laundrette/ dry cleaners and health services) and walkability factors (pedestrian crossing aids and visible mixed land use on street segments).

the increased purchase power of the older participants in the CNES study (i.e. young people aged 10–11 years). Leung *et al.* offered no explanation of wider neighbourhood land use mix influence. Leung *et al.*'s scale definitions make the results challenging to interpret in relation to CNES due to the fact that CNES incorporated non-food shops and services and food outlets in a single unifying land use mix variable.

The relationship between neighbourhood land use mix and dietary intake is most commonly studied in isolation – in association with food outlets, i.e. rather than as an aspect of the broader land use mix construct. In literature *built* (or mixed land use) and *food* environments are consistently investigated separately often by different groups of professionals i.e. planners and public health professionals respectively (Lake and Townshend, 2006). Consistent with this literature precedent CNES subdivided the overarching *land use* construct (or variable) into *food* and *non-food* shops and services variables to enable the dissection of specific land use influences. Findings from these analyses shall be discussed alongside the wider discussion on land use mix. To ensure comprehensive engagement with literature a discussion of the food environment, and its contributing part in the association between land use mix and dietary intake shall now follow.

In their recent review of childhood obesity and the built environment (Casey *et al.*, 2014) stated *"it is indeed likely that the effects of the built environment differ greatly across countries, cultures and climate"* (p. 170). Similarly Black *et al.* (2014), Beaulac *et al.* (2009) and Lake and Townshend (2006), in their reviews and commentaries, reported heterogeneous food environments across different countries of study. For this reason, UK-only studies shall be used for comparison.

Only two UK papers, both examining results pertaining to the same research study, directly associated the neighbourhood food environment and dietary intake. The Sport, Physical Activity and Eating behaviour: Environmental Determinants in Young people (SPEEDY) study employed self-report dietary intake measures and objective measurement of food outlets within 800m neighbourhood buffers of young people age 9–10 years from Norfolk, UK. Jennings *et al.* (2011) reported children (n=1,669) living in neighbourhoods with BMI-unhealthy[52] outlets had diets containing significantly more fizzy and noncarbonated fruit drinks, and non-statistically significantly more savoury snacks but less pure fruit juice. Conversely children living in neighbourhoods containing BMI-healthy outlets[53] had diets containing, non-statistically significantly, more pure fruit juice, vegetables, red meat and fish but fewer ice cream/ desserts, fruit, fizzy and non-carbonated fruit drinks. Skidmore *et al.* (2010) reported children (n=1,721) living further away from a supermarket had generally more favourable dietary intakes (more fruit and vegetables and less white bread). Neighbourhood supermarket *density* (or access) was associated with favourable fruit and vegetable intakes but unfavourable intakes of sweets, sugary soft drinks, breakfast cereals and white bread. Children living further away from convenience stores and takeaways had generally more favourable dietary intake (fewer crisps, chocolate and white bread for both, and fewer sweets or sugary soft drinks, respectively). Neighbourhood convenience store and take-away outlet densities were associated with higher fruit juice and vegetable intakes, respectively.

Two detailed studies broadly associating neighbourhood takeaway outlets and dietary intakes found unfavourable associations. In their study of 11–14 year olds from London (n=193) Patterson *et al.* (2012) reported broadly positive association between elevated frequency of eating at takeaway outlets (>4 times/ week) and preference for large portions and sweetened fizzy drinks with subsequent higher total energy intake. Likewise, in their study of adolescents aged 13 years from Bristol (n=3,620) Fraser *et al.* (2011) reported positive association between increased frequency of eating at takeaway outlets, higher HFSS foods and lower fruit and vegetables intakes. Findings from Tyrrell *et al.* (2013) supported these findings, authors reported in adolescents aged 16–18 years from the North East,

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[52] BMI-unhealthy outlets comprised takeout/fast-food outlets and convenience stores.

[53] BMI-healthy outlets comprised supermarkets and fruit and vegetable stores.

most out-of-home food was sourced from takeaway outlets and there was positive association between food outlet sourced eating events and total daily energy density.

To augment the limited literature on neighbourhood environment, research on proximal school food environments (school fringe) and its association with young people's dietary intakes are also presented to support the discussion. In their London-based study of 11–12 year olds (n=1,382) Smith *et al.* (2013) positively correlated healthy (self-reported) diets with proximal grocery stores, and unhealthy diets with proximal takeaways. Interestingly authors also reported a proliferation of convenience stores between 2001 and 2005 within school fringes. Sinclair and Winkler (2008) reported adolescents aged 16–17 years (n=322) obtained 23% of their recommended total energy from food outlets within the school fringe, most of which was HFFS foodstuffs of which the majority were sourced from supermarkets and local independent takeaways. Though not associating diet and school fringe food environments Gallo *et al.* (2014b) reported a dominance of unhealthy food outlets within the primary school fringe environments (n=10 schools, 400m buffer) in Newcastle upon Tyne.

To summarise, unhealthy food outlets (consistently comprising: Takeaway eateries and Convenience and incidental outlets) show consistent *positive* association with *less* healthful dietary intake and vice-versa with healthy outlets (consistently comprising: Grocers and traditional sit-in eateries) within UK literature. Consistent with this literature CNES results similarly *positively* associated *unhealthy* food outlets with *less* healthful dietary intakes. This is indicative of an inherent association between access, purchase and consumption behaviours. Unhealthy food outlets represented the majority of food outlets within CNES participant's neighbourhoods: 55.5% total food outlets and 64.9% age appropriate accessible outlets (i.e. not pubs or private outlets). This exemplifies the association between food outlet access and diet illustrating the, tentatively reported in lieu of non-statistical significance, apparent *negative* influence of the food environment on health.

Interestingly neighbourhood access to non-food shops and services were *positively* associated with *more* healthful dietary intakes. This is implies that there is isolated influence on dietary intake by the *food environment* distinct from overarching *land use mix*, which may in fact justify the separation of *built* and *food* environment literatures previously criticised. The mechanism for positive association between non-food (shops and services) land use mix and dietary intake is not debated in literature but may be owing to the diversion of attention away from eating towards other leisure pursuits by the presence of these neighbourhood amenities.

To conclude the UK food environment has a putative negative influence on dietary intake of young people owing to the high concentration of unhealthy food outlets. The role of food outlets within the wider land use mix construct is poorly studied but CNES indicates a, non-statistically significant, negative role of these amenities on health in young people. Despite CNES findings indicating the distinct influences of food and non-food land uses, which may justify their isolated study, there remains a need to better understand broad urban context (or land use) and its' influence on diet adequately accounting for confounding or influencing of a wide range of neighbourhood environment features. Better integration of public health and planning literature is therefore recommended. This would enable a joined up approach to health promotion and facilitation.

5.7.3 BMI

High neighbourhood land use mix was statistically significantly *inversely* association with healthy BMI in CNES participants. To author's knowledge only four studies have investigated this association (at the broad land use level); all studies irrespective of country were therefore utilised for comparison with the CNES finding.

CNES results are consistent with findings from Oreskovic *et al.* (2009), in their study of 2–18 year olds (mean 9.3 years) from the US (n=21,008), authors reported that proximal access to schools and public transport was *negatively* associated with healthy BMI (environment exposure and BMI outcome both objectively measured). The assumed mechanism for *negative* association is, as discussed in section 5.7.1, the low need for active travel due to close proximity of amenities and reduced access to open and green space, an assumed natural consequence of higher levels of built environments. The co-location of food outlets in mixed land use neighbourhoods, as discussed in section 5.7.2, which ensue to promote dietary consumption is an alternative or potentially accompanying mechanism for this association. Indeed, this is supported by UK literature. When the food environment is objectively measured consistently positive association is reported between neighbourhood takeaway outlets and elevated BMI (Fraser and Edwards, 2010; Fraser *et al.*, 2011; Jennings *et al.*, 2011; Fraser *et al.*, 2012). It should be noted that no such association was observed by Patterson *et al.* (2012) in their study which assumed exposure from frequency of consumption from these outlets. This highlights the need for robust research methods in the study of obesogenic environments.

The remaining three studies reported *no* association between neighbourhood land use mix and BMI. In their UK study of young people aged 9–10 years (n=1,995) Harrison *et al.* (2011b) reported mixed land use (objectively measured) in the neighbourhood environment (800m buffer) was not associated with fat mass index (objectively measured). Authors did however report *inverse* association between healthy BMI, high mixed land use and unhealthy food outlet access within the school fringe in females who travelled actively to school. In their study of 2,535 Irish adolescents aged 15–17 years Nelson and Woods (2009) reported no association between weight status (objectively measured) and adolescent perceptions of neighbourhood proximity to shops and facilities. Authors did however report significant inverse association between healthy BMI and perceived poor neighbourhood access to spots and leisure facilities. In their study of 2,682 adolescents aged 14–18 years from the US Wall *et al.* (2012) (n=2,682) reported no association between BMI (objectively measured) and commercial land use or transit stop density (objectively measured) but significant *inverse* association between healthy BMI and convenient access to convenience stores. In all instances authors cited the larger (or more significant) influence of other neighbourhood features (e.g. parks and GSs and the food environment) on BMI as compared to land use mix. As previously discussed literature applied heterogeneous definitions of land use mix which complicated study interpretation. Consistent application of a standard land use mix definition is again recommended.

Neighbourhood land use mix is reported to be a statistically significant *negative* influence on healthy weight outcome. More work is needed to identify key land use amenities and their favourable or detrimental bearing on weight status outcome. Such work would best enable urban planners to effectively ‘plan for health’ positively influencing public health.

Land Use influence on PA, dietary intake and BMI summary:

Statistically significant negative association between neighbourhood mixed land use and youth PA was reported in the CNES population. The mechanism of association is assumed to be low-level requirement for active travel (i.e. owing to close proximity) and the loss of open and green spaces which show consistent positively association with youth PA in order to accommodate built land uses. The overarching conclusion from this section is that further research, using consistent definition of land use mix, is required in this age group.

Neighbourhood land mix showed a non-significant negative trend with healthful dietary report in the CNES population. The assumed mechanism for association was co-location of food outlets in mixed land use areas. Unhealthy food outlets (takeaways and convenience outlets) show consistent negative association with unhealthful dietary intake both within the neighbourhood, school and CNES participant environments. Owing to the inherent association between access, purchase and consumption behaviour. Non-food land uses were positively associated with healthful dietary intake which adds justification for the isolated study of food and non-food land uses in literature. Despite this, there is a need for a more joined up approach between health and planning professional to best facilitate public health.

High neighbourhood land use mix was statistically significantly *inversely* associated with healthy BMI in CNES participants. Enabling and disabling PA and dietary intake (healthful and not) are the assumed mechanisms. Further investigation on specific land uses, and their association with PA and diet, to enable targeted urban planning supportive of health was recommended.

5.8 Outdoor Food and Drink Advertising

The NPPF calls for the promotion of healthy communities through Local Authority (LA) planning; LAs are the governing bodies of outdoor advertising planning control within in the UK (Town and Country Planning Authority, 2007; Communities and Local Government, 2012). LA policy and guidance on outdoor advertising and signage within the North East at the time of CNES was sparse and if present related predominately to sizing restrictions with limited mention of design quality (Sunderland City Council, 2007; Newcastle City Council, 2012; Gateshead Council *et al.*, 2013). No explicit policies or guidelines were available for food and drink advertisements.

On average 60 food and drink adverts were observed within CNES participant's neighbourhoods. The vast majority of CNES participants (93.5%) had food and drink advertising present within their neighbourhood environments. This points towards high-level exposure to food and drink advertising within UK neighbourhood environments.

CNES reported a *similar* proportion of HFSS food and drink adverts but a markedly *higher* proportion of low fat and/ or sugar (LFS) food and drink adverts to Adams *et* *al.* (2011) in their city-wide study of food and drink advertising in Newcastle upon Tyne (+0.8% and +40.4%, respectively). Comparison between studies, though useful, is inherently biased due to definition and measurement differences between studies (e.g. all static materials pertaining to food and drink in CNES compared to (an implied though not explicitly defined) large-scale advertisements with a clear selling intent by Adams *et al.*; advert count compared to size (m^2); and neighbourhood- compared to city- scale). The high level of LFS advertising reported in CNES is both surprising and encouraging.

Only two per cent of adverts (n=94) were directly targeted[54] at young people within CNES neighbourhoods. Though it was beyond the scope of this study to assess the increased (or not) influence or salience of *targeted* media on young people's awareness or perception of advertising this is a stand-out result being much lower than expected. This may be indicative of the lack of preference for static outdoor advertising for this age range and may in part explain the high proportion of targeted advertising on TV, online websites/ applications and computer games within this age range (i.e. to offset the lack of outdoor advertising). Dominance of advert USP *price* and *promotion* (61%) is worthy of consideration alongside this finding. Young people are known to be price sensitive due to limited spending power therefore adverts which publicise cost, though targeted at the general public, and may have high-level salience with the target audience. Qualitative study is required to better understand which outdoor advert types have greatest salience with young people.

Consistent with studies of alternate advertising media, i.e. TV, product packaging and online/ social media campaigns, the majority (73.4%) of outdoor food and drink advertisements targeted at young people were for high fat and/ or sugar (HFS) food and drinks (Hastings *et al.*, 2006; Pasch and Poulous, 2013).

[54] Target audience was determined by OFDAAT according to pre-defined age categories.

The majority of food and drink adverts were affixed to the outside of food outlets (92.1%). Significant association was observed between food and drink advert *grouping* and food outlet *type* with unhealthy food outlets having proportionally more HFS food and drink adverts than healthy food outlet types. And vice versa with LFS food and drink adverts. Whilst it was beyond the scope of this study to ascertain whether the influence of food and drink advertising was additive to, or mechanistic within, food outlet influence on energy balance; it is certainly an area that warrants future examination.

Outdoor food and drink advertising was not included in the PA and BMI binary logistic regression models due to multicollinearity (high levels of correlation) with Land Use Mix variable. This was due to the co-location of outdoor food and drink adverts with food outlets in mixed land use areas as previously discussed. Accordingly outdoor food and drink advertising is not discussed explicitly in association with these health behaviour or outcome factors.

5.8.1 Dietary Intake

Neighbourhood presence of HFS[55] food and drink adverts showed a non-significant *positive* trend with healthful dietary report in the CNES population. The association direction is counter-intuitive; the result may be skewed by the co-location of LFS adverts, the dominant advert type in CNES, which are presumed to have a health-promoting effect. This assertion is justified by multicollinearity shown between HFS and LFS adverts within the model. Despite the direction the result, this builds upon CNES focus group findings which asserted presence of print media in the neighbourhood environment positively affected young people’s desire to purchase and consume (section 4.5, page 114).

CNES is the first study, to the author’s knowledge, to associate outdoor food and drink advertising and diet. The non-statistical significance of this result may

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[55] Only HFS food/drink adverts were included in model due to issues of multicollinearity with LFS adverts, food outlets and non-food shops and services (i.e. high mixed land use).

indicate null association, I would argue however that that research methods of CNES were insufficiently sensitive or powered to detect the association. The crude 400 metre buffer definition of neighbourhood *access* to food and drink adverts did not measure actual advert *exposure* by CNES participants. This is further complicated by the application of *access* as the single measure of *exposure* within the binary logistic regression model, this omits a fundamental aspect of *exposure*, that being *perception*. As an illustration of this, a well-placed advert within a neighbourhood (i.e. along an actively-travelled school route or adjacent to a frequented leisure location) has high-level *exposure* which accordingly may be highly *perceived* and therefore salient. Such an environment, even with potentially fewer actual stimuli than a neighbourhood with a high frequency of advertisements within a defined geographical area but located with non-habitually exposed locales, could be considered more saturated and/ or salient and therefore effecting. The means of dietary assessment and binary categorisation of dietary intake utilised in CNES may additionally have been insufficiently sensitive to detect the potentially diminutive or complex effects of advertising on diet.

In their review of food promotion Hastings *et al.* (2006) asserted that a direct association between all types of food and drink advertising and childhood obesity, and by implication dietary intake, is unlikely to ever be convincingly established due to high-level confounding. The notable absence of research on this subject may indeed be owing to this complexity. Notwithstanding this, the translational effect of advertising on dietary outcomes requires greater interrogation to better understand the nature of association, and with it any potential utility of advertising restrictions (imposed by Local Authorities) or public health. Notably the lack of LA policy and guidance previously noted is likely due to the lack of research focus and consequent absence of robust conclusions. Qualitative interrogation of food and drink advertising effects on behaviour is warranted to better establish the mechanism of association and identify confounders and necessary controls. Following this further quantitative study employing robust measures of: advert *exposure* and *perception* and dietary intake, with a sufficiently *powered* sample size to mitigate confounders is advised.

Outdoor Food and Drink Advertising influence on dietary intake summary: Neighbourhood presence of HFS food and drink adverts showed non-significant *positive* association with healthful dietary report in the CNES population. The translational effects of food and drink advertising on dietary intake are poorly understood and there is an assumption that this was due to inherently flawed and insensitive *exposure* and *outcome* measurement employed in CNES. This is the first study to directly associate outdoor food and drink advertising and dietary outcomes. Alongside the absence of wider study of the outdoor food and drink advertising environments CNES fails to reach firm consensus or conclusion on association actuality or mechanism.

5.9 Walkability

Within CNES roads and streets were measured discretely, for the purpose of both succinctness and interconnectedness within this chapter they are onwardly discussed together under the banner of *walkability*. The NPPF references walkability in relation to enabling healthy communities: *"safe and accessible developments, containing clear and legible pedestrian routes… protect and enhance public rights of way and access"* (pp. 17–18); and in relation to sustainable transport *"developments should be located and designed where practical to give priority to pedestrian and cycle movements… [and] create safe and secure layouts which minimise conflicts between traffic and cyclists or pedestrians"* (Communities and Local Government, 2012 p.10). This is indicative of the UK perspective jointly comprising *road* safety and *street* access and quality features which adds further justification for the walkability banner.

Roads and streets made up a large proportion of total neighbourhood environments in the CNES population, on average 8,121 meters per neighbourhood (within a 400m buffer). This is indicative of the dense and connected urban neighbourhoods within the sample.

5.9.1 Physical Activity

Total neighbourhood road and street lengths[56] were statistically significantly *positively* associated with PA in CNES participants. Conversely A road length (a measure of high speed and characteristically ‘dangerous’ road type), road safety and street quality showed non-significant *negative* trend association with PA in CNES participants.

There are a number of explicit differences cross-nationally with roads, road speed, pavement presence and neighbourhood density; for this reason a number of UK commentaries on obesogenic environments in relation to walkability have questioned the validity of international literature comparison within this sub-field (Lake and Townshend, 2006; Millington *et al.*, 2009; Townshend and Lake, 2009). Consistent with this, UK only literature was used for comparison.

Built surfaces, roads and pavements are consistently shown in UK literature to be the location for the majority of time spent outdoors by young people aged 10–11 years (Jones *et al.*, 2009; Lachowycz *et al.*, 2012). In their study of young people aged 9–10 years (n=100) Coombes *et al.* (2013) reported roads and pavements were used mostly for light activity (i.e. walking) but also for moderate-vigorous activity (i.e. play). This same distinction between *active travel*[57] and *active play*[58] was made in CNES; consequently this sub-section is further sub-divided to reflect these different behaviours.

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[56] For definition of roads and streets by type see Table 26 and Section 3.16.7, respectively.

[57] Defined as all-time reported by participants walking, jogging, running, cycling, skating or scooting for the purpose of travel within the neighbourhood.

[58] Defined as all-time reported by participants playing, doing sports, athletics, dance, activity clubs, walking, jogging, running, cycling, skating, scooting, gardening or DIY within the neighbourhood.

Active Travel

Active travel literature on young people addresses two overarching elements of walkability: *connectivity* (broadly comprising road/ street length and street segment intersection density (or neighbourhood connectedness)) and *road safety*. These were addressed in turn.

Connectivity (objectively measured) was discussed in relation to active travel (subjectively reported) in three papers. Panter *et al.* (2010b) (n=805) and Carver *et al.* (2014) (n=1,121) reported on SPEEDY (previously outlined in section 1.7.1) which defined the neighbourhood at the 800 metre neighbourhood buffer level. Steinbach *et al.* (2012) studied 8,082 young people aged 5–17 years from London, authors defined the neighbourhood at the larger LSOA-level. Panter *et al. positively* associated active travel to school with road (but not street) density (broadly consistent with the CNES definition of length). *Null* association was reported between road density and active travel to school by Carver *et al.* and all forms of active travel (comprising school commute and leisure-time travel) by Steinbach *et al.* Street segment density was reported to be *negatively* associated with active travel to school by Panter *et al.*; *negatively* associated for boys but *not* associated with girls active travel to school by Carver *et al.*; and *negatively* associated with active leisure-time travel but *not* associated with school commuting by Steinbach *et al.*

The assumed mechanism for *positive* association between PA and road/ street lengths observed in CNES was assumed to be owing (in part) to the facilitation of active travel – both by *access* (measured by length) and *connectedness* (measured by street segment intersection density). Though the latter was not accounted for within the PA model statistically significant correlation was observed between street length and intersection density ($r=0.93$, $p<0.01$ 2-tailed) in CNES participant’s neighbourhoods therefore it was reasonable to argue a case for both. This assumption was informed both by logic and the statistically significant *positive* association observed between street length and parental happiness for child to be in the neighbourhood unsupervised and encouragement of child's active travel to school (see Table 55). This mechanism however, is questionable in light of these very mixed findings from literature. Lack of consistency across studies may be in part owing to the absence of consistency at the neighbourhood-scale level however the disparity between the two SPEEDY papers calls this into question. Alternately the high level of confounding between this associations may be insufficiently accounted for within the size of study samples. The challenge in comparing results from CNES and literature is significant due to the papers stratifying out *active travel* as a single activity behaviour, and CNES utilising an overarching *total PA* variable (i.e. it is CNES PA variable constitutes other forms of PA than active travel singularly). Due to the small CNES sample size such stratification was not sufficiently statistically powered to produce meaningful conclusion.

The direction of association between active travel and *road safety* was more consistently reported across literature. Road safety was discussed in relation to three attributes which are discussed in turn: A-road length, traffic speed and volume, and perception of road safety.

A-road length was reported to be *negatively* associated with walking by both Steinbach *et al.* (2012) and Panter *et al.* (2010b). This was consistent with the negative, though non-statistically significant, direction of association with PA observed in CNES. The assumed mechanism for this association is the deterrence of PA by the perceived and actual danger of A-road[59] density within the neighbourhood owing to elevated vehicle speed. Worthy of note was the statistically significant *positive* association observed between parental

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[59] A-road is defined as a: Public road, classified as an A road by the Department for Transport (DfT) connecting areas of regional importance, always numbered, sometimes named, often with addresses Ordnance Survey (2013a) *ITN attribute definitions and values*. Available at: http://www.ordnancesurvey.co.uk/oswebsite/support/products/os-mastermap/itn-layer-technical-specification/attribute-definitions-and-values.html (Accessed: 11-7-2013)..

encouragement of active travel to school and neighbourhood A-road length. This counter-intuitive result signposts that actual danger, and consequent assumed avoidance of neighbourhood space, is of greater import than perceived danger. Further research is required to confirm this.

Steinbach *et al.* (2012) reported higher neighbourhood traffic volume and speed was *positively* associated with an increased likelihood of walking at weekends and during school holidays but was not associated with school or leisure commuting. Similarly Alton *et al.* (2007) reported higher perceived heavy traffic and road danger near home was associated with *higher* rates of walking (self-reported) in their study of 9–11 year old from Birmingham (n=473). CNES measured traffic speed (actual) and volume (perceived) as constituent elements within the road safety variable. *Negative* association (non-statistically significant) was therefore consistent with literature. The direction of this association is counter-intuitive and may, in part, be owing to the confounding of consistently high traffic density and volume within urban areas. It is not unreasonable to assume that parents living in neighbourhoods with high traffic speed and volume would teach their children good road safety practices but still necessarily allow their children’s use of these spaces. Alternately the direction of association may signpost the positive effect of consistently high-levels of road safety features as observed within CNES (i.e. 1.7 per street segments) with limited, and therefore non-significant, value of even more safety features.

In their qualitative study of 9–11 year olds (n=39) from London Pearce *et al.* (2009) reported child-perceived parental concerns of neighbourhood road safety deterred their PA. Three studies directly investigation parental perceptions of road safety. Gilhooly and Low (2005) reported parental concerns (self-reported by questionnaire) about traffic led to car-usage for children’s commuting to school in parents of children aged 5–11 years in Scotland (n=776). Panter *et al.* (2013) similarly reported poor parent perceived (reported by questionnaire) school-route safety was *negatively* associated with active travel in young people aged 10–11 years from Bristol (n=912). Jago *et al.* (2009b) reported on leisure-time travel and found parental perceived traffic danger (reported by telephone interview) restricted the boundaries of children's outdoor play locations/ facilities (n=24, parents of children aged 10–11 years). In their study of children's perceptions Page *et al.* (2010) found *no* association between child-perceived traffic safety and active travel to school (reported by questionnaire) in their study of young people 10–12 years from Bristol (n=1,300). Negative associations were not reported within the CNES parent population but this theme was discussed in the focus group. Disparity with parental perception literature in the CNES population may be owing to the overarching 'safety' variable (comprising multiple facets of road safety) not being sufficiently sensitive to isolate specific perceptions and resultant actions. Alternately it may have been skewed by the limited 10% sampling approach to road safety analysis which may not have adequately detected neighbourhood road safety (i.e. biased sampling). Alternately again the imperfect buffer definition of 'neighbourhood' utilised in CNES (400m buffer), compared to the self-defined neighbourhood definition used in literature, may not have adequately accounted for the neighbourhood area actually encountered by young people. These biased methods issues may likewise explain the counter-intuitive, though non-significant, negative association between PA and road safety.

Active Play

Neighbourhood-level influence on young people's *active play* (exclusively within the neighbourhood i.e. not in parks, GSs or sports facilities) was discussed in three UK papers which are discussed in turn.

In their study of young people aged 10–12 years (n=1,300) Page *et al.* (2010) correlated self-reported outdoor play frequency (consistent with CNES active play variable) and neighbourhood environment perceptions. In girls, perceptions of high traffic safety and neighbourhood disorder (comprising crime, noise and neighbourhood bullying) were *negatively* associated with time reported in active play. Authors reported no such association in boys. Furthermore, neither personal safety (comprising perceived stranger and area-level danger) nor neighbourhood aesthetics showed any association with active play in boys or girls. In CNES road safety showed *negative* (but non-significant) association with PA, moreover there was *no* association between child-perceived neighbourhood safety and reported active play time (F=1.20, p=0.31). The disparity between Page *et al.*'s findings and CNES is potentially due to the inclusion of male participants within the CNES population, owing to smaller (and therefore lesser powered) sample size; or may be a consequence of the flawed/ insensitive methods employed as previously discussed. The non-significant negative association observed between CNES participant's street quality and active play is consistent with Page *et al.*'s findings on neighbourhood aesthetics. This in part indicates children's readiness to use neighbourhoods regardless of their attractive or it may signpost towards other more salient factors as being of greater import.

Two papers addressed the association between children's active play and parental perceptions of neighbourhood safety. Jago *et al.* (2009b) found most parents (n=21) expressed safety and road safety concerns as deterrents of their child's engagement in outdoor play and PA in their telephone survey of 24 parents of children aged 10–11 years from Bristol. Similarly Bentley *et al.* (2012) reported parent's perceptions of the lack of safe outdoor space was a barrier to their children's PA in their telephone survey of 32 parents of children aged 6–8 years old. Such associations were not reported by the CNES parental population; potential causes for this disparity are previously discussed.

To conclude, the association between PA and walkability is not clear-cut and findings from CNES are generally inconsistent with UK literature. *Connectivity* shows less consistent association with *active travel* in UK literature than it does internationally; this is likely owing to the cross-national disparities previously highlighted of which urban density, and the consequent ubiquity of 'access', is likely to be of considerable importance. To ensure that urban-planners can effectively apply NPPF guidance on the provision of 'safe and accessible developments' greater clarification of the mediating effects of connectivity on active travel and neighbourhood activity are needed within the UK context. Without such clarity planners will unavoidably continue to apply established international knowledge which has questionable national applicability.

The disparity in actual and perceived neighbourhood *road safety* and PA behavioural outcomes is noteworthy. With poor road safety being associated with higher rates of PA in young people there is a need to ensure adequate road safety knowledge by young people. The counter-intuitive association is likely symptomatic of the dense urban nature of the UK and is not something that can be averted easily. That being said worsening road safety to improve PA outcomes is not the intended message. Road safety features are consistently shown to be supportive of safe pedestrian use (Elvik, 2001; Bunn *et al.*, 2003) and such features should continue to be implemented. Parent perceptions of road safety were of greater importance than children's own perceptions within the target age range. Consequently it is advised that parents should be the target of public health intervention within this context.

5.9.2 Dietary Intake

Neighbourhood street length and healthful dietary report showed a non-significant *negative* trend in the CNES population. Conversely neighbourhood road length showed a non-significant *positive* trend with healthful dietary report in the CNES population. Consistent with section 5.9.1 UK only literature was used for comparison.

Only two UK studies broadly associated walkability and dietary intake. In their qualitative study of 39 9–11 year olds from London Pearce *et al.* (2009) reported young people associated their dietary intake and the neighbourhood environment in relation to *access* and *proximity* to food outlets (predominately: takeaways, convenience outlets and supermarkets). In their study of 3,204 9–10 year olds in Liverpool Hackett *et al.* (2008) associated neighbourhood environment characteristics (measured by GIS-defined participant clustering and photo-voice) with desirable/ undesirable dietary intake (self-reported) controlling for socio-economic status. Unhealthy dietary intakes were *positively* associated with neighbourhood residential density, narrow streets, heavy traffic, lack of neighbourhood greenness and open space, and high-level access to takeaway and convenience food outlets. By contrast healthy dietary intakes were *positively* associated with lower neighbourhood residential density, wider streets, neighbourhood greenness and open space and low-level access to food outlets. Authors proposed that the mechanism for such association was the interaction between the built environment and development of food choice social–cultural *norms* and *habits*. For example in the first area type access to food outlets was high therefore visiting a convenience store, buying and eating sweets was enabled.

Both studies broadly attribute the association between diet and walkability to access and proximity to food outlets; this is discussed in greater detail in section 5.7.2 (page 275). The concept of neighbourhood access has some inherent association with street length when considered in conjunction with the high-level access to food outlets within the CNES population and the wider UK. This therefore is the assumed mechanism of negative association between street length and healthy diet reported in CNES. The direction of association between road length and healthful dietary intake was not consistent between Hackett *et al.*'s findings and CNES. This mechanism was not discussed by authors and I would argue is arbitrary in relation to young people.

5.9.3 BMI

Neighbourhood A-road length, street length and road safety showed non-significant *inverse* trend association with healthy BMI in CNES participants. Conversely neighbourhood road length and street quality showed non-significant *positive* trend association with healthy BMI in CNES participants. To author's knowledge walkability has not been studied in association with BMI in UK young people, therefore international literature was used for comparison.

In their study of 485 German adolescents aged 9–11 years (Gose *et al.*, 2013) reported no predictive effects of walkability (street segment intersection density), street type or parent-perceived traffic on BMI longitudinally (4 preceding years). Conversely in a study of North American adolescents aged 13–18 years Slater *et al.* (2013) reported communities (n=154, 2 mile school fringe buffer) with more walkable streets (comprising land use mix, road safety and street quality objectively assessed attributes) were *inversely* associated with adolescent overweight and obesity. The author's sensitivity analyses highlighted the following street features as having the greatest influence: pavement presence and road safety features (the latter was protective against obesity only). In another US study (Jerrett *et al.*, 2010) *positively* associated high neighbourhood (500m buffer) traffic density (objectively measured) and attained BMI (objectively measured) at age 18 (n=3,318, preceeding 8–9 years). Timperio *et al.* (2004b) reported elevated BMI (objectively measured) was *positively* associated with parent-perceptions of heavy neighbourhood traffic in their study of 916 families of 10–12 year old children in Australia. Moreover children's perceptions of their parent's perception of the same variable showed *positive* association with BMI. Authors reported neither parent nor child's perceived access to neighbourhood streets, road safety and street quality variables showed any association with BMI.

The assumed mechanism of association between BMI and walkability in literature was consistently reported to be the facilitation (or not) of active travel (i.e. energy expenditure influence on energy balance). Neighbourhood pavement presence was reported by Slater *et al.* (2013) to be the key *enabler*; this findings is conflicting with the CNES result: *inverse* association between healthy BMI and neighbourhood street length (non-statistically significant). This disparity is assumed to be owing to the explicit cross-national differences in pavement presence previously discussed in this chapter (i.e. their universal presence) or may be due to elevated traffic densities associated with neighbourhoods having higher street lengths. Neighbourhood traffic density, both perceived and actual, was reported across literature as the key *disabler* of active travel and consequent elevated BMI; this association was previously discussed in detail in section 5.9.1. In short the methods used (overarching ‘road safety’ variable, 10% sampling approach, 400 metre neighbourhood buffer definition) may have confounded a result consistent with literature. Alternately there may be no association within the UK context – further work is required to assure conclusions.

It is interesting to note that the only European study included within this literature comparison was the one paper to report null findings. The built environment of Germany is more directly comparable to England than either the US or Australia, as previously referenced. Gose *et al.*’s non-statistically significant findings consistent with null findings from CNES may be indicative of absence of influence within a European context. Reasonably owing to favourable walkability by dense urban locales. Further work is required to verify this hypothesis. With an absence of UK and Eurpoean literature within this field and acknowledged flawed methods employed by CNES further reserch is required to better interrogate any associations, and metidating factor, between BMI and walkability.

Walkability influence on PA, dietary intake and BMI summary:
Neighbourhood walkability (comprising roads and streets) showed mixed association with PA in the CNES population. Neighbourhood road and street length was *positively* associated but A-road length, road safety and street quality *negatively* associated with PA in CNES participants. Neighbourhood-level PA broadly comprised active travel and play. Neither the direction nor mechanism of association between active travel and neighbourhood *connectivity* were well established across UK literature; CNES findings did little to add clarity to this. There is a need to better understand this association within a UK context to ensure neighbourhood activity is safely and appropriately enabled by urban planners. Negative association between neighbourhood *road safety* and PA was consistently shown. The confounding effect of highly dense urban neighbourhoods was discussed as the likely cause for this and the consequent need for appropriate road safety knowledge in young people highlighted. With parental perceptions of road

safety having greater influence on children's behaviour outcomes that their own perceptions the importance of targeting this population group was emphasised. It was argued that CNES' results inconsistency with literature was owing to the imperfect and insensitive research methods utilised rather than CNES null findings being accurate.

Neighbourhood street length was *negatively* associated and road length *positively* associated with healthy dietary intake in the CNES population. This association has been scantly studied within UK literature but a broad consensus (and reasonable logic) assumes that the association is connected to neighbourhood access to food outlets.

Neighbourhood walkability (comprising roads and streets) showed mixed and non-statistically significant association with BMI in the CNES population. Neighbourhood A-road and street lengths and road safety were *inversely* associated but road length and street quality *positively* associated with healthy BMI in CNES participants. The assumed mechanism of association between BMI and walkability in literature was the facilitation of active travel enabled by pavement presence and disabled by traffic density. It was argued that pavement presence has questionable applicability as a determining factor on active travel within the UK owing to their ubiquity. The association with BMI and traffic density was unable to be isolated within CNES therefore no firm conclusion was drawn. Further research within this field was recommended.

5.10 Cyclability

The NPPF discusses cycling facilities in reference to sustainable transport: *"developments should be located and designed where practical to …give priority to pedestrian and cycle movements… create safe and secure layouts which minimise conflicts between traffic and cyclists or pedestrians"* (Communities and Local Government, 2012 p. 10). The impetus is placed on neighbourhood cycling being facilitated and safety enabled. This is generally accepted in literature to be best achieved by cycle lanes (Fraser and Lock, 2011). The *cyclability* variable in CNES comprised both cycle lanes and bike parking facilities. The latter was included in analysis as it was deemed particularly important for use of bikes for active travel.

Cycling facilities were present in 35.2% (n=38) of CNES participant neighbourhoods with an average of only 0.6 facilities per neighbourhood. It should be noted that due to the 10% sampling strategy employed in CNES this figure is distorted, therefore approximately 6 facilities is the average density expected to be found per neighbourhood.

The cyclability variable was not included in the dietary intake binary logistic regression model for two reasons: it weakened the model's predictive power (it was included in model building but was removed from the final model accordingly) and it is not discussed in literature as a predictive factor on behaviour. Accordingly cyclability is not discussed in association with this health behaviour.

5.10.1 Physical Activity

Neighbourhood cyclability and PA showed a non-significant *positive* trend in CNES participants. UK-based studies examining this association were limited to those examining active travel to school, therefore studies outside the UK were looked to for comparison. Consistent with the rationale laid out in section 5.9.1 pertaining to cross-national differences in road and street environments (i.e. where some cycling takes place), literature comparison was limited to a European context. Although there is some disparity in cycling culture and road and street environments across Europe (i.e. the Netherlands and Denmark have a stronger culture than the UK), when compared to the wider international disparity (i.e. the USA and Australia) the disparity is lesser; therefore the comparison is more meaningful (Fraser and Lock, 2011).

The majority of literature reported *no* association between PA and neighbourhood cycling facilities. In their UK-based study of 1,121 young people aged 9–10 years (results pertaining to SPEEDY which is previously outlined in section 5.7.1) (Carver *et al.*, 2014) reported school cycling access (comprising cycle lane presence on the route-to-school and on-site school bike lockers, both objectively measured) was *not* associated with children's cycling to school behaviour (self-reported). Prins *et al.* (2009) reported *no* association between neighbourhood cycle lanes, either perceived or actual (objectively measured at the postcode-level), and self-reported time walking/ cycling for leisure (30+ minutes) or doing sports (3+ times weekly) in their study of 654 12–15 year olds from the Netherlands. In a study of active and non-active obese girls aged 12–16 years from Portugal (n=162) Mota *et al.* (2009) reported activity status (self-reported) was *not* associated with perceived neighbourhood cyclability. Similarly, Santos *et al.* (2009) found *no* association between perceived neighbourhood cycling facilities (presence, usability or safety) and self-reported PA in their study of 1,124 Portuguese adolescents (12–18 years). Contrastingly, though consistent with the *positive* but non-statistically significant, direction of association reported in CNES, Panter *et al.* (2010b) reported presence of cycle lanes on the school-route (defined as the area within a 100m buffer of the shortest route to school) were *positively* associated with cycling to school in their UK-based study (SPEEDY) of 186 young people aged 9–10 years.

Broadly, CNES included, studies examining cycling facilities at the neighbourhood level found *no* association with PA. This is likely owing to the proportionally low amount of time spent cycling as an aggregate of total PA by young people. Certainly within CNES participant's time reported cycling constituted only 2.2% of total activity time (proportion of total cohort activity time). Likewise, within CNES cycling facilities were not commonly observed in neighbourhoods, on average 6 per neighbourhood. Whilst this may have been owing to the skewed sampling method, as previously highlighted, it may be that the potential PA *enabling* of these facilities was not fully realised due to insufficient density. Moreover, even when taking cycling behaviour in isolation (of wider PA behaviour) access to cycling facilities is not the only factor involved in cycling behaviour. For example, Carver *et al.* (2014) reported *inverse* association between children's active travel behaviour and parent's limiting of active travel due to traffic concerns. And Kirby and Inchley

(2009) reported children's own concerns around personal safety mediated their likelihood of cycling to school in a qualitative study of 66 Scottish children aged 10–13 years. Within the CNES population Sara (under and healthy weight deviant case) reported some time cycling despite having no neighbourhood cycling facilities; juxtaposition the overweight and obese case pair Josh and Luke who both had neighbourhood cycling facilities but reported no time cycling.
In summary, there is currently insufficient evidence to warrant a recommendation for urban planners to implement cycling facilities to enable PA in young people. Notwithstanding this, there is some preliminary evidence from the UK that town-wide cycle lanes, cycling education and promotion, positively enhance cycling behaviours (Goodman *et al.*, 2013). Further investigation into facilitators of cycling *cultures* and *behaviours* in children and their parents is warranted. There is a need to better understand the salience of cycling facilities beyond other mediating factors, markedly safety concerns, to ensure the public and environmental health (sustainability) benefits can be maximised by urban planners and public health professionals.

5.10.2 BMI

Neighbourhood cyclability was statistically significantly *positively* associated with healthy BMI in CNES participants. Limited investigation of this association in literature means international studies were necessarily used for comparison.

Positive association with BMI outcome, consistent with CNES direction of association, was reported by Slater *et al.* (2010) in their large-scale sample of 16,016 North American adolescents aged 13–16 years. Authors reported presence of neighbourhood bike paths (objectively measured) had a *positive* association with healthy BMI (objectively measured). Likewise, in a study of 2,690 children aged 3–10 from Portugal Ferrão *et al.* (2013) reported parent's perception of neighbourhood places to cycle was *positively* associated with child's healthy BMI (objectively measured). Authors however also found *no* association between child's BMI and parent's perception of neighbourhood cycling facilities or traffic as a cycling deterrent. Timperio *et al.* (2004b): similarly reported *null* association between parent perceived access to bike tracks within the neighbourhood and BMI in their study of 916 families of 10–12 year old children in Australia. Contrastingly in the only UK-based study Harrison *et al.* (2011a) reported *negative* association between school cycling provision (comprising presence of cycle lanes on the roads/ streets surrounding schools and presence of on-site bike lockers) and healthy BMI in girls (objectively measured), but *no* association in boys, in their study of 1,724 young people aged 9–10 years.

Positive association between BMI and cycling facilities is logically assumed to be owing to the facilitation of PA thus increasing energy expenditure and *positively* affecting energy balance. Indeed, in a paper not explicitly examining cycling facilities but interrogating cycling influence on both sides of the energy balance equation, Dudas and Crocetti (2008) reported cycling had greater influence on BMI (positive association with low weight status) than participation in sports, exercise and sedentary time, or dietary composition (n=100, 8–18 years, USA). This mechanism is questionable when taken in conjunction with section 5.10.1 which reported *no* statistically significant association. It is possible that presence of cycling facilities co-locate with other health promoting features or aid in improving environmental perception within the neighbourhood environment – though neither are well established as casual factors.

Generally, literature points to *favourable* association between cycling facilities and BMI when measured at the neighbourhood-scale, but unclear association at the school-fringe scale and according to parent perception. Further work is needed to establish causality and threshold facility levels before policy recommendation would be asserted. Nevertheless cycling facilities are exposed as a viable health-promoting neighbourhood environment feature worthy of further investigation.

Cyclability influence on PA and BMI summary:
Neighbourhood cyclability showed a non-significant positively trend with PA in CNES participants. Across European literature cycling facilities showed *null*

association with PA and neighbourhood cycling behaviour. It was postulated that lack of association was likely owing to the low level contribution of cycling to total PA (i.e. too crude to detect association); low density of cycling facilities and other mediating factors on cycling behaviour (notably safety concerns). Whilst some evidence points to PA enabling of cycling facilities there is a need for better understanding of threshold levels, types of and best location for cycling facilities to best enable PA in young people.

Healthy BMI was statistically significantly *positively* associated with neighbourhood cyclability in CNES. The assumed mechanism of association was facilitation of PA, though this is inconsistent with prior assertions. Consequently there is a need to better understand the mechanics of the association to enable maximising of this health-promoting feature by urban planners and health professionals.

Strengths and Limitations

This section outlines the strengths and limitations of CNES research: Approach, Sample, Methods and Analysis.

CNES strengths and limitation are discussed in turn sub-divided by: Approach, Sample, Methods and Analysis. Attribute strengths and limitations are referenced collectively; this joined up approach to discussion was used to ensure conciseness.

5.11 Approach

A mixed methods approach to research was adopted encompassing both qualitative and quantitative methods. As discussed in section 3.1.1 from page 38 this facilitated data triangulation to offset methodological biases; and supported deep holistic environmental examination using multiple lenses to elaborate a comprehensive understanding. Furthermore, use of both qualitative and quantitative methods ensured the research output was acceptable to both medical and social science research precedents and expectations, i.e. medical sciences is inclined towards quantifiable quantitative evidence preference whereas social sciences places value in both quantifiable and richer meaning based data types.

Mixed methods comparison, asserted as a strength of this approach, was challenging due to the inherently incongruous nature of these evidence types. This was further complicated by the small sample size (discussed further in section 5.12) and the research objective to identify environmental influences within a holistic neighbourhood environment. This disabled the inclusion of all examined factors within the regression model. Therefore it is questionable whether the richness of the data collected was adequately reported in this thesis. This is discussed as a potential pitfall of mixed-methods research by Bryman (2006) and shall be reflected upon in greater detail in section 5.14.

The cross-disciplinary approach to research is a significant strength of this thesis. The need for cross-, multi- and trans- disciplinary study of the obesogenic environment is widely called for in literature owing to its inherent multi-connectedness (Davison and Lawson, 2006; Lake and Townshend, 2006). Examining the physical environment (comprising geography, planning and architecture) through a public-health lens – or arguably vice-versa – is however not without complexity. The disparateness of literature sources; (at times) absence of language cross-over; complexity and specialist nature of the measurement tools; and underlying paradigm precedents added significant complexity to this thesis.

5.12 Sample

A targeted approach to sampling was employed in CNES utilising three national datasets to isolate cases according to features of interest (i.e. controlling for urbanicity and preferencing by socio-economic status and school-level obesity prevalence rates). This targeted approach is a strength of this study on a number of counts: this was the first UK study to author's knowledge to use the NCMP data to preferentially select a study population. During CNES mapping of this data the National Obesity Observatory (2011) released an e-mapping tool to enable such comparison which indicates a desire to use this data for this purpose. The selection of cases based on an outcome of interest, notably high/ low obesity prevalence, is a logical approach and therefore is a strength of this research. The outcome of this approach however had poor follow through for BMI. Correlation between school (high/ low obesity prevalence rate) and child (high – overweight and obese/ low – heathy and underweight) showed no statistical association ($\chi 2=0.19$, $p=0.66$). This was potentially owing to the use of historical data 2007–2010 i.e. with the potential for transient environmental changes, or may be indicative of area-level obesity influence being unable to be determined at the school-level (i.e. due to selective application to schools outside a typically framed catchment area).

Once area-level factors were controlled/ preferenced for CNES adopted a random approach to participant recruitment through schools, i.e. offering equal opportunity for all children to be included in the study. This is a robust recruitment method and is a strength of this research. Participant recruitment however was overseen by school teaching staff which may have been the source of unseen-bias for the researcher; this has been previously discussed in section 5.3. Recruitment by teaching staff limited the burden on school, teacher and participant time and was deemed necessary to maximise recruitment and retention rates. Being beyond the scope of the researcher this bias however could not be verified and therefore represents a limitation of this research.

CNES sample size was small (n=108) and therefore had low-level statistical power, (discussed further in section 5.11) which represented a significant weakness to this research. The sample size was necessarily small due to the capacity of a single researcher completing all data collection and analysis. Positively, the attrition rate of participants was low: 118 recruited, 108 completed; which indicates the study population were highly engaged in CNES, this is a notable strength. As well as being diminutive, the sample were discussed in sections 5.1–5.3 as being poorly representative of the wider UK population according PA, Dietary Intake and BMI. This was previously discussed as likely owing to targeted recruitment strategy (i.e. urban, high/ low affluent school catchment and high/ low school-level obesity prevalence rate). This poor representativeness ensues to the limited generalizability of CNES findings to the wider UK which represents a further weakness of this research; albeit generalizability was not an explicit purpose.

5.13 Methods

The multi-phase multi-method nature of this research is a strength of this research. It enabled the author to draw themes and results from multiple sources to discuss in association with environmental influence discussion. The respective strengths and weaknesses of these methods are discussed in turn.

5.13.1 Objective Exposure Measurement

Environmental exposure was objectively measure by multiple methods within the neighbourhood environment. To ensure conciseness three key themes were drawn out for discussion which are discussed in turn: neighbourhood definition, neighbourhood amenity mapping and neighbourhood amenity classification.

Neighbourhood Definition

CNES defined the neighbourhood environment at the 400 metre postcode buffer-scale. Justification for employing this buffer type and scale are outlined in section 3.16; discussion of this shall therefore not be repeated. Rather, the over-arching approach and assumptions of this method are appraised within this section.

In existing obesogenic environment literature there is an, at times unwritten, assumption that neighbourhoods have inherent *types*, for example: high/ low walkable neighbourhoods or healthy/ unhealthy food environments (Saelens *et al.*, 2012; Adams *et al.*, 2013). CNES found that neighbourhood *types* were, in most cases, neither fully nor even scaled *healthy* or *unhealthy* across all measures within a given *type*[60] (e.g. a neighbourhood may contain predominately healthy food outlets but the closest outlet to home may be an unhealthy outlet), for this reason a critical question is raised about measurement metrics (i.e. access or proximity). To authors knowledge there is a lack of clarity in literature regarding measurement ‘hierarchy of effect’ which is needed to better inform research design. Furthermore CNES found that neighbourhood *types* were not mutually exclusive i.e. a neighbourhood may be highly walkable but contain no leisure facilities, or may be highly enabling of PA but have an unhealthy food environment. This questions the fundamental concept of ‘obesogenic environments’ within a metric buffer, and inherently questions the use of neighbourhood typologies as a viable output. This is worthy of further investigation.

A potential explanation of this was the high-level heterogeneity of neighbourhood environments exposed within the CNES sample. For example one CNES

[60] This interrogation of findings was not discretely reported in the final thesis but was part of the wider CNES analysis, notwithstanding this it would be remiss to exclude from discussion as this is a novel uncovering of CNES results.

participant's neighbourhood environment comprised four distinct areas: industrial, out-of-town shopping, traditional housing with dispersed access to shops and services and a traditional high street. This picture of multi-faceted environment types within a defined buffer was not exceptional. Such heterogeneity further calls into question the use of straight-line or network buffers within a UK context. For example, the justification for using such measures within the US and Australia are owing to the homogeneity of census blocks. CNES results question whether the same rationale is justified within the UK context.

A further limitation of utilising neighbourhood buffers is the inability to adequately capture the *used* environment. It is not unreasonable to assume that young people do not occupy their neighbourhoods within a circular parameter. Though this may justify the use of a larger-scale buffer, there is a danger that greater confounding would occur (i.e. at a big enough scale anything can be found, and the wider the buffer the less likely a child is to interact with the complete area).

On balance, future research of environmental influence on health should preferentially use GPS technology. This tracking technology is enabling of categorical determination (and measurement) of the environment which young people inhabit or use, which would better facilitate robust assessment of environmental influence. GPS technology was considered for use in CNES but was disabled owing to budgetary constraints.

Neighbourhood Amenity Mapping

To author's knowledge this is the first research study to employ primary collection of neighbourhood amenities at this scale i.e. across number of participants and number of variables. Holistic neighbourhood environment assessment is a significant strength of this research.

Neighbourhood amenities comprising: parks, GSs, leisure facilities, shops and services, food outlets and outdoor food advertising were mapped (via GIS) using primary collection of GPS coordinates. This was a significant strength of this research with primary data of this kind accepted as the ‘gold standard’ approach. Primary data collection ensures timely and verified amenity presence; this is especially true for shops, services and adverts which are transient and therefore liable to change (Lake *et al.*, 2012; Burgoine and Harrison, 2013). Use of GPS coordinate mapping enabled examination of both access and proximity to amenities which is a strength. Additionally the robust de-lineation of buffer limits using GIS technology ensured no amenities outside the defined buffer metric biased data.

The mapping of road and street length and type using national datasets is an established and robust means of measurement. These neighbourhood features are significantly less transient than amenities, previously discussed, therefore this was deemed the most appropriate and adequately robust method. Notwithstanding this, alteration of roads/ streets either physically or by classification, is acknowledged as a potential source of bias.

Alongside secondary data, CNES objectively assessed road safety, street quality and density of cycling facilities using the Scottish Walkability Assessment Tool (SWAT). The justification for using SWAT is outlined in detail in section 3.16.6. Triangulation of primary and secondary data to create walkability and cyclability variables is a strength of this study. A 10% random street segment sampling approach was used in accordance with literature precedent: 5–25% (Boarnet *et al.*, 2006; McMillan *et al.*, 2010; Casagrande *et al.*, 2011). McMillan *et al.* (2010) explicitly state a 25% sampling strategy should be adopted for a 400 metre buffer; this was beyond the capacity of the single researcher therefore this is acknowledged as a source of bias, particularly in light of discussion around UK neighbourhood heterogeneity.

Neighbourhood Amenity Classification

Validated classifications were employed across all amenity types. Selection of classification tools was informed by literature preferencing, UK applicability, and intended use for study on young people. Application of these classifications enhances the comparability or generalizability of CNES findings with/ across literature and is a strength of this research.

5.13.2 Perceived Exposure Measurement

Child and parent perceptions of their neighbourhood environments were collected using questionnaires. Questions within children's questionnaires were tested and validated using comprehension testing, see section 3.7 on page 52 for full details. Questions within parent surveys were taken from published studies which employed testing and validation. Use of validated questions is a strength in this research.

The ability to triangulate objective and subjective environment measurement is a strength of this study; though as previously discussed this was not achieved within the regression model. However, a limitation of both surveys was the absence of neighbourhood definition and consequent potential for inconsistency between measured and perceived environments. No definition of neighbourhood was provided in CNES due to the absence of an established definition in literature. More qualitative research is required to better understanding what children and parents perceive the neighbourhood environment to encompass.

5.13.3 Objective Outcome Measurement

BMI was objectively assessed using researcher measured height and weight and categorisation by validated cut-offs. Objective measurement is a strength of this research as this is accepted to be the 'gold standard' of weight measurement. Such measurement omits the widely accepted biases of subjective reporting which is compounded by gender (bias towards females) and weight status (bias towards higher weight status) within young people (Sherry *et al.*, 2007).

5.13.4 Subjective Outcome Measurement

PA and dietary intake were self-reported using a developed-for-purpose feasibility and validity tested four-day dairy (see section 3.8, page 53). Diary content and precedent was developed by the researcher building upon a range of published and validity tested diaries which augments content validity. Diaries have the advantage of capturing data in real-time i.e. not relying on memory recall or quantified estimation of past activity/ consumption which can be complex, especially within young people. Limitations of self-report measures are outlined in detail in sections 3.10 and 3.11 for PA and dietary intake respectively. Moreover, worthy of additional note is a question regarding the ability of young people aged 10–11 years to accurately comprehend and then self-report *time*. As discussed in section 4.13.3 (from page 131) on 15% (n=29 of 189) of break time activity occasions CNES participants reported time <15 or >20 minutes (i.e. the actual break time). This provides an objective indication of the probable extent of PA misreporting in the CNES population (5% under and 10% over reporting). Notwithstanding the valid critique of diaries they were deemed the most appropriate means of collecting behavioural data in CNES congruent with data requirements.

A notable limitation of the CNES diary was the limitation of this method to capture unstructured activities characteristic of young people (Armstrong *et al.*, 1990; Coombes *et al.*, 2013). Without this detailed information it is likely that subtle influences of the environment on behaviour were not fully exposed. GPS enabled accelerometers would overcome this limitation and therefore should be preferenced in future research of this nature. GPS technology was considered for use in CNES but was disabled owing to budgetary constraints.

A further limitation of the CNES diary was the detailed quantification of dietary intake. To minimise reporter burden in CNES food intake was reported ‘as eaten’ without portion information. The consequence of this was crude measurement metrics with insufficient sensitivity to extrapolate detailed dietary intake information.

This is acknowledged as a potential reason for the absence of statistically significant associations observed between the environment and dietary intake.

5.14 Analysis

CNES analysis was broadly segmented into three parts: descriptive analysis, regression analysis and detailed nested case study. Strengths and weakness of these approaches shall be outlined in turn.

Descriptive analysis offers a picture of reality at a snapshot in time. The utility of this picture to inform wider literature is problematic owning to the poor generalizability of the population nevertheless it is a ubiquitous output of an observational study.

Regression analysis was used to draw conclusions about environmental influence on health behaviours and outcomes consistent with research objectives. Binary logistic regression was employed (i.e. rather than multinomial logistic regression) due to restrictions on the data owing to sample size, variable count and ensuing statistical power. Binary logistic regression disables analysis of *scaled* influence and therefore may have had insufficient sensitivity to detect subtle influences. Moreover a number of potentially influential factors were excluded from the model due to model power limitations (i.e. including amenity proximity and child and parent perspective data). This represented a significant weakness of the CNES results. Fundamentally there were multiple ways to interrogate the data and necessary decisions were made on included variables. There is wide-ranging opportunity for additional interrogation of the CNES data deep-diving into highlighted associations of interest. Use of cross sectional data means that CNES was unable to assert causal inferences about whether environmental factors directly affected PA and dietary behaviours or weight outcomes. This represents a weakness of observational approaches to research. Nevertheless CNES has effectively uncovered areas of suggested environment affect which are worthy of further investigation.

Nested case study analysis was adopted in CNES to illustrate and interrogate the intricacies of environmental influence on health behaviours and outcome using *typical* and *deviant* cases. I would question the success of this approach in integrating the multi-factorial influence of the holistic environment. Qualitative interview with these cases would have added richness to these case studies and is a weakness of this approach.

Overarching Conclusions

This section outlines overarching conclusions of this thesis comprising research contribution; research implications for future research and policy; and closing remarks addressing research objectives.

This section outlines key research contributions and corresponding opportunities for health promotion; discusses high-level implications of CNES findings on future research and policy; and addresses key findings under research objectives.

5.15 Research Contribution and Future Research Implications

Eight key research contributions from this thesis have been drawn out of the results and analysis; Table 67 provides a high-level summary. Their contribution to and context within wider literature are discussed in turn with corresponding opportunities for health promotion outlined alongside any overriding future research implications. In addition to future research implications highlighted within this section, additional research suggestion was interwoven within the wider discussion chapter according to variable specific need (sections 5.4–5.10).

5.15.1 Gender

It is well established that young males are *more* physically active than females and findings from CNES support this (Esliger and Hall, 2009; Jones *et al.*, 2009; Pickup and Gunning, 2009; Basterfield *et al.*, 2012). Notably within the CNES study population males spent *more* time in parks, GS and sports facilities and had statistically significantly more *positive* perceptions of neighbourhood activity facilitation than female participants. This is indicative of neighbourhood environment level influence on PA both behaviourally and attitudinally.

Issue	Key contribution	Opportunity
Gender	Males reported *more* time in neighbourhood parks, GSs and sports facilities and had more *positive* perceptions of neighbourhood activity facilitation than females	There is opportunity for public health intervention within the neighbourhood context to address gender disparity
Parks and PA	Neighbourhood access to parks and GSs was *positively* associated with PA Access to these spaces was not equal which represents a public heath injustice	More meaningful partnering between urban planning, Local Authority leisure services planners and public health is needed
Land use	High neighbourhood land use mix was *negatively* associated with PA and BMI	There is a need to elucidate an acceptable mid-point between child and adult preference for mixed land use density to facilitate PA in both population groups and highlight key facets of mixed land use on health
Outdoor food and drink advertising	Novel methods development and testing of an internationally applicable audit tool There were minimal adverts directly targeting children and young people	There is a need for more interrogation of this under-studied area to expose behavioural influence
Walkability	Neighbourhood walkability is enabling of PA but is not without danger	Road safety must be a public health priority to safeguard safety in children
Cyclability	Neighbourhood cyclability was positively associated with healthy weight outcomes	Cycling facilities are a viable health-promoting feature worthy of further investigation
Neighbourhood definition	Neighbourhood definition by metric buffer is an inadequate method of assessing the neighbourhood environment	*Used* environments should be the locale for assessment of environmental influence on behaviour
Cross-disciplinary research	Literature, skills, and precedents are distinct and at times incompatible between planning, geography, architecture, health and medical disciplines	Increased value and salience of cross-disciplinary knowledge would enable more meaningful partnerships

Table 67: Summary of key research contributions (significant associations only)

Though these findings are not novel, they function to reiterate the gender disparity in PA and highlight an opportunity for public health intervention within a neighbourhood environment context.

5.15.2 Parks and GSs

Consistent with wider literature, neighbourhood park and GS access was *positively* associated with PA in the CNES population (Sallis and Glanz, 2006; Limstrand, 2008; de Vet *et al.*, 2011). With this well-established *positive* association, the lack of equality in neighbourhood provision (both access and proximity) and quality of parks and GSs observed across CNES participant's neighbourhoods represents a cause for concern, that being environmental advantage or disadvantage.

There is a need to better understand minimum threshold requirements of access and proximity and gain deeper insight into what draws young people to parks and GS to best enable urban planners to 'plan for health'. Furthermore there is significant opportunity to enhance leisure time within these spaces in a youth population. To facilitate this there is a need for urban planners, Local Authority leisure services planners and health professionals to build stronger and more meaning collaborations to ensure that critical messages between the professional groups are freely shared and exploited.

5.15.3 Land Use Mix

High neighbourhood land use mix was *inversely* associated with PA and healthy BMI in CNES participants. The direction of PA association is broadly inconsistent with the wider literature, see section 5.7.1 on page 270, but the assumed mechanism for *negative* associations were: limited need for active travel owing to close proximity of amenities, low-level usage of these amenities by young people, constrained neighbourhood activity due to loss of open and green spaces which represent established locales enabling of PA, and enhanced access to food outlets which may lead to high-level dwell time (i.e. hanging around convenience outlets) and/ or unfavourable dietary patterns of consumption.

Well-established *positive* association is recognised for mixed neighbourhood land use and PA in adults (Sugiyama *et al.*, 2014). It is questionable as to whether young people readily engage with neighbourhood amenities beyond age-appropriate targeted amenities therefore explaining the disparity of findings across child and adult population literature. If urban planners maximise mixed land uses to enable adult PA, CNES results would argue that in doing so there is a risk of disabling children's PA. Greater clarity of environmental effect on health behaviour and outcomes within younger population groups is recommended to elucidate an acceptable land use mix mid-point enabling of both children and adult PA.

5.15.4 Outdoor Food and Drink Advertising

CNES is within the first handful of studies to investigate the effect of outdoor food and drink advertising on health behaviour outcomes. A principal feature of this research was the development of a bespoke and validity tested outdoor food and drink advert audit instrument.

Exposure to outdoor food and drink advertising within the neighbourhood environment was shown to be *high* across the CNES population. Worthy of note was the high proportion of adverts promoting healthy foodstuffs and scarcity of adverts directly targeted at young people; although the content of the latter was overwhelmingly promoting high fat and/ or sugar food and drinks (Hastings *et al.*, 2006; Pasch and Poulous, 2013). There is a need for further interrogation within this field to better understand the behaviour affecting (or not) nature of these adverts; and any resulting need for advertisement restriction within this context.

5.15.5 Walkability

The direction of association between neighbourhood walkability and PA was ambiguous. Broadly, PA was *positively* associated with neighbourhood street length (and by extension connectivity); associations between PA, road safety and street quality however were unclear. The prominent message from this finding is not to be misinterpreted as 'build more streets' instead, the role of active *travel* and *play* and their enabling by accessible, connected (and safe) streets should be the focus of both future research and urban planning priority.

The ubiquity of roads and associated road safety issues within densely populated and travelled urban neighbourhoods requires that public health policy prioritises road safety education in young people. Especially owing to the constantly reported constraint in child's neighbourhood active travel and play by parents concerned with neighbourhood road safety (Gilhooly and Low, 2005; Jago *et al.*, 2009b; Pearce *et al.*, 2009; Panter *et al.*, 2013). With an established *positive* association between time spent outside and PA within young people, this behaviour needs to be both enabled and secured.

5.15.6 Cyclability

CNES is the first UK study to *positively* associate neighbourhood cycling facilities with healthy BMI in young people. The assumed mechanism of this association was by the facilitation of active travel and it was postulated that there may be co-location of health-promoting facilities within neighbourhoods containing these facilities, though the latter was not confirmed. With low-level density of these facilities observed within CNES population neighbourhoods there is a need to better understand threshold-levels of effect on health outcomes, especially when taking into account the preliminary positive outcomes of cycling facility interventions reported within a UK context (Goodman *et al.*, 2013). Neighbourhood cyclability is viable health-promoting feature which warrants further investigation.

5.15.7 Neighbourhood Definition

The validity of neighbourhood definition by buffer zoning around home addresses was critically questioned as a result of CNES findings. Absence of defined neighbourhood typologies, owing to high-level neighbourhood heterogeneity, fundamentally questions the utility of metric buffers within a UK context. The validity of buffers within rural and international contexts where there is characteristically greater area homogeny is not diminished, though there is a need for further interrogation to confirm this (Burgoine *et al.*, 2011; Boone-Heinonen and Gordon-Larsen, 2012).

The concept of 'neighbourhood' influence according to the environment proximal to home was also questioned. CNES indicates the use of space by young people was characterised by defined activity, for example going to the park, playing in the garden, or shopping. Consequently a question is raised about the use of buffers as an appropriate proxy for *used* environment. It is not unreasonable to project that someone may interact with a limited set of destinations and therefore be unaffected by large swathes of a circular/ network buffer.

5.15.8 Cross-Disciplinary Research

The call for cross-disciplinary research in the study of obesogenic environments is widespread. As previously discussed the practicalities of achieving this are complex: literature is disparate, language and saliency of variables do not align, application of appropriate tools is challenging due to their inherent complexity and specialism, and there are fundamental differences in paradigm precedents and requirements. Similar challenges have been debated by natural and social scientists see papers by Rice (2013) and Cao and Hu (2014) for comprehensive overview.

The call for increased knowledge *sharing* and *application* between planning, geography, architecture, health and medical disciplines will not cease till greater unity is achieved. Increased importance needs to be placed on cross-functional information sharing and dissemination. Furthermore there is a need to better integrate learning and the consistent application of standardised measures across disciplines. For example, teaching planning and health professionals together may better set a precedent for enhanced knowledge cross-overs.

5.16 Recommendations to Academia

Recommendations for academic research are embedded within the neighbourhood amenity discussion chapters (sections 5.5–5.10). Those areas deemed to be of highest priority are also summarised below.

Exploration of the relationship between objective and subjective (the latter both child and parent) park and GS *access* and *proximity* and its determination of *usage* is needed. With greater clarity in this area policy makers would better be able to employ and exploit minimum metric standards (e.g. ANGSt) or alternatively develop more meaningful (“real-world”) standards. CNES represents one of only two studies to have investigated park and GS access and dietary intake association. With both studies indicating a *positive* trend towards access and healthful dietary intake greater exploration of the mechanism and extent of this association is needed.

There is wide heterogeneity in methodology and methods used to characterise and measure neighbourhood land use which precludes definitive health behaviour outcome *associations* and *correlations* within young and adult populations. Greater homogeny would better enable cross-study comparison and subsequent robust research conclusions. There is indication from CNES and other studies that correlation between objective and subjective amenity *presence* and health behaviour *influence* is inconsistent therefore more work is also advised to elucidate this. Furthermore, as outlined in section 5.7.1, behavioural associations in young and adult populations are not compatible therefore the balancing of both group’s needs to be further examined to ensure subsequent policy does not favour one population group at the expense of another.

There is an absence of research interrogating *presence* of and *health behaviour outcomes* associated with outdoor food and drink advertising. Though CNES results failed to reach statistical significance the viability of such associations were not ruled out. Further work in this field is needed to elucidate the translational effect(s) of advertising on diet and BMI outcomes and brand and product awareness. Only with this information are meaningful advertising restrictions or public health policy able to be applied.

There is an absence of qualitative data pertaining to young people interrogating the association between road and street *characteristics* and *use* (the latter both for active travel and play). Without such data, complexity in quantitatively measured behavioural outcome associations is poorly explained within literature. Moreover, as with other facets of the neighbourhood environment, heterogeneity in research methodology and methods impedes robust conclusions.

UK-based research on the facilitators of cycling behaviour (and culture) is needed. Within CNES cycling facilities showed favourable association with BMI despite an absence of association with PA (postulated to be owing to flawed measurement). Robust conclusions within the wider literature are lacking. Consequently there is a need to further explore: causality; threshold facility levels; key site location factors; the role (if any) of co-located health-promoting amenities; and behaviour mediating factors (i.e. own and parent safety concerns). In the absence of such knowledge cycling facility policy and planning regulations within the UK are necessarily founded on an incomplete and unsubstantiated evidence base.

CNES highlighted absence of distinct health-based neighbourhood 'typologies' and critically questioned the utility of metric buffers to define 'the neighbourhood' within a UK context. Further work is needed to better understand subjective and objective *neighbourhood realities* and *used environments* specific to population groups. Work building upon that of Crawford *et al.* (2014) which explores neighbourhood scale parity between participant and investigator defined boundaries is advised.

Finally, there is a need within academia to foster more meaningful cross-disciplinary *information sharing* and *knowledge development* employing cross- and trans- disciplinary research across planning, geography, architecture, health and medical disciplines.

5.17 Recommendations to Government and Policy

Within Section Eight of the NPPF ‘Promoting Healthy Communities’ (2012) the government set out an overarching priority for: social, healthy and inclusive communities; created by Local Authorities with active public engagement; enabled through safe, accessible environments with valued community services and facilities and access to high quality open and green spaces. Whilst it is encouraging to see health represented at the national policy level, the diminutive detail means assessment of the realisation of such health-promoting communities is challenging.

Whilst recognising the wide ranging pressures on built and physical environment design, including but not limited to: economics, sustainability, conservation, climate, infrastructure, design and the competing needs of a diverse population and acknowledging that there are a multitude of factors, outside the environment, which influence health. The following three *general* recommendations to government are proposed:

Firstly, there is a need to better integrate learning and professional networks across planning, geography, architecture, health and medical disciplines to facilitate cross-disciplinary knowledge, working and solutions.

Secondly, there is a need to develop mainstream evidence-based planning and design guidance which enables ‘planning for health’. This should be based on high-quality cross-disciplinary research which would function to bring together, and onwardly align these shared knowledge bases.

Thirdly, there is a need to integrate established knowledge of health promoting planning within existing regulations and guidelines for the built environment with measurable outcomes. For example setting minimum access or proximity guidelines for access to GS. Areas for initial priority should be: parks, GSs and walkability as knowledge within these areas is most well established.

In addition to the *general* recommendations above the following three areas are highlighted as high priority for public health and planning policy *intervention*:

Disparity in gender participation in PA is both well documented and historically enduring – intervention(s) to enhance female participation in activity from a young age (to maximise life-long health benefits and tracked behaviour) is needed. CNES results indicate headroom opportunity to target such interventions within neighbourhood, park, GS and sports facility locales.

Neighbourhood-level park and GS access (and quality) is recognised as unequal within the UK (Institute of Health Equity, 2014). With an increasing body of literature associating parks and GS with health there is a need to ensure ample and equal access to all. Implementation of mandatory policy dictating minimum access and proximity standards would be a useful startpoint.

Active travel offers a significant opportunity to increase PA participation. Whilst designated ‘active time’ (i.e. sports or active play) is optional, travel to and from destinations is obligatory. Active travel therefore affords significant opportunity. CNES highlighted road safety and neighbourhood cycling facilities as enabling of healthful behaviours in young people; as such these areas are recommended to be the focus of intervention for this population group.

5.18 Overall Conclusions

This section summarises *statistically significant* results only under the four thesis research objectives before presenting final concluding summing up the overall contribution of this research.

5.18.1 Environmental Correlates of Energy Expenditure

Youth PA was shown to be *enabled* by neighbourhood access to parks and GSs, especially parks containing facilities for structured play (i.e. playground equipment and sports pitches). Sizeable headroom opportunity to increase time within these spaces was indicated, therefore they represent a meaningful opportunity as sites for public health intervention; especially those targeted at young girls. Park access was unequal across the study population which is indicative of environmental injustice. With inconsistency between perceived and actual access to parks and GS better understand is needed about the mediating role of perception on usage.

Neighbourhood walkability was indicated as an *enabler* of PA in young people, although not all elements showed consistent direction of association within this variable, and there was some inconsistency with the wider UK literature. More work is needed within the UK context are needed to elaborate opportunity for facilitated active travel and play. Environmental safety and perceptions of this (both in children and especially their parents) were critical moderators of active travel and activity performed within these spaces. Owing to this, and the ubiquity of road safety hazards in densely populated and travelled urban areas, securing road safety must be a priority.

Mixed neighbourhood land use was indicated as *disabling* of youth PA. This was postulated to be owing to the reduced need for active travel owing to having neighbourhood amenities within close proximity; low-level use of these amenities; constrained access to parks and GS (PA enabling locales) owing to loss of these land uses; and potentially longer dwell time around fast food and convenience stores. With well-established positive associations accepted between high land use mix and adult PA there is a need to better understand which facets of land use are enabling or disabling of PA within these two population groups to ensure maximised PA outcomes for both groups.

5.18.2 Environmental Correlates of Energy Intake

Despite non-significant association between neighbourhood food environment and dietary intake there was some indication of positive/ negative influence according to food environment healthiness/ unhealthiness respectively. Development of a bespoke outdoor food and drink advertising tool and the profiling of neighbourhood food and drink advertising environments was a novel feature of this research. Notwithstanding the absence in association significance reported between advert density and dietary outcomes, this association was not ruled out and is worthy of further investigation.

5.18.3 Environmental Correlates of Energy Balance

Elevated weight status was *positively* associated with mixed neigbourhood land use, the assumed mechanism for this association was by the enabling of active travel, active play, enhanced sedentary time and unfavourable dietary intake owing to the co-location of food outlets in areas with high mixed land use. There is a need for greater consistency in *amenity* and *access* definition within the field; as well as better understanding of the specific facets of land use which are enabling or disabling of energy intake and expenditure to fully comprehend the association with healthy behaviour outcomes. *Positive* direction of association between neighbourhood cycling facilities and healthy BMI was observed in this research which is consistent with wider literature. Further work is needed to establish both causality and threshold facility levels to best maximise cycling facilities as a health-promoting neighbourhood environment feature.

5.18.4 Personal Correlates

A weakness of the analytical approach of this research was the exclusion of personal correlates (except for gender and deprivation) included within the binary logistic regression association analysis. Owing to this personal correlates were not fully explored as mediating factors on environmental influence. There is ample opportunity to supplement the thesis output with further analysis of this nature.

Notwithstanding this, in the case study analysis which contrasted objective and subjective environmental assessment child and parent environmental perceptions were indicated to mediate behaviour in disparate ways. Parental perceptions, especially of child safety, were strongly indicated to restrict children's use of the neighbourhood environment which is consistent with the wider literature.

5.18.5 Concluding Remarks

This research is the first of its kind within the UK to measure and associate holistic multi-faceted, multi-factorial physical and built neighbourhood environments with health behaviours and outcomes across the energy balance equation. This research has succeeded in identifying strategic areas to target further investigation, public health intervention and health promoting urban planning. As well as raising critical questions about the means of measuring the environment to assure meaningful outcomes within a UK context.

Public health and urban planning priorities highlighted:

- Address gender disparity in PA participation;
- Ensure ample and equal access (with measurable policy metrics) to parks and GSs within the neighbourhood environment to facilitate PA;
- Maximise active travel by: 1) prioritising children's road safety knowledge and application (where possible include parents to maximise PA facilitation) and 2) providing neighbourhood cycling facilities where safe cycling is compromised;
- Enhance current cross-disciplinary networks and information sharing between health and planning professionals developing and augmenting policies according to enhanced understanding.

Academic research priorities highlighted:

- Address shortcomings in knowledge regarding subjective and objective neighbourhood-level park, GS and other amenity access and proximity and the resultant health behavioural outcomes;

- Address shortcomings in knowledge regarding the association (extent and mechanism) between parks and GSs and dietary intake;
- Address shortcomings in knowledge regarding optimal land use mix to facilitate PA in both adults and children;
- Address the absence of knowledge regarding behavioural outcomes of outdoor food and drink advertising;
- Address the shortcomings in knowledge regarding optimal neighbourhood-level cycling facility density and health behavioural implications;
- Implement consistency in neighbourhood definition based on robust investigation of subjective and objective realities and used environments according to population groups;
- Moderate heterogeneity in characterisation, methodology and methods used to examine neighbourhood environment amenities and health behaviours within these spaces;
- Enhance cross-disciplinary information sharing and knowledge development across health and planning disciplines.

Appendices

This section contains supplementary materials to the Thesis. Where appropriate/ possible the full material is provided, where this is not the case full materials are provided on the supplementary Appendices Disk.

Full Ethical Assessment Form

Newcastle University

APPLICATION FOR ETHICAL APPROVAL OF A RESEARCH PROJECT FROM FACULTY ETHICS COMMITTEE

This application form is to be used by **STAFF** and **PGR STUDENTS** seeking ethical approval for an individual research project where preliminary ethical assessment indicated full ethical review was required.

A completed version of this document should be emailed to the Secretary of your appropriate Faculty Ethics Committee in the University. *Applications must be completed on this form; attachments will not be accepted other than those requested on this form. This form has been designed to be completed electronically; no handwritten applications will be accepted.*

Research must NOT begin until approval has been received from the appropriate Faculty Ethics Committee.

SECTION 1: APPLICANT DETAILS

Name of Researcher (Applicant):	Rachel Gill Gallo
Email Address:	Rachel.Gallo@ncl.ac.uk
Faculty & School:	Architecture, Planning and Landscape
Contact Address:	School of Architecture Planning and Landscape, Newcastle University, Claremont Tower, Claremont Road, Newcastle upon Tyne, NE1 7RU
Telephone Number:	07824614207

SECTION 2: PROJECT DETAILS

Project Title:	Exploring the relationship between prevalence of overweight and obesity in 10-11 year olds and the outdoor physical environment, North East England	
Name of Supervisor(s) (for PGR):	Tim Townshend (Newcastle University Amelia Lake (Northumbria University) Louisa Ells (North East Public Health Observatory)	
Is this project:	Internally Funded ☐	Externally Funded ☒
If externally funded, please provide the My Projects BH reference number:	BH 083190	
Category of Research:	Postgraduate Research ☒	Staff Research ☐

Full_ethical_assessment_form_Rachel_Gallo_2 Page 1

Figure 88: Ethical approval final draft (part 1 of 10)

SECTION 3: TYPE OF PROJECT

Please indicate the predominant nature of this project (tick one box only):

Questionnaire/Survey e.g. surveys of members of particular groups / organisations; mail out questionnaires, street surveys	☐
Experiments e.g. participants completing tasks under controlled conditions, use of tasks/method other than or in addition to questionnaires/surveys	☐
Observational e.g. observing how people behave in a natural setting or in a laboratory	☐
Data-based e.g. the use of official statistics where individuals could be identified	☐
Other	☒
If you answered 'Other' please describe.	Phase 1: Cognitive Interview Young people 10–11 years will be asked to complete a cognitive interview regarding comprehension of a 4-day Food and Activity Photo Diary. Phase 2: Pre-pilot Young people 10–11 years will complete a small group focus group discussing diet, activity and suitability of a 4-day estimated Food and Activity Photo Diary. They will also complete an observed half day estimated Food and Activity Photo Diary. Phase 3: Pilot and Main Studies Young people 10–11 years will be asked to complete a 4-day estimated Food and Activity Photo Diary and be height and weight measured. Young people's parent/guardians shall complete a questionnaire assessing attitudes towards their local neighbourhood environment, food and activity. School food and activity environments shall be audited. Postcode data will be collected, 400m buffer zones will be mapped from postcode centroid around young people's homes and schools. Buffer zones will be audited to assess local environment exposure to food and activity facilities and amenities. A number of validation studies will support research method validity (phases 1 and 2).

Figure 89: Ethical approval final draft (part 2 of 10)

SECTION 4: PROGRAMME STUDY DETAILS

Proposed date on which project or study will begin:	01/04/2011
Proposed date on which project or study will end:	31/08/2012

Project Outline & Aims:
Briefly describe the aims of this research as well as the main tasks (or tests) that participants will be required to complete or what use will be made of sensitive economic, social or personal data. This description must be in everyday language, free from jargon, technical terms or discipline-specific phrases.
(No more than 300 words) aggressive

The physical environment influences obesity by providing opportunities for energy intake and expenditure, the two key factors in the obesity equation. Mechanisms that cause obesity are however, extremely complex[1]. The aim of this study is to explore the ways in which physical environment factors affect energy intake behaviour (food acquisition, in who's company, types and amounts of foods eaten etc) and energy expenditure (setting, nature of, in who's company etc), and thus energy balance and adiposity among 10–11 year olds.

This research will use mixed methods and multi-disciplinary expertise to explore in-depth the nature of the physical environment of the areas identified in the mapping exercise. This will be carried out in a number of phases.

1) Pre-pilot Cognitive Interview
Young people 10–11 years will be questioned about their comprehension of a Food and Activity Photo Diary to ensure diary is fit for purpose.

2) Pre-pilot
Focus groups will be held with young people to establish an 'average' sphere of influence around their school and home in relation to physical activity and food behaviours (i.e. the physical environment in which they mostly engage). Children shall also validate Food and Activity Photo Diary.

3) Pilot and Main Studies
Young people shall complete a 4-day Food and Activity Photo Diary to include school and weekend days establishing patterns of actual behaviour in the environment.

Young people's parents will complete a Questionnaire assessing attitudes towards their local neighbourhood environment, food and activity.

School food and activity environments shall be audited.

A buffer (e.g. 400m) will be drawn around home and school postcode centroids to map areas for detailed audit survey. Local environments shall be audited for 1. Food outlet access, availability and healthfulness; 2. Facility/amenity provision; 3. Green Space and Leisure Centre quality and service provision; 4. Walkability.

1. Butland B, Jebb S, Kopelman P, McPherson K, Thomas S, Mardell J, et al. 2007. FORESIGHT Tackling Obesities: Future Choices – Project Report.

PROPOSED RESEARCH METHODS
Please provide an outline, in layman's terms, of the proposal research methods, including where and how data will be collected and stored, and all tasks that participants will be asked to complete. Specify if the research will take place outside of the UK or in collaboration with internationally-based

Figure 89: Ethical approval final draft (part 3 of 10)

partners, and/or if research will take place using the Internet. Present an outline of the method in a step-by-step chronological order, and avoid using jargon and technical terms as much as possible. (No more than 700 words)

This research will be completed in Durham and Newcastle Upon Tyne. There are three main phases of research which shall be discussed in turn; phases will inform research methods sequentially.

1) Pre-pilot Cognitive Interview
Convenience sample, 4 young people, proposed time April 2011

Young people 10–11 years will be interviewed to assess comprehension and suitability of the 4 day estimated Food and Activity Diary (appendix A). Young people will be asked to read, part-complete and answer questions about the diary (appendix B1, B2, B3). Interviews will be held at participant's homes or in Newcastle or Northumbria University buildings.

2) Pre-pilot
School recruited sample*, Durham, 10 young people, proposed time April – May 2011

Young people will validate tools and guide focus of research. Consenting young people will participate in a focus group (3 – 4 students per group) where they will be asked to discuss their neighborhood environment, eating and activity behaviours (appendix C). Young people will undertake training in how to complete the Food and Activity Photo Diary (appendix D1, D2, D3, D4). Young people shall undertake observed diary completion for 1 school day. Young people will be observed in dining hall and playground during break and lunch times (appendix E).

3) Pilot and Main Studies
School recruited sample*, Durham, Gateshead, Newcastle upon Tyne, and Sunderland 12 and 128 young people, proposed times June – July 2011 and October 2011 – August 2012

Young people will undertake training in how to complete the Food and Activity Photo Diary (appendix F1_draft2, F2_draft2, F3, F4, F5). Young people shall complete the 4 day Food and Activity diary – 2 school and 2 weekend days. Parents will receive instructions to help them in supporting their child to complete the Diary (appendix P1) and a reminder half way through the study (appendix P2). If children do not complete their diaries correctly on their first attempt they will be asked to have a second go; parents will receive a prompt letter (appendix P3). Young people shall complete a follow-up interview (appendix G) discussing missing/ unclear data. Young people shall be height and weight measured by 2 trained researchers (appendix H). If children fail to return their diary or camera they will receive a letter for parents to take home (appendix P4); the school shall also be informed as asked to support the researcher in retrieval.

Young people's parents shall undertake a Questionnaire (appendix I_draft2) about their opinions and values around the neighbourhood environment, dietary and activity behaviours.

School food and activity environments shall be audited: school dinner menu shall be measured against school food policy to assess compliance, kitchen staff shall be informally interviewed about school food and school playground and green spaces shall be audited using SPEEDY audit tool[1].

Local food and activity environments (400m buffer zones around home and school postcode centroids) shall be audited. The food environment shall be audited using: 25 point classification tool[2]; Measuring Food Environment tools[3]; static advertisement shall be counted photographed and classified. Neighborhood environments shall be audited using: Ordinance Survey Points of Interest Classifications[4] and Observational Park Audit Tool[5]. Leisure Centres shall be assessed for age appropriate service provision and cost and Walkability factors shall also examined.

All paper records for this study will be handled confidentially and held securely at Newcastle University. There is no public access to the building where the paper records will be held. Electronic

Figure 89: Ethical approval final draft (part 4 of 10)

data will be stored on a computer system that is not a public access network, and on a database accessible only to members of the research team.

* Schools will be recruited according to recruitment criteria: identified as within a hot/ cold spot for childhood overweight and obesity according to National Child Measurement Programme data. High and low SES areas and matched for urbanicity.

1. Jones NR, Jones A, van Sluijs EMF, Panter J, Harrison F, Griffin SJ. 2010. School environments and physical activity: The development and testing of an audit tool. Health & Place 16(5): 776-783.
2. Lake AA, Burgoine T, Greenhalgh F, Stamp E, Tyrrell R. 2010. The foodscape: Classification and field validation of secondary data sources. Health & Place 16(4): 666-673
3. Lake A, Tyrrell R, Greenhalgh F, Stamp E, White M, Mathers J, et al. In preparation. Measuring the Food Environment of Young Adults: the development and early piloting of tools.
4. OS Ordinance Survey. 2011. Point of Interest Classifications. Available: http://www.ordnancesurvey.co.uk/oswebsite/products/pointsofinterest/classifications.html [accessed 16/03/11].
5. Gallo R, Townshend T, Lake A. Under review. Measuring the Park Environment in relation to Physical Activity – Development and validity testing of an Observational Park Audit Tool.

SECTION 5: PARTICIPANT DETAILS

Does this research specifically target (select all that apply):

Students or staff of this University	☐
Adults (over the age of 18 years and competent to give consent)	☒
Children/legal minors (anyone under the age of 18 years)	☒
The elderly	☐
People from non-English speaking backgrounds	☐
Welfare recipients	☐
Anyone who has a physical disability	☐
Clients of professionals	☐
Anyone who is a prisoner or parolee	☐
Any groups where a leader or council of elders may need to give consent on behalf of the participant	☐

Number of participants required:	154
Age from:	10 years
Age to:	11 years and parents
Source and means by which participants are to be recruited:	1) Pre-pilot Cognitive Interview A convenience sample of 4 young people will be recruited through posters displayed in Newcastle and Northumbria Universities. Recruitment data shall also be displayed on Newcastle University

Figure 89: Ethical approval final draft (part 5 of 10)

	IHS sharepoint. 2) Pre-pilot Ten young people will be recruited through schools chosen according to recruitment criteria as previously discussed. 3) Pilot Twelve young people will be recruited through schools chosen according to recruitment criteria as previously discussed. 4) Main Study One hundred and twenty eight young people will be recruited through schools chosen according to recruitment criteria as previously discussed.

	YES	NO
Does this project require approval from an external authority (e.g. LEA, school, governing body)?	☒	☐
Has approval already been granted?	☐	☒ School approval pending recruitment

SECTION 6: PARTICIPANT INFORMATION	YES	NO
Will you inform participants that their participation is voluntary?	☒	☐
Will you inform participants that they may withdraw from the research at any time and for any reason?	☒	☐
Will you inform participants that their data will be treated with full confidentiality and that, if published, it will not be identifiable as theirs?	☒	☐
Will you provide an information sheet that will include the contact details of the researcher/team?	☒	☐
Will you obtain written consent for participation?	☒	☐
Will you debrief participants at the end of their participation (i.e., give them an explanation of the study and its aims and hypotheses)?	☒	☐
Will you provide participants with written debriefing (i.e., a sheet that they can keep that shows your contact details and explanations of the study)?	☒	☐
If using a questionnaire, will you give participants the option of omitting questions that they do not want to answer?	☒	☐
If an experiment, will you describe the main experimental procedures to participants in advance, so that they are informed about what to expect?	☐	☐
If the research is observational, will you ask participants for their consent to being observed?	☒	☐

Figure 89: Ethical approval final draft (part 6 of 10)

Full Ethical Assessment Form

Newcastle University

SECTION 7: PARTICIPANT CONSENT

Please describe the arrangements you are making to inform participants, before providing consent, of what is involved in participating in your study:

1) Pre-Pilot Cognitive Interview
A convenience sample of young people (10–11 years) will be recruited through posters (appendix J1) and interactive display in Newcastle and Northumbria Universities. In the first instance parents/guardians will receive a recruitment leaflet (appendix J2) stating what will be involved in the pre-pilot study. Before beginning the Cognitive Interview the researcher shall discuss with the young people what will be involved in the study.

2) Pre-Pilot
Young people (10–11 years) will be recruited through schools (appendix K1) chosen according to recruitment criteria. In the first instance schools will receive a recruitment letter (appendix K2) and study information leaflet (appendix K3) detailing what the pilot study involves. This will be followed up by a phone call to ascertain whether they would be interested in taking part offering schools a chance to question researcher about the study. On receipt of the school consent form and according to a pre-agreed recruitment procedure, children will deliver recruitment leaflet (appendix L1) stating what will be involved in the pilot study to parents. Before beginning the focus group the researcher shall discuss with the young people what will be involved in the study.

3) Pilot and Main Studies
Young people (10–11 years) will be recruited through schools (appendix M1_draft2) chosen according to recruitment criteria. In the first instance schools will receive a recruitment letter (appendix M2_draft2) and study information leaflet (appendix M3_draft2) detailing what the study involves. This will be followed up by a phone call to ascertain whether they would be interested in taking part offering schools a chance to question researcher about the study. Schools will receive confirmation by letter or email (appendix Q1 and Q2). On receipt of the school consent form and according to a pre-agreed recruitment procedure, children will deliver recruitment information to parents. Recruitment information shall contain a recruitment leaflet (appendix N1_draft2) stating what will be involved in the study. Promotional posters (appendix M5_draft2) will be sent to schools to promote study participation; they shall be displayed at the school's discretion. Before beginning the study the researcher shall discuss with the young people what will be involved.

Please describe the arrangements you are making for participants to provide their full consent before data collection begins:

Written consent will be obtained from young people and parents. Verbal consent will also be obtained from young people before study commences. Written consent shall also be obtained from School Head teachers when schools are the route of recruitment.

1) Pre-Pilot Cognitive Interview
In the first instance parents/guardians will receive a consent form (appendix J2) stating that there is no obligation to take part in the study and that participants are free to withdraw at any time. Before beginning the interview the researcher shall discuss with the young people what will be involved in the study, show young people their consent forms and offer a chance to withdraw.

2) Pre-Pilot
In the first instance schools will receive a consent form (appendix K4), alongside the recruitment letter and leaflet, stating that there is no obligation to take part in the study and that participants are free to withdraw at any time. On receipt of the school consent form and according to a pre-agreed recruitment procedure children will deliver a consent form (appendix L1) to parents. Consent form states that there is no obligation to take part in research and that participants are free to withdraw at any time. Before beginning the study the researcher shall discuss with the young people what will be involved in the study and show young people their consent form offering a chance to withdraw.

Full_ethical_assessment_form_Rachel_Gallo_2 Page 7

Figure 89: Ethical approval final draft (part 7 of 10)

3) Pilot and Main Studies
In the first instance schools will receive a consent form (appendix M6), alongside the recruitment letter and leaflet, stating that there is no obligation to take part in the study and that participants are free to withdraw at any time. On receipt of the school consent form and according to a pre-agreed recruitment procedure children will deliver a recruitment leaflet (appendix N1_draft2) stating that their child will be participating in the study unless they opt-out using the consent form. Consent form states that there is no obligation to take part in research and that participants are free to withdraw at any time. Before beginning the study the researcher shall discuss with the young people what will be involved in the study and offer a chance to withdraw.

Participants should be able to provide written consent. If you think gaining consent in this way is inappropriate for your project, then please explain how consent will be obtained and recorded.

SECTION 8: PARTICIPANT DEBRIEFING

Please describe the debriefing that participants will receive following the study and the exact point at which they will receive the debriefing:

On completion of the study, during the final interview, all participants will be personally thanked for their involvement in the study and be presented with an envelope containing a letter of thanks (appendix O1), certificate (appendix O2) and £5 Shopping voucher. Schools shall also receive a letter of thanks (appendix O3).

Once all data have been collected and analysed participants will receive a lay summary detailing the findings of the study and the anticipated impact of the research. This cannot be produced in advance of the study analyses.

It is a researcher's obligation to ensure that all participants are fully informed of the aims and methodology of the project, and to ensure that participants do not experience any levels of stress, discomfort, or unease following a research session. Also describe any particular provisions or debriefing procedures that will be in place to ensure participants feel respected and appreciated after they leave the study. Please attach the written debriefing sheet that you will give to participants. If you do not plan to provide a written debriefing sheet, please explain why.

SECTION 9: INSURANCE & RISK CONSIDERATIONS

The appropriate arrangements concerning insurance and/or indemnity to meet the potential legal liability of the University or other external funders for harm to participants arising from the management, design and conduct of this research will be confirmed by the University's Insurance section.

Potential risk to participants and risk management procedures

Identify, as far as possible, all potential risks (small and large) to participants (e.g. physical, psychological, etc.) that are associated with the proposed research. Please explain any risk management procedures that will be put in place and attach any risk assessments or other supporting documents.

There are six ethical issues:

Vulnerable study participants:

Researcher has obtained full CRB clearance.

One-to-one interactions with study participants in the Pre-pilot Cognitive Interview phase shall be performed in the participant's home or in university buildings with supervision from parent. All one-to-one interaction with study participants in the Pre-pilot, Pilot and Main Studies shall be done within schools. Room door shall be left open and child will sit closest to the door to allow easy exit. It shall

Figure 89: Ethical approval final draft (part 8 of 10)

be requested that the room schools provide to researcher have a clear window.

During weight and height measurements two research assistants subject to enhanced CRB check shall be present at all times. Measurements shall be taken for children one at a time, not in front of other children or staff members. No data shall be shared. Measurements shall follow National Child Measurement training and protocol[1].

The focus of this research being diet and activity may invoke elevated attention to be paid to the role of body-size/shape in children which has the potential to result in problems surrounding self-esteem and emerging identity. When training children to complete Food and Activity Diary researcher shall stress that all children lead different lifestyles and that these may be influenced by the physical environment in which they live – no comment shall be made about 'more' or 'less' healthy or desirable. When measuring children researcher shall avoid making comparison between children and, if questioned by children will comment that 'all children have different shapes and sizes' – no comment shall be made about 'more' or 'less' healthy or desirable. Researcher will ensure school nurse is made aware of children being height and weight measured to alert them to the potential of increased questions regarding body size/shape.

Consent – for the cognitive interview and pre-pilot fully informed written consent will be obtained from young people and parents opting-in to the study. For the pilot and main studies parents and children will be offered to opt-out of the research using fully informed written consent. Particular care will be taken to ensure that participants are not coerced and confirmation of understanding will be obtained by verbal consent before the commencement of all phases of research. Fully informed verbal consent will be obtained from staff at retail and leisure facilities/services before auditing.

Participant and Area confidentiality – children will be assigned ID number and will not be identified by name during analysis. Areas shall be assigned ID number and pseudonyms during analysis and reporting. Results will be presented in summarised tabulated form and no information will be attributable to individuals.

Data confidentiality – all paper records for this study will be handled confidentially and held securely at Newcastle University. There is no public access to the building where the paper records will be held. Electronic data will be stored on a computer system that is not a public access network, and on a database accessible only to members of the research team.

Observation of the local food and activity environments - auditing of local environments is not centred on people and is publically accessible data. Anonymity of retail outlets and activity facilities/amenities shall be ensured by exclusion of outlet names and classification into broad groupings.

Invasion of privacy - auditing of local environments shall be completed during school time hours to avoid researcher and research participant meeting outside formal settings. Children will be advised during training to keep diary information shielded from other children. This will avoid any copying of data or personal information sharing which may be of a sensitive nature.

1. Cross-Government Obesity Unit. 2010. The National Child Measurement Programme Guidance for PCTs 2010/11. London.

Potential risk to researchers and risk management procedures

What are the potential risks to <u>researchers</u> themselves? For example, personal safety issues such as lone or out of normal hours working or visiting participants in their homes; travel arrangements, including overseas travel; and working in unfamiliar environments. Please explain any risk management procedures that will be put in place and attach any risk assessments or other supporting documents.

Figure 89: Ethical approval final draft (part 9 of 10)

Full Ethical Assessment Form

Newcastle University

Cognitive Interview one-to-one interactions shall be done with within private residences or public buildings. When interviews are to be performed in private buildings researcher shall call in and out at designated times. When in public buildings room doors shall be left open and parental supervision shall be requested. For the Pre-pilot, Pilot and Main Studies all one-to-one interactions with study participants shall be done within public buildings. Room doors shall be left open and adherence to school safe practice guidance shall be followed. Observation of neighbourhood food and activity environments shall be completed in daylight hours. Researcher shall contact designated safety contact hourly. A fully charged mobile phone with university emergency contact number and local police number saved on phone shall be carried at all times.

SECTION 10: SUPPORTING DOCUMENTATION

Please supply copies of any applicable documents in support of your answers. Ensure that attached files have appropriate file names.

Document	Attached
Participant Consent Form	☒
Participant Information Sheet	☒
Participant Debriefing Document	☒
Questionnaire(s)	☒
Outline Protocol	☒
Risk Assessment	☒
Others (please list):	See other appendices

SECTION 11: DECLARATION

I certify that the information contained in this application is accurate. I have attempted to identify the risks that may arise in conducting this research and acknowledge my obligations and the rights of the participants.	
Name of Principal Investigator:	RACHEL GALLO
Signed:	
Date:	19-5-11

If you have any queries on this form, please contact your Faculty Ethics Coordinator or visit the website at http://www.ncl.ac.uk/business-directorate/ethics/index.php

Please email or send this form to the appropriate Faculty Ethics Coordinator

Full_ethical_assessment_form_Rachel_Gallo_2 Page 10

Figure 89: Ethical approval final draft (part 10 of 10)

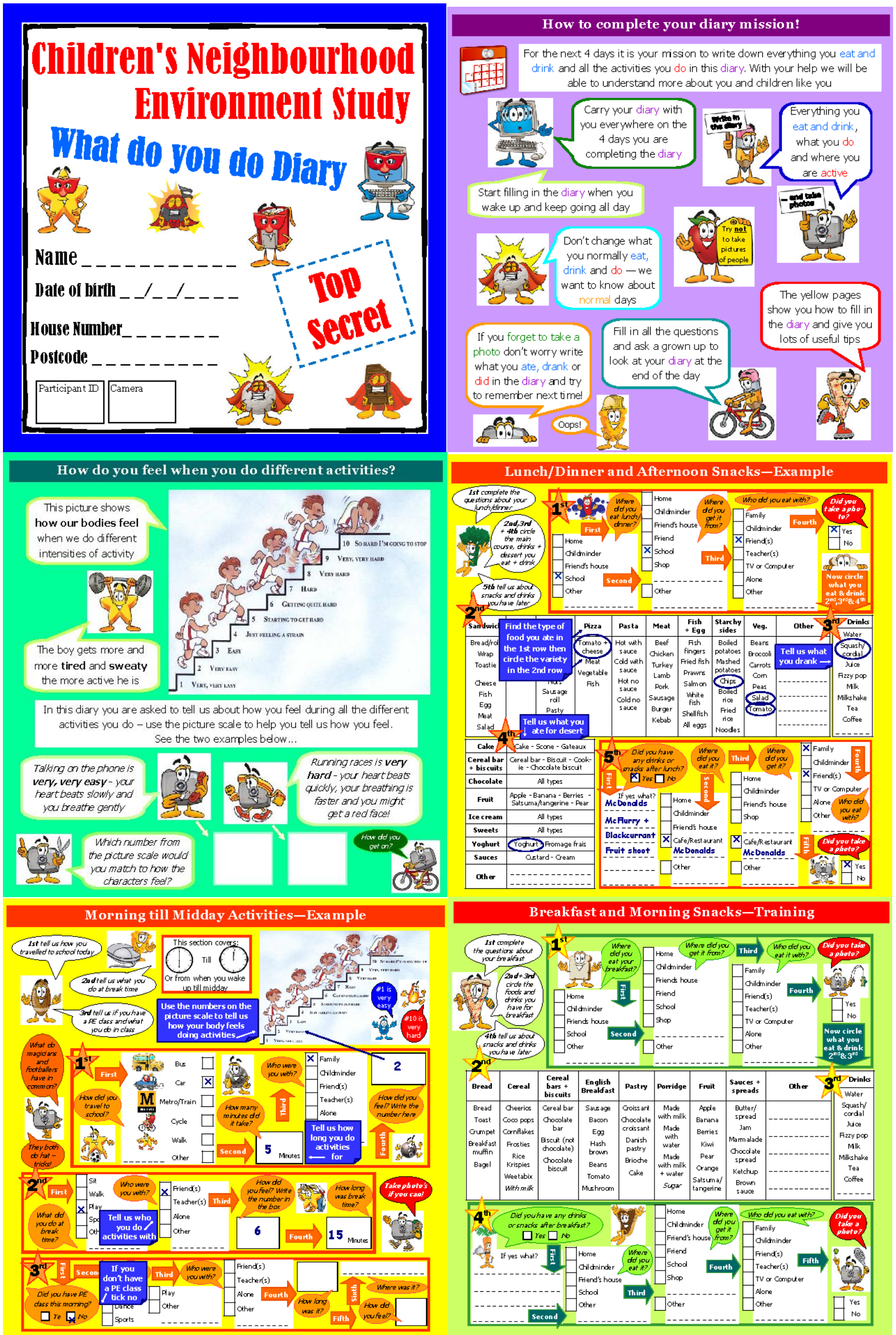


Figure 89: Exert from four day Activity and Dietary Intake Diary (part 1 of 2)

For Full Diary refer to the Appendices Disk

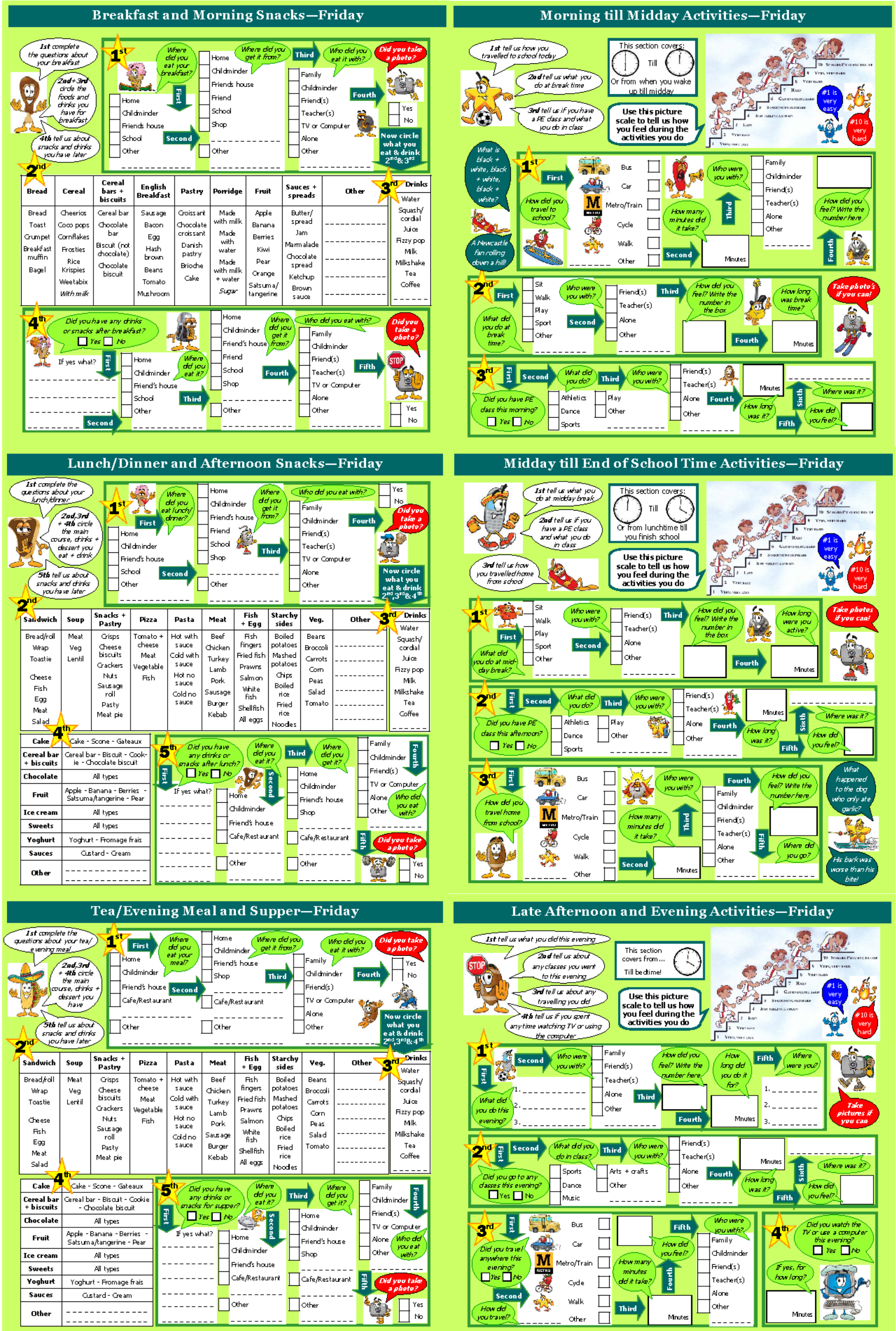
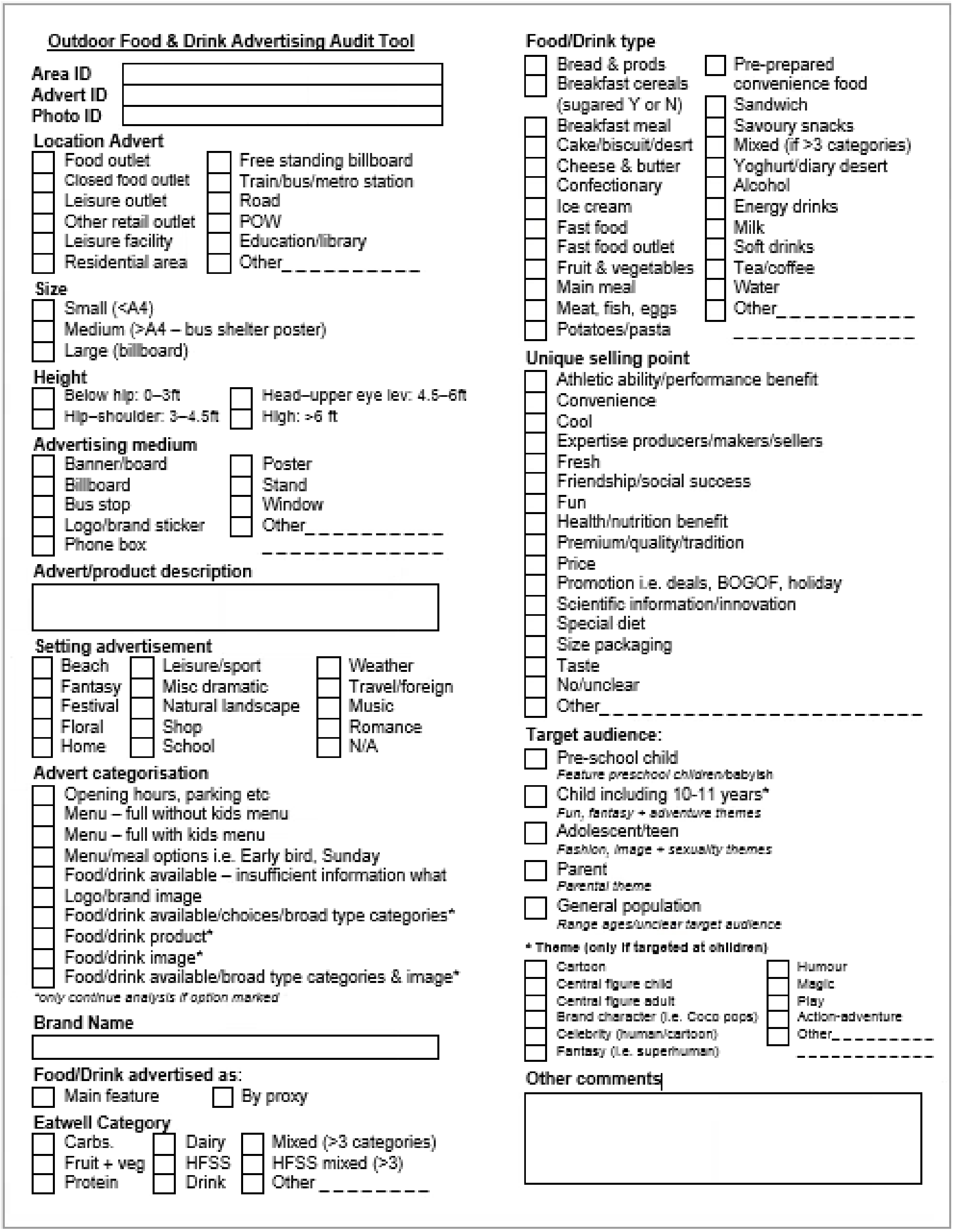


Figure 89: Exert from four day Activity and Dietary Intake Diary (part 2 of 2)

For Full Diary refer to the Appendices Disk

Stage	Protocol
Set up	• Measurements were taken within-school in a private room or screened-off area where results were secure and could not be heard by anyone not directly involved in taking the measurements; • Leicester Portable height measure and Tanita TBF 300MA scales were assembled on firm, level surfaces. Set-up was checked by two trained researchers; • Equipment was sterilised using antiseptic wipes between uses
General matters	• Researchers were aware of the sensitive nature of participants being measured and were sensitive to anxieties and respectful of privacy dignity and cultural needs. Participants were never coerced into being measured; • Measurements were not shared with participants unless requested and data was not disclosed to school staff; • Two researchers were present at all times, one took the measurements and the second double-checked measurement and positioning; • Measurements were entered onto paper spread-sheet at the moment of collection but were transferred to an encrypted, password-protected computer and anonymised by ID on the day of measurement. Spread-sheets were securely discarded
Measuring height	• Participants were asked to remove outdoor (heavy) clothing, shoes and socks; • Participants were asked to stand on the height measure with their feet flat on the floor, heels together and touching the base of the vertical measuring column; • Participants were asked to relax their arms and bottom with shoulders touching the vertical measuring column; • Participants were guided to move their head so that the Frankfurt Plane was horizontal; • The measuring arm of the height measure was lowered gently but firmly onto participant's head; • One researcher ensured the participant maintained the correct position/ posture whilst the second read the measurement; • Height in metres and centimetres was measured to the first decimal place; • Measurements were taken twice and mean result used
Measuring weight	• Participants were asked to remove outdoor clothing, shoes and socks; • Participants were asked to stand still and face forwards with both feet in the centre of the scales; • Weight in kg was measured to the first decimal place; • Measurements were taken twice and mean result used

Table 68: CNES height and weight measurement protocol (informed by and consistent with NCMP protocol (Department of Health Obesity Team and Department for Education, 2011))



Outdoor Food & Drink Advertising Audit Tool

Area ID
Advert ID
Photo ID

Location Advert
- Food outlet
- Closed food outlet
- Leisure outlet
- Other retail outlet
- Leisure facility
- Residential area
- Free standing billboard
- Train/bus/metro station
- Road
- POW
- Education/library
- Other__________

Size
- Small (<A4)
- Medium (>A4 – bus shelter poster)
- Large (billboard)

Height
- Below hip: 0–3ft
- Hip–shoulder: 3–4.5ft
- Head–upper eye lev: 4.5–6ft
- High: >6 ft

Advertising medium
- Banner/board
- Billboard
- Bus stop
- Logo/brand sticker
- Phone box
- Poster
- Stand
- Window
- Other__________

Advert/product description

Setting advertisement
- Beach
- Fantasy
- Festival
- Floral
- Home
- Leisure/sport
- Misc dramatic
- Natural landscape
- Shop
- School
- Weather
- Travel/foreign
- Music
- Romance
- N/A

Advert categorisation
- Opening hours, parking etc
- Menu – full without kids menu
- Menu – full with kids menu
- Menu/meal options i.e. Early bird, Sunday
- Food/drink available – insufficient information what
- Logo/brand image
- Food/drink available/choices/broad type categories*
- Food/drink product*
- Food/drink image*
- Food/drink available/broad type categories & image*

only continue analysis if option marked

Brand Name

Food/Drink advertised as:
- Main feature
- By proxy

Eatwell Category
- Carbs.
- Fruit + veg
- Protein
- Dairy
- HFSS
- Drink
- Mixed (>3 categories)
- HFSS mixed (>3)
- Other ________

Food/Drink type
- Bread & prods
- Breakfast cereals (sugared Y or N)
- Breakfast meal
- Cake/biscuit/desrt
- Cheese & butter
- Confectionary
- Ice cream
- Fast food
- Fast food outlet
- Fruit & vegetables
- Main meal
- Meat, fish, eggs
- Potatoes/pasta
- Pre-prepared convenience food
- Sandwich
- Savoury snacks
- Mixed (if >3 categories)
- Yoghurt/diary desert
- Alcohol
- Energy drinks
- Milk
- Soft drinks
- Tea/coffee
- Water
- Other__________

Unique selling point
- Athletic ability/performance benefit
- Convenience
- Cool
- Expertise producers/makers/sellers
- Fresh
- Friendship/social success
- Fun
- Health/nutrition benefit
- Premium/quality/tradition
- Price
- Promotion i.e. deals, BOGOF, holiday
- Scientific information/innovation
- Special diet
- Size packaging
- Taste
- No/unclear
- Other______________________

Target audience:
- Pre-school child
  Feature preschool children/babyish
- Child including 10-11 years*
  Fun, fantasy + adventure themes
- Adolescent/teen
  Fashion, image + sexuality themes
- Parent
  Parental theme
- General population
  Range ages/unclear target audience

*** Theme (only if targeted at children)**
- Cartoon
- Central figure child
- Central figure adult
- Brand character (i.e. Coco pops)
- Celebrity (human/cartoon)
- Fantasy (i.e. superhuman)
- Humour
- Magic
- Play
- Action-adventure
- Other__________

Other comments

Figure 90: Outdoor Food and Drink Advertising Tool

For OFDAAT Manual refer to the Appendices Disk

Children's Neighbourhood Environment Study (CNES)
~ Parent Questionnaire ~

Please take a few minutes to fill in this survey about yourself and your child. Tick the answer which best describes your agreement or behaviour with the statements given. Answer as honestly as possible – there are no right or wrong answers.

All data is entirely anonymous and strictly confidential.

When you have completed the questionnaire please return it to school

Child's Participant ID ☐

Child's ethnic group _________________

What is your relationship to the child participating in CNES?

☐ Mother	☐ Guardian Male	☐ Childminder
☐ Father	☐ Grandparent	☐ Other
☐ Guardian Female	☐ Sibling	_______________

What is your height?

____

What is your weight?

____

What is your highest academic achievement?

☐ N/A ☐ GCSE ☐ A or O level ☐ GNVQ level ___ ☐ Undergraduate degree ☐ Postgraduate degree

To what degree do you agree with these statements?

	Disagree Strongly	Disagree	Agree	Agree strongly
There are strict rules my child must follow	☐	☐	☐	☐
There are rules my child and I make and they follow them	☐	☐	☐	☐
My child can easily persuade me	☐	☐	☐	☐
My child does or gets what they want	☐	☐	☐	☐

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1. Neighbourhood Environment
Tick the statement that best describes your agreement

	Disagree Strongly	Disagree	Agree	Agree strongly
I am happy for my child to be alone, or with friends unsupervised, in the neighbourhood	☐	☐	☐	☐
There are many places to go within easy walking distance of my house	☐	☐	☐	☐
There are lots of shops & services within walking distance of my house	☐	☐	☐	☐
There are lots of recreation opportunities & services within walking distance of my house	☐	☐	☐	☐
I am happy with the number & quality of food outlets in my local neighbourhood	☐	☐	☐	☐
There are lots of public transport options & routes within walking distance of my house	☐	☐	☐	☐
There are lots of walking routes within my neighbourhood enabling walking to places	☐	☐	☐	☐
Cycle tracks & pedestrian trails in or near my neighbourhood are easy to get to	☐	☐	☐	☐
My neighbourhood is generally rubbish free	☐	☐	☐	☐
The streets in my neighbourhood are well maintained (i.e. paved, not a lot of cracks)	☐	☐	☐	☐
My neighbourhood is attractive (i.e. buildings, planting & natural sights)	☐	☐	☐	☐
Traffic speed on the street & nearby streets that I live on is usually slow (<30 mph)	☐	☐	☐	☐
There is so much traffic in my neighbourhood that it makes it difficult or unpleasant to walk	☐	☐	☐	☐
My neighbourhood streets are well lit	☐	☐	☐	☐
There is a high crime rate in my neighbourhood	☐	☐	☐	☐
	Rarely	**Sometimes**	**Usually**	**Always**
I walk/cycle in my local neighbourhood	☐	☐	☐	☐
I walk/cycle with my child in my local neighbourhood	☐	☐	☐	☐
My child walks or cycles to school	☐	☐	☐	☐
I encourage my child to walk/cycle to school	☐	☐	☐	☐

2. Physical Activity
Tick the statement that best describes your agreement

	Rarely	Sometimes	Usually	Always
I enrol my child in sports teams & clubs such as football, basketball & dance	☐	☐	☐	☐
I enrol my child in community-based programs (i.e. Scouts & Guides) where he/she can be active	☐	☐	☐	☐
I find ways for my child to be active when school is out by, for example enrolling him/her in summer camp & after school programs	☐	☐	☐	☐
I encourage my child to use resources in our neighbourhood to be active (i.e. park, green space, school or playground)	☐	☐	☐	☐
I take my child to places where he/she can be active	☐	☐	☐	☐
I watch my child play sports or participate in activities such as football, dance & karate	☐	☐	☐	☐
I encourage my child to be physically active by leading by example (by role-modelling)	☐	☐	☐	☐
I exercise or am physically active on a regular basis	☐	☐	☐	☐
I enjoy exercise & physical activity	☐	☐	☐	☐
I limit how long my child plays video games (including Playstation, Xbox & Gameboy)	☐	☐	☐	☐
I limit how long my child can watch TV or DVDs each day (including educational & non-educational programs)	☐	☐	☐	☐
	Disagree Strongly	**Disagree**	**Agree**	**Agree strongly**
I think the local leisure centre offers good age-appropriate services for my child	☐	☐	☐	☐
I think the local leisure centre offers lots of good classes for my child	☐	☐	☐	☐
I think the local leisure centre offers value for money for my child	☐	☐	☐	☐

What is the name of the leisure centre your child uses most

____

3. Food and Diet
Tick the statement that best describes your agreement

	Rarely	Sometimes	Usually	Always
My child eats breakfast	☐	☐	☐	☐
My child eats fast food/takeaway with our family	☐	☐	☐	☐
My child eats snacks without permission	☐	☐	☐	☐
My child eats meals in front of the TV/computer	☐	☐	☐	☐
My child eats at the dining table	☐	☐	☐	☐
I eat healthy snacks or meals in front of my child	☐	☐	☐	☐
I use food to reward my child	☐	☐	☐	☐
My child has to eat all the food on his/her plate	☐	☐	☐	☐
If my child dislikes something I tell him/her that he/she will get desert if they eat it	☐	☐	☐	☐
When my child does not like something he/she gets something they do like	☐	☐	☐	☐
My child has limited portion sizes at mealtimes	☐	☐	☐	☐
I keep sugary drinks/snacks where they can be easily seen/reached by my child	☐	☐	☐	☐
I keep fruits & vegetables where they can be easily seen/reached by my child	☐	☐	☐	☐
If my child asks for sugary drinks/snacks I give them to him/her	☐	☐	☐	☐
If my child asks for fruits & vegetables I give them to him/her	☐	☐	☐	☐
How often do you tell your child that confectionary/sugary drinks are bad for their teeth or will lead to weight gain or are unhealthy	☐	☐	☐	☐
How often do you tell your child that eating fruit & vegetables is good/healthy?	☐	☐	☐	☐

Thank you for completing this survey. Please return it to school with your child

Figure 91: Parent/ Guardian Attitude, Perception and Behavioural Survey

For full sized Parent/ Guardian Survey refer to the Appendices Disk

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